L. 109 JANUARY & FEBRUARY, 1998 US ISSN 0013-872X
NO. 1

ENTOMOLOGICAL NEWS

SCIENTIFIC NOTES:

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.

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(Continued on inside of back cover)

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DISPERSAL AND RANGE EXPANSION OF AN INTRODUCED SAND WASP, *OXYBELUS BIPUNCTATUS* (HYMENOPTERA: SPHECIDAE), IN NORTHEASTERN NORTH AMERICA[1]

Frank E. Kurczewski[2]

ABSTRACT: Range expansion of an introduced sphecid, *Oxybelus bipunctatus*, is traced through the northeastern United States and southeastern Canada. This species apparently is displacing *O. uniglumis quadrinotatus*, a species with similar behavior and ecology, in abundance as it moves northward through the Great Lakes Region, St. Lawrence River Valley, and Maritime Provinces to become the most common *Oxybelus* in small inland sandy areas. Its southward dispersal probably is limited by climatic, ecological and edaphic factors such as high summer and warm winter temperatures, thermal soil temperature regime, and absence of appropriate sandy soils.

Oxybelus bipunctatus Olivier is a small digger wasp that usually excavates 1- and 2-celled nests in sandy soil, impales adult flies on its sting, removes the temporary nest closure with the fly still impaled, and stocks its cells mostly with several male Brachycera and/or Cyclorrapha (Peckham et al. 1973; Krombein 1979; Kurczewski 1996). This wide ranging Holarctic species evidently was accidentally introduced into the northeastern United States from Europe before 1935 (Pate 1943; Krombein 1979), perhaps in ship ballast or molding sand deposited dockside. Based upon insect museum specimens, the earliest dates of its occurrence in North America are 1935 from Essex County, New Jersey and Hampden County, Massachusetts, and 1936 from Suffolk County, New York (Table 1). By the 1940's *O. bipunctatus* was firmly established in the Middle Atlantic Region and New England (Pate 1945, pers. obs.). Since that time the range of this species has been expanding primarily northward, most recently into western upper Michigan, central Wisconsin, and Nova Scotia.

Within 10 years of its introduction into the U. S., the range of *O. bipunctatus* extended to Washington, D. C., a distance of over 300 km from its first North American collection locality (Fig. 1). In only 20 years' time, this species dispersed to North Bay, Ontario and central lower Michigan, a distance of 660-900 km. In less than 50 years, *O. bipunctatus* moved as far west as western upper Michigan and central Wisconsin, a distance of 1,250 km. On a smaller scale, this species dispersed from Ottawa to North Bay, Ontario, probably across sandy sections of the Ottawa-Mattawa River Valley,a distance of about 300 km,

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[1] Received March 21, 1997. Accepted June 29, 1997.

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in nine years (1947-1956). *Oxybelus bipunctatus* moved from Clinton County to Ogemaw County, Michigan, a distance of about 170 km, in five years (1954-1959). Using these durations and distances as gages of dispersal, the rate of movement of *O. bipunctatus* amounted to approximately 30-45 km per year assuming the species was not transported to these regions by some means other than its own flight. This is a remarkably rapid rate of dispersal for a species limited to short flights by its small size and stocky build, although the possibility of wind carriage should not be overlooked.

In only a half century, this species dispersed through New England to the Maritime Provinces (New Brunswick, Nova Scotia) and St. Lawrence River Valley (southern Quebec), across the Great Lakes Region (upstate New York, southern Ontario, northwestern Pennsylvania, northern Ohio, upper and lower Michigan, central Wisconsin), and down the Atlantic Coastal Plain to Maryland, District of Columbia, and northern Virginia (Table 1, Fig. 1). The lack of specimens of *O. bipunctatus* from southern Ohio and southern Virginia indicate that its southward dispersal may be climatically and ecologically limited by factors such as high summer and warm winter temperatures and/or thermal soil temperature regime (USDA 1984), or it may simply reflect inappropriate habitat (soils) for this species in these areas.

Despite its adventive status, *O. bipunctatus* is one of the most common sphecids in small inland sandy areas in the northeast (Kurczewski and Harris 1968; Kurczewski and Acciavatti 1990). O'Brien (1996 pers. comm.) found it to be the most numerous species of *Oxybelus* in Malaise traps at the Huron Mountain Club, Marquette County, Michigan beginning in the early 1980's (Fig. 1). McCorquodale (1997 pers. comm.) indicated that this species is more common than any other species of *Oxybelus* in sandy areas on Cape Breton Island, Nova Scotia. Its abundance in these regions probably can be attributed to cold hardiness, long flight season, relatively short generation time, wide prey selection (Peckham et al. 1973; Krombein 1979; Kurczewski 1996), scarcity of natural enemies (Spofford and Kurczewski 1990), and ubiquity in nesting habitat. *Oxybelus bipunctatus* nests opportunistically in such varied places as flower pots, children's sand boxes, temporary highway sand piles, and the sand bases of swimming pools. Because of its small size and capability to nest shallowly in soil, it is an excellent candidate for transport by human means from one place to another including transoceanic portage.

Although quantitative data are unavailable, *O. bipunctatus* apparently is supplanting *O. uniglumis quadrinotatus* in abundance in sandy and gravelly areas as it disperses northward through the Great Lakes Region, St. Lawrence River Valley, and Maritime Provinces. The displacement in upstate New York began rather suddenly during the 1950's (Evans 1960 pers. comm.). *Oxybelus bipunctatus* appeared in the Ithaca, New York area as early as 1937 (Pate 1943), possibly transported there by human means, and by the 1960's it was flourish-

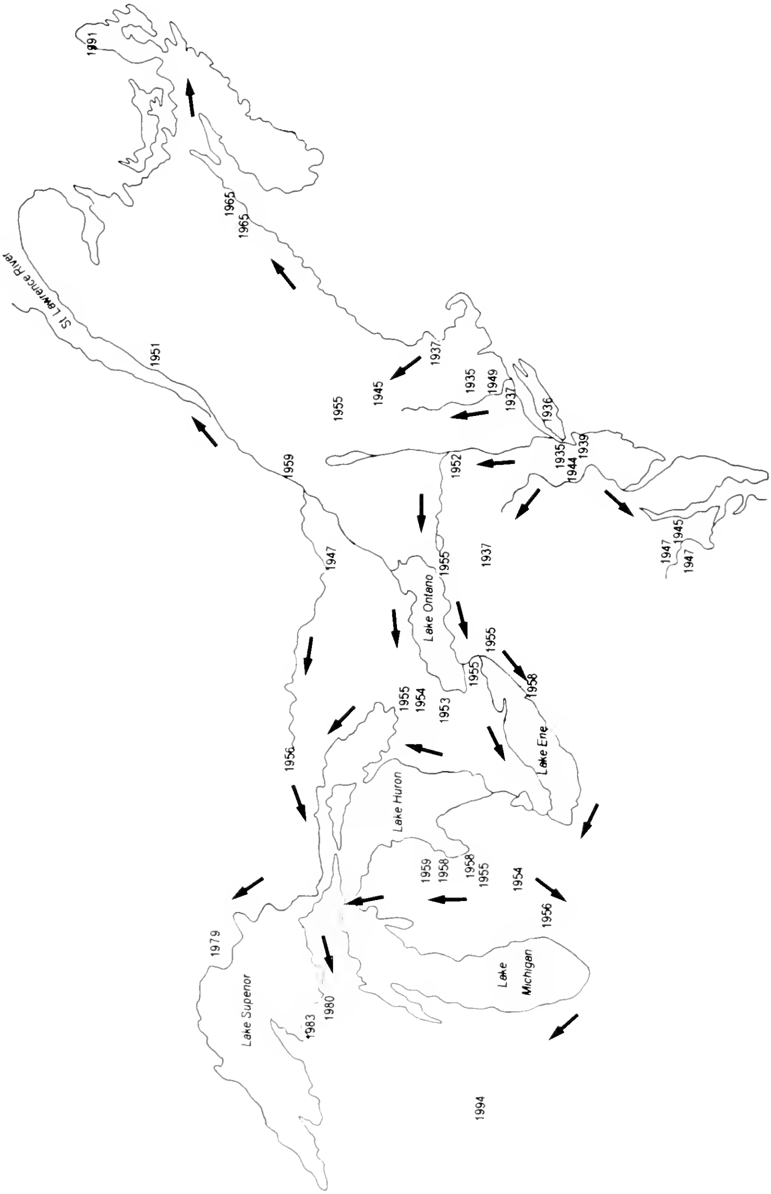

Fig. 1. Regional dispersal of *Oxybelus bipunctatus* by year of collection. Arrows indicate probable dispersal pathways.

ing in small inland sandy areas of upstate New York (Kurczewski and Harris 1968; Peckham et al. 1973; Kurczewski and Acciavatti 1990). *Oxybelus bipunctatus* is now the most abundant member of the genus in northeastern United States and southeastern Canada (pers. obs.). Some nesting aggregations

Table 1. Pre-1955 dates and localities of collection of *Oxybelus bipunctatus* arranged in chronological order.

DATE	LOCALITY	SOURCE
July 4, 1935	Bloomfield, Essex County, NJ	AMNH
July 29, 1935	Holland, Hampden County, MA	MCZ
June 7, 1936	Half Hollows, Suffolk County, NY	Pate 1943
July 11, 1937	Reading, Middlesex County, MA	MCZ
August 2, 1937	Durham, Middlesex County, CT	MCZ
August 2, 1937	Ithaca, Tompkins County, NY	Pate 1943
August 31, 1939	Kearny, Hudson County, NJ	AMNH
July 2, 1944	Princeton, Mercer County, NJ	USNM
May 4, 1945	Stinson Lake, Grafton County, NH	CU
July 23-25, 1945	Washington, DC	USNM
July 24, 1945	Washington, DC	Pate 1945
June 23, 1946	Princeton, Mercer County, NJ	USNM
[F12], 1947	Princeton, Mercer County, NJ	USNM
June 11-July 15, 1947	Washington, DC	USNM, MSU
June 22-29, 1947	Arlington, Fairfax County, VA	USNM
June 27, 1947	Silver Springs, Montgomery County, MD	USNM, UCD
July 3, 1947	Ottawa, Municipality of Ottawa-Carleton, ONT	CNC
June 15, 1949	East Hartford, Hartford County, CT	CU
July 14, 1951	Parke Reserve, Kamouraska County, QUE	CNC
July 22, 1952	Rensselaerville, Albany County, NY	USNM
June 7-August 20, 1953	Ithaca, Tompkins County, NY	MCZ, USNM
July 26, 1953	Guelph, Wellington County, ONT	UG
June 25, 1954	Guelph, Wellington County, ONT	UG
July 8, 1954	Clinton County, MI	MSU
July 9, 1954	Orangeville, Dufferin County, ONT	UG
September 8, 1954	Ithaca, Tompkins County, NY	MCZ

Abbreviations for insect museums are as follows: AMNH, The American Museum of Natural History; CNC, Canadian National Collection; CU, Cornell University; MCZ, Museum of Comparative Zoology, Harvard University; MSU, Michigan State University; UCD, University of California-Davis;UG, University of Guelph; and, USNM, United States National Museum.

of this species number several hundred individuals (Peckham et al. 1973; Kurczewski and Acciavatti 1990).

Why is *O. bipunctatus* displacing *O. uniglumis quadrinotatus* in the northeastern United States and southeastern Canada? Although the two species seemingly have identical nesting behaviors and similar ecological requirements (Peckham et al. 1973), *O. uniglumis quadrinotatus* is almost twice the size of O. *bipunctatus*. Because of this size difference the two species might be expected to prey upon different families, genera and species of flies. However, they capture some of the same groups of prey with *O. uniglumis quadrinotatus* taking a slightly greater proportion of Cyclorrapha and fewer Brachycera than *O. bipunctatus*. Within the suborder Cyclorrapha, there is some predation on the same species of flies (Peckham et al. 1973; Krombein 1979). *Oxybelus uniglumis quadrinotatus* never captures Nematocera while *O. bipunctatus* occasionally preys upon mosquitos, midges, and blackflies (Evans 1963; Kurczewski 1996). A broader spectrum of prey, smaller size and inconspicuousness, potentially fewer predators, and a lower rate of cleptoparasitism (Spofford and Kurczewski 1990) are some reasons why *O. bipunctatus* is more successful and, therefore, more numerous than *O. uniglumis quadrinotatus* in many sandy areas of the northeastern U. S. and southeastern Canada.

ACKNOWLEDGMENTS

The following persons provided specimens, collection data, and/or abundance information for *O. bipunctatus*: Bert Finnamore, Alberta Provincial Museum; Rick Hoebeke, Cornell University; Michael Kelly, Museum of Comparative Zoology, Harvard University; Lynn Kimsey, University of California-Davis; Steve Krauth, University of Wisconsin-Madison; Lubomir Masner, Canadian National Collection; David McCorquodale, Guelph University, Nova Scotia Natural History Museum, and University College of Cape Breton; Ron McGinley and Arnold Menke, United States National Museum; Mark O'Brien, Museum of Zoology, The University of Michigan; Mark Snethurst, The American Museum of Natural History; Andrey Sharkov, The Ohio State University; Jeff Skevington, Pinery Provincial Park; Don Snitgen, Northern Michigan University; and John Willerding, Michigan State University. I am grateful to David McCorquodale and two anonymous reviewers for critically reviewing the manuscript. Julie Cushine-Rigg finalized Figure 1.

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SCIENTIFIC NOTE

EUHRYCHIOPSIS LECONTEI (COLEOPTERA: CURCULIONIDAE): A NEW STATE REPORT FOR INDIANA[1]

R.D. Waltz[2], G.M. White[3], R.W. Scribailo[4]

The range of the native North American aquatic weevil species *Euhrychiopsis lecontei* (Dietz) is poorly documented (Sheldon and O'Bryan 1996) although it has been reported from coast to coast in various northern and central states including Iowa, Michigan, Wisconsin, Alberta, British Columbia, and Saskatchewan (O'Brien and Wibmer 1982), Washington (Creed and Sheldon 1994), Minnesota (Newman and Maher 1995), and Connecticut, Illinois, Massachusetts, New York and Vermont (Sheldon and O'Bryan 1996). Because this species is recognized as a potentially effective endemic biological control agent of watermilfoils (Haloragaceae: *Myriophyllum* spp.) (Creed and Sheldon 1993; Sheldon and O'Bryan 1996), records of its distribution are of special interest to those managing lakes and to those who have an interest in the documentation of insect faunae within regional or politically delineated contexts.

Euhrychiopsis lecontei has not been reported previously from Indiana (above citations; Blatchley and Leng 1916; Downie and Arnett 1996). Herein, we report the first known record of this species in Indiana. Voucher specimens were taken from: In: LaPorte Co., Saugany Lake, May 16, 1997, G.M. White, collected in association with Eurasian watermilfoil (*Myriophyllum spicatum* L.). Voucher specimens have been deposited at Purdue University Entomological Research Collections, West Lafayette, Indiana.

Adults were collected and numerous eggs were observed on the stem apices of Eurasian

(continued on page 14)

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[1] Received June 7, 1997. Accepted July 4, 1997.

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RELATIONSHIP OF CELL DEPTH AND SOIL MOISTURE IN *OXYBELUS BIPUNCTATUS* (HYMENOPTERA: SPHECIDAE)[1]

Frank E. Kurczewski, Donna L. Wochadlo[2]

ABSTRACT: Nests of *Oxybelus bipunctatus* were excavated and cell depth measured in control and experimentally watered plots in a recently bulldozed sandy field in central New York in June 1987. There was a trend for cell depth to be inversely related to soil moisture under natural conditions and in artificially watered replicates.

Soil moisture content is extremely critical for the survival of the immature stages of ground inhabiting solitary wasps. Too little moisture in the soil results in dessication of the paralyzed prey in the cells and the eventual death of the wasp egg or larva. Too much soil moisture increases the likelihood of mold development in the cell and this, too, can destroy the cell contents and wasp egg or larva. A delicate balance in the amount of soil moisture is necessary for the immature stages of the wasps to develop properly. Many physical and biotic factors influence soil moisture content and regulate cell environment. Cell depth and amount of precipitation are two such factors that can be readily measured without elaborate or expensive equipment. The present study is an attempt to investigate the relationship between the amount of rainfall, depth of soil moisture line, and cell depth in a ground-nesting sphecid, *Oxybelus bipunctatus* Olivier.

Oxybelus bipunctatus, a species adventive from Europe (Pate 1943, 1945; Krombein 1979; Kurczewski 1998), is one of the most common digger wasps in the northeastern U. S. (Kurczewski and Harris 1968; Kurczewski and Acciavatti 1990). Ubiquity in nesting habitat, a long and continuous flight period involving two or three generations per year, and high nest density make this species an excellent subject for studying nesting behavior in a solitary wasp. Peckham et al. (1973) investigated the behavior of *O. bipunctatus* over three years. Although they carefully measured nest dimensions, these authors did not examine the relationship between cell depth and soil moisture content. Kurczewski (1996) noted the difference in cell depth of *O. bipunctatus* between localities in central New York and northwestern Pennsylvania but he, too, did not account for soil moisture level. In a 15 weeks-long investigation of *O. bipunctatus* at a site in upstate New York, the same author (in prep.) observed weekly fluctuation in cell depth that seemed to be linked to soil moisture level

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[1] Received March 20, 1997. Accepted June 27, 1997.

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as influenced by the amount of rainfall. The present study is an extension of this finding. Using measurements of rainfall, soil moisture line, and cell depth, we tried to corroborate Kurczewski's (in prep.) results. By artificially adding water to designated sand plots, we attempted to demonstrate a relationship between soil moisture content and cell depth.

MATERIALS AND METHODS

A recently bulldozed sandy field in northwestern Madison County, New York, 5.6 km NW of Chittenango, a site used previously by Spofford et al. (1986) for a study on the cleptoparasites of another sphecid, *Tachysphex terminatus* (Smith), was selected as the study area. Natural conditions were monitored during 5-15 June 1987. This involved collecting and measuring the amount of rainfall from the previous day(s) and/or night(s) in mm, taking air (shade), sand surface and cell depth temperature in degrees C, and noting any change or disturbance to the area. Morning activity of individual wasps was correlated with air and cell depth temperature.

Females were observed digging burrows in the morning on 5, 6, 10, 11, and 14 June 1987, and their nest entrances were marked with color-coded toothpicks after completion of the temporary nest closures. (The wasps themselves were too small to color-code).

The cells were excavated the following morning or afternoon after the wasps completed their final closures, measurements were taken, and new nests were found and marked for the next day, weather permitting.

The relationship between cell depth and soil moisture line, a readily visible band of dark moist sand underlying a layer of light colored dry sand (Kurczewski in prep.), was examined for 35 of the cells. Depths of soil moisure line and cell to its bottom were measured with a metric ruler and recorded in mm. Depths of 53 other cells were also measured and recorded. Each excavation was then levelled flush with the surrounding sand and lightly packed down to encourage renesting.

Two areas of bare sand of equal size were selected and each area divided into control and experimental plots (Fig. 1). The selection of these areas was based upon local topography, lack of vegetation, and density of nesting wasps. One area was divided in half by a north-south line into 240 X 280 cm plots and labelled NC (North Control) and NE (North Experimental). The other area was divided in half by an east-west line into 480 X 140 cm plots and labelled SC (South Control) and SE (South Experimental). The direction of division into control and experimental plots coincided with slight slopes in the respective areas and was an attempt to eliminate any variables.

On June 16, we artificially watered the experimental plots to achieve a soil moisture level sufficiently higher than that in the control plots yet not inhibit wasp excavation or create soil surface run-off. Using a 1.5 gal sprinkling can, we evenly applied 10 gallons of water to each experimental area in rows 20 cm wide beginning at 0920 hrs (EDT). Prior to watering, five 50 ml plastic graduated cylinders were set into the sand in each experimental plot, four of them each 30 cm in from a corner and one directly in the center of the plot (Fig. 1).

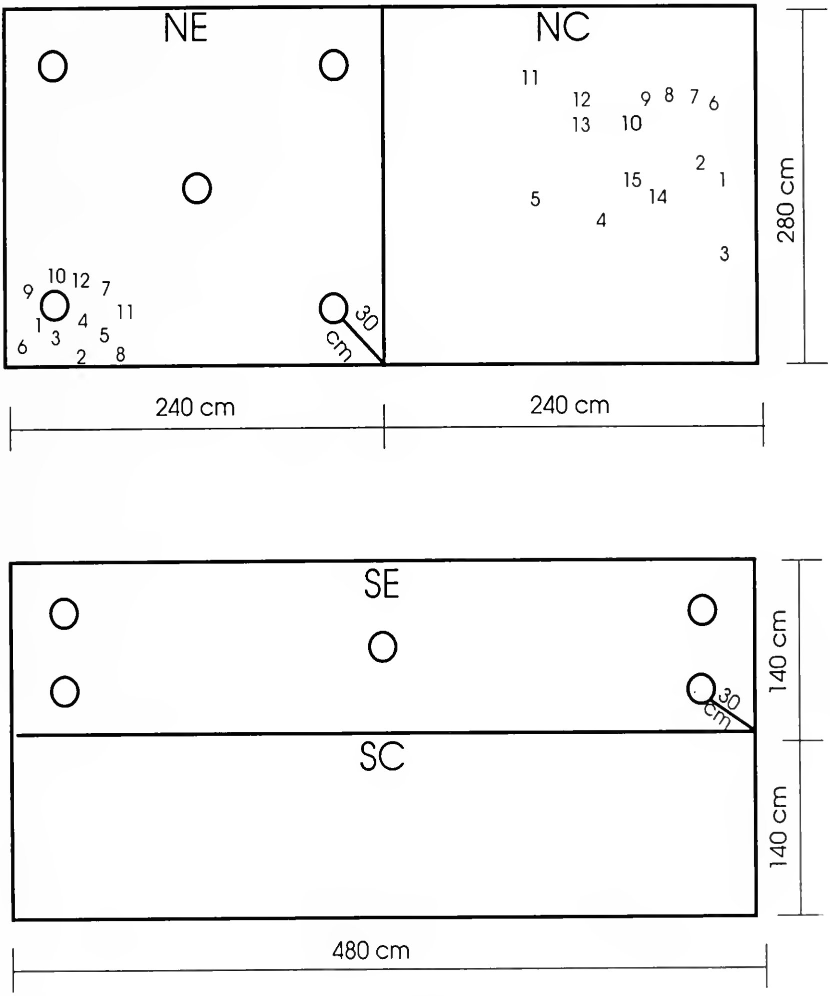

Fig. 1. Design of control (NC, SC) and experimental (NE, SE) plots in *Oxybelus bipunctatus* study area. Circles represent graduated cylinders set into sand to collect water. Numbers in NE and NC are locations of nest entrances sequentially marked on 24 June 1987.

The relative uniformity of our watering technique was reflected in the amount of water collected by the graduated cylinders: (NE), 4.0, 4.5, 6.0 (central), 5.0, 5.0 ml; and, (SE), 5.0, 4.0, 4.0 (central), 4.5, 5.0 ml.

On 24 June, we applied 20 gal of water to the NE plot utilizing the same technique, except the application was made between 2000-2100 hrs. We felt that an application at dusk would substantially decrease water evaporation from the sand surface and, by doubling the amount of water put into the soil, the wasps might dig significantly shallower nests in this plot. After the application, each of the five plastic graduated cylinders placed in the plot contained 7.5-8.0 ml of water. We intended to similarly water the SE plot the same evening, but it had been severely disturbed the previous night by a truck carrying a bulldozer and was abandoned for further use.

RESULTS

Temperature and rainfall. Only five of the 11 days (see above) set aside to study *O. bipunctatus* under natural conditions were suitable for wasp nesting. During these days, air temperatures averaged 22.8° C (18-25° C, n=5) and soil temperatures at cell depth averaged 26.7° C (23-31° C, n=5) at 1100 hrs (EDT). The six other days set aside for study under natural conditions were non-conducive for wasp nesting because of cool temperatures, cloud cover, and rain. It rained sporadically in three and heavily during two of the days (Fig. 2).

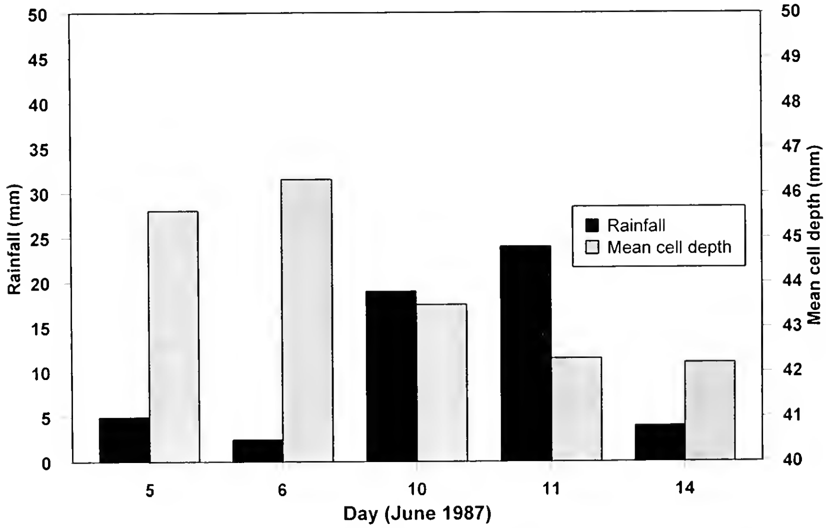

Fig. 2. Amount of rainfall and mean cell depth in *Oxybelus bipunctatus* study area, 5-14 June 1987. Amount of rainfall is a measurement from previous day(s) and/or night(s).

The average air and mean cell depth temperatures on these mornings at 1100 hrs (EDT) were only 17.2° C (15-18° C, n=6) and 21.1° C (18-22° C, n=6), respectively.

Soil moisture line. The soil moisture line was indistinguishable from the overlying sand on days when it rained heavily. On non-rainy days, this line was clearly visible and cells were invariably excavated below it in moist sand. There was an imperfect positive correlation between soil moisture line and cell depth (Fig. 3). In some nests, the soil moisture line to cell depth value was more disparate than in other nests (Fig. 3).

Cell depth. Females excavated fewer and deeper nests in drier soil. They dug clumped and shallower nests in moister soil. Nests excavated in neither dry nor wet sand were intermediate in depth and more evenly distributed than nests in wet or dry sand (Figs. 1, 2). Mean cell depth and amount of rainfall from the previous day(s) and/or night(s) were inversely related (Fig. 2). In early to mid-June, slight increases or decreases in mean cell depth followed corresponding decreases or increases, respectively, in the amount of rainfall (Fig. 2). For example, shallowness in mean cell depth on 10, 11 and 14 June was probably linked to a substantial amount of rainfall and increased soil moisture content on 10-11 June. Nests excavated during 5-14 June under natural conditions had, on average, shallower cells ($\bar{x}$=44.4±5.38 mm; n=88; Fig. 2), albeit not significantly so, than control plot nests dug on 16-24 June ($\bar{x}$=47.3±6.29 mm; n=67; Table 1). This difference probably was due to the different amounts

Table 1. Cell depth of *Oxybelus bipunctatus*, control and experimental plots, 16-24 June 1987.

Site Information		Cell Depth (mm)		
Date	Plot	n	Range	Mean
6/16/87	NC	10	38-59	46.6+5.99
6/16/87	SC	10	38-58	47.8+6.23
6/17/87	SC	17	38-56	45.8+5.54
6/17/87	SE	10	26-45	37.8+8.16
6/17/87	NC	15	35-55	48.1+5.79
6/17/87	NE	11	37-65	45.2+8.22
6/24/87	NC	15	34-63	48.2+7.88
6/24/87	NE	12	39-61	47.6+6.77

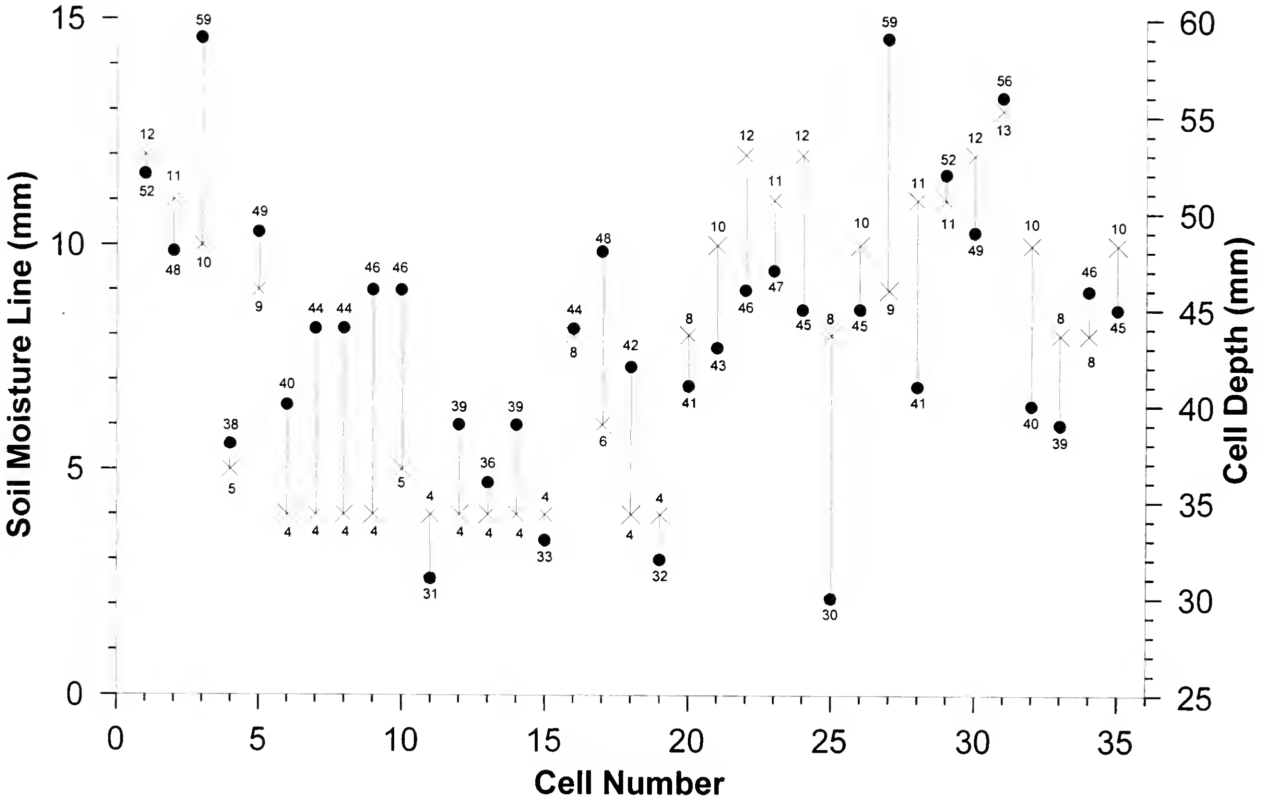

Fig. 3. Difference between soil moisture line and cell depth in *Oxybelus bipunctatus* nests, 5, 14 June 1987. Measurements are in mm below sand surface, X representing soil moisture line and ● cell depth; vertical line indicates difference in the two measurements.

of rainfall during these times of the month (5-14 June, 54.5 mm; 16-24 June, 45.7 mm).

Mean cell depth for 16 June NC and SC nests was similar (t=0.0793, df=18, $\alpha>0.20$) (Table 1). On 17 June, wasps excavated significantly deeper cells in SC than in SE (t=3.0415, df=25; $\alpha<0.01$) (Table 1). There was no significant difference in mean cell depth between two samples each comparing NC and NE nests (June 17, t=1.0572, df=24, $\alpha>0.20$; June 24, t=0.0397, df=25, $\alpha>0.20$), although the wasps did excavate slightly shallower cells in both NE plots (Table 1). All nests (n=12) in NE excavated on 24 June were clustered downslope in the SW corner in moist sand (Fig. 1).

DISCUSSION

Few studies on fossorial sphecid wasps considered the influence of relative soil moisture on cell depth. Moisture gradient influenced cell depth throughout the nesting season in *Microbembex nigrifrons* (Provancher). Deeper cells were dug in drier and shallower cells in wetter sand (Alcock and Ryan 1973). Soil moisture level was related to cell depth in *Ammophila harti* (Fernald). Cells excavated in drier sand remained deeper than those dug in wetter sand regardless of generation of wasp (Hager and Kurczewski 1986). Cell depth and, less so, soil moisture line closely followed an increase or decrease in relative soil moisture, as governed by the amount of rainfall, throughout the nesting season in *Oxybelus bipunctatus* at one locality in central New York (Kurczewski in prep.).

In the present study, both soil moisture line and cell depth were inversely related to the amount of rainfall. There was, however, an imperfect positive correlation between soil moisture line and cell depth with some values being more disparate than others, even in perfectly flat sand. Regardless of possible flaws in the experimental design, shallower cells were usually excavated in moister and deeper cells in drier sand. However, only one control versus experimental plot sample was conclusive. In this comparison, SE cells in artificially watered sand were excavated at significantly shallower depths than SC cells.

ACKNOWLEDGMENTS

We thank M. G. Spofford for assisting with field work on the last day of the study. We are grateful to D. J. Peckham for reading the manuscript critically. Use of a college vehicle was made possible through an NYS-UUP Faculty Development Award to the senior author.

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(continued from page 6)

watermilfoil. Based on the observation of adult activity in May and the presence of numerous eggs, we believe *E. lecontei* is established in Indiana and we anticipate that the biology of *E. lecontei* in Indiana will be very similar to that reported by Sheldon and O'Bryan (1996).

ACKNOWLEDGMENTS

We thank C.W. O'Brien and Peter Kovarik, Florida A&M, for providing comparative material to confirm our identification of the species, and thank David Barnes, Mitchell Alix, and Bob Jankowski, Purdue University North Central, for assisting in making collections of this species.

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ADVENTIVE LADY BEETLES (COLEOPTERA: COCCINELLIDAE) IN EASTERN NOVA SCOTIA, CANADA[1]

D. B. McCorquodale[2]

ABSTRACT: Specimens in three small insect collections document the arrival of four species of adventive lady beetles in Nova Scotia. All four have experienced dramatic range expansions in eastern North America in the past 25 years. *Coccinella septempunctata* arrived by 1984 and by the 1990's was the most common coccinellid in disturbed habitats on Cape Breton Island, NS. The more recent arrivals in Nova Scotia of *Propylea quatuordecimpunctata* (1990), *Harmonia axyridis* (1995) and *Hippodamia variegata* (1996) are reported.

Several species of lady beetles have become established in North America after either accidental or intentional introductions in the past 25 years (Gordon 1985; Gordon and Vandenberg 1991). Populations of some of these introduced species have burgeoned to the extent they have the potential to change dramatically populations of both native and other introduced lady beetles (e.g. Tedders and Schaefer 1994; Wheeler and Hoebeke 1995). Coccinellids deserve attention so that we can document which introduced species become established, the speed of range expansion and major changes in populations.

Recently, Hoebeke and Wheeler (1996) recorded the range expansion of adventive lady beetles in the Maritime provinces of Canada through the summer of 1995. Here I provide updated information from eastern Nova Scotia on three of the four species they reported, *Propylea quatuordecimpunctata*, *Hippodamia variegata* and *Harmonia axyridis*, and information on a species established earlier, *Coccinella septempunctata*.

METHODS

All specimens of Coccinellidae in the small insect collections at the University College of Cape Breton, Sydney, Nova Scotia (UCCB), St. Francis Xavier University, Antigonish, Nova Scotia (STFXU), and the Nova Scotia Department of Natural Resources, Belmont, Nova Scotia (NSDNR) were examined. Identifications were based on Gordon (1985), Gordon and Vandenberg (1991), and comparison with specimens in the University of Guelph Collection, Guelph, Ontario. Representative specimens will be deposited in the Canadian National Collection, Ottawa, Ontario and/or the Nova Scotia Museum of Natural History, Halifax, Nova Scotia.

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[1] Received June 6, 1997. Accepted July 19, 1997.

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ENT. NEWS 109(1): 15-20, January & February, 1998

RESULTS

Coccinella septempunctata L.: Since 1973 this species has spread over most of the continental United States and southern Canada (Gordon and Vandenberg 1991). Schaefer et al. (1987) reported it in Nova Scotia in 1985. Collections from mainland Nova Scotia in 1984 and Cape Breton Island in 1985 demonstrate that the species was widespread in the province by 1985.

Additional Locality Records:
Cumberland County, Chignecto, 5 June 1984, E. Georgeson, NSDNR; Cape Breton County, Sydney, 26 August 1985, S. Tynski, UCCB; Cape Breton County, Sydney, 16 May 1986, S. Tynski, UCCB

Since 1990, students at the University College of Cape Breton have collected 171 specimens in the subfamily Coccinellinae. Collections are largely from disturbed or anthropogenic habitats in the Sydney-Glace Bay area of Cape Breton Island. About half of these specimens are *Coccinella septempunctata* (86 or 50%), while native species are the next four most frequently collected: *Adalia bipunctata* (24, 14%), *C. trifasciata* (19, 11%), *Anatis mali* (10, 6%) and *Psyllobora vigintiduopunctata* (9, 5%).

Propylea quatuordecimpunctata (L): This species was established in Quebec by 1968, had spread to Maine by 1988 and since then to much of the northeastern United States (Day et al. 1994). There is a strong probability that an independent establishment occurred in lower New York State in the mid-late 1980's (Yanega 1996). Hoebeke and Wheeler (1996) provide the first report for Nova Scotia and record collections from Cape Breton Island in 1995. Collections in the summer of 1996 from Cape Breton and Antigonish Counties indicate that it is now established in eastern Nova Scotia.

Additional Locality Records:
Cape Breton County, Georges River, 8 June 1996, DB McCorquodale, UCCB; Cape Breton County, Sydney, UCCB Campus, 4 September 1996, S. Berrigan, UCCB; Cape Breton County, Sydney, 5 September 1996, T. Rideout, UCCB; Antigonish County, Pomquet, 05 June 1996, R. Lauff, STFXU; Antigonish County, Pomquet, 22 July 1996, R. Lauff, STFXU; Antigonish County, Pomquet, 21 August 1996, R. Lauff, STFXU; Antigonish County, Antigonish, 15 July 1996, R. Lauff, STFXU

Propylea quatuordecimpunctata was established in Nova Scotia for several years prior to the first collections reported by Hoebeke and Wheeler (1996). The Nova Scotia Department of Natural Resources collection has 35 specimens collected between 1990 and 1995, mostly from Colchester County, but also from Pictou and Halifax Counties. The earliest collections are from Debert, Colchester County in 1990. Nine more were collected in Debert in 1991. The first collections from Pictou County were in 1994 and in Halifax County in 1995.

Additional Locality Records:
Colchester County, Debert, 13 June 1990, E. Georgeson, NSDNR; Colchester County, Debert, 16 June 1990, T.D. Smith, NSDNR; Colchester County, Debert, 19 June 1990, E. Georgeson, NSDNR; Pictou County, Lyons Brook, 4 July 1994, E. Georgeson, NSDNR; Halifax County, Peggy's Cove, 15 August 1995, J. Ogden, NSDNR

Harmonia axyridis (Pallas): Many attempts to introduce this species in North America, including Nova Scotia, occurred between 1916 and 1983 (Gordon 1985; Hoebeke and Wheeler 1996). The first established population was recorded in Louisiana in 1988 (Chapin and Brou 1991). Since then there has been an explosive range expansion and population explosion in northeastern North America (see Kidd et al. 1995), with the first records for Canada in 1994 (Coderre et al. 1995; Marshall 1995). This range expansion has continued into the Maritimes with Hoebeke and Wheeler (1996) reporting it from three sites, including two in Nova Scotia (Lunenburg and Digby Counties). They did not record it from Cape Breton Island, where it has since been collected during the summers of 1995 and 1996.

Additional Locality Records:
Cape Breton County, Sydney, UCCB Campus, 19 September 1995, K.J. Aucoin, UCCB; Cape Breton County, Sydney, 15 July 1996, A.A. Risk, UCCB

Hippodamia variegata (Goeze): This species first became established at Montreal, Quebec before 1984 (Gordon 1987). By 1992 it was widely distributed from northern New Jersey through New York, Connecticut and Vermont to Quebec (Wheeler 1993). The continuing range expansion to southern New Brunswick in 1993 and to Prince Edward Island and Colchester County, Nova Scotia in 1995 was documented by Hoebeke and Wheeler (1996). One year later, the spread has continued another few hundred kilometres to Antigonish County and Cape Breton County.

Specimens:
Antigonish County, Antigonish, 10 May 1996, B. Jones, STFXU;
Cape Breton County, Sydney, September 1996, J. Meagher, UCCB

The coccinellid fauna of Nova Scotia has changed dramatically in the past 15 years with the addition of four adventive species. The addition of these species is similar to what has occurred over much of northeastern North America (Gordon and Vandenberg 1991).

It is interesting to compare the rate of range expansion for the four species, from their initial establishment in North America until they reached Cape Breton Island (Table 1). Cape Breton is at the northeastern limit of possible range expansion on continental North America. Further expansion requires a major water crossing to Newfoundland. I have collated the information based on the first established population in North America, as reported in Gordon

Table 1: Average range expansion per year for four species of adventive coccinellids now established on Cape Breton Island, Nova Scotia. First established populations are from Gordon and Vandenberg (1991). The distance to Sydney, NS was measured from "The International Atlas" (McNally 1979).

Species	First established population	First Sydney, NS record	Approximate Distance (km)	Average range expansion per year (km)
Coccinella septempunctata	Bergen County, NJ	1985	1300	108
Propylea quatuordecimpunctata	Quebec City, PQ 1968	1995	850	31
Harmonia axyridis	Abita Springs, LA 1988	1995	3100	442
Hippodamia variegata	Montreal, PQ <1984	1996	1050	80

and Vandenberg (1991) and the first record for Sydney, Cape Breton Island. Linear distance was based on a straight line measurement in "The International Atlas" (McNally 1979).

Rapid range expansion, with a minimum of 30 km/year and maximum of more than 400km/year, is clear for all four species. The rates of range expansion give a good picture of how quickly these species have colonized North America. It is possible these overestimate 'real' rates of range expansion. There have been many releases and attempts to introduce these species in many locations in eastern North America (e.g. Chapin and Brou 1991; Wheeler 1993) and some releases or accidental introductions (e.g. Yanega 1996) closer to Nova Scotia than the first established population, may have been successful. However, the rates are still useful because they emphasize the explosive potential for range expansion of introduced species in North America.

Beyond impressive rates of range expansion, the newly established species will have an effect on the existing assemblage of coccinellids. Within five years of establishment on Cape Breton Island, *Coccinella septempunctata* became the most common species in anthropogenic habitats, as documented by the collections of UCCB students. Now, there are three more adventive species in Cape Breton. It remains to be seen whether one or more of these will displace *C. septempunctata* as the common coccinellid of disturbed habitats. There is also the potential for these adventive species to reduce populations of native species. Wheeler and Hoebeke (1995) have documented dramatic declines in the populations of the native *C. novemnotata* in eastern North America. Attention should be focused on the influence of these new adventives on the common native species such as *Adalia bipunctata* and *C. trifasciata* in the next few years.

This note documents useful additions to our knowledge on range expansion and establishment of adventive coccinellids based on specimens in small regional insect collections. This type of collection should play a primary role in documenting population changes of these species in the next 15 years.

ACKNOWLEDGMENTS

I thank Eric Georgeson and Jeff Ogden of the Nova Scotia Department of Natural Resources Insect Collection, Belmont, Nova Scotia, Randy Lauff of St. Francis Xavier University, Antigonish, Nova Scotia, Barry Wright and Andrew Hebda of the Nova Scotia Museum of Natural History, Halifax, Nova Scotia, and Steve Marshall, University of Guelph, Guelph, Ontario for allowing me to examine specimens under their care and for discussions about coccinellids. Chris Thomson, Steve Marshall and Randy Lauff kindly reviewed the manuscript. I also thank the students of Biology 375 (Entomology) for providing many useful specimens. Financial support was provided by Natural Sciences and Engineering Research Council and UCCB.

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SCIENTIFIC NOTE

RECENT INTERCEPTION OF LIVE KHAPRA BEETLE, *TROGODERMA GRANARIUM* (COLEOPTERA: DERMESTIDAE), AT THE PORT OF BALTIMORE, MARYLAND[1]

Michael L. Zimmerman, Julia A. Barron[2]

The khapra beetle, *Trogoderma granarium* Everts, is a quarantined insect pest under United States Department of Agriculture (USDA) regulations. Each day, USDA Animal and Plant Health Inspection Service - Plant Protection Quarantine officers (USDA-APHIS-PPQ) examine a multitude of commodities entering the United States from all over the world looking for numerous foreign insect / plant / animal pests in order to ensure that none are present prior to entering the United States. Inspections are made of both commercial and personal freight arriving daily at ports of entry in vehicle, rail, airline, and ocean liner luggage/baggage. The khapra beetle is one of the major concerns for USDA-APHIS-PPQ officers when examining these imported goods. It is a serious pest of food items including stored cereal grains, dried fruits and other plant and animal materials, and does not occur in North America. Khapra beetles can survive long periods without food and make a habit of hiding in cracks and crevices in the warehouse making them hard to detect (Anonymous, 1983).

In June 1996, a shipment of Basmati rice from Pakistan was off loaded at the Dundalk Marine Terminal, Port of Baltimore, Maryland, U.S.A. Investigators from the U.S. Food and Drug Administration (FDA) collected a surveillance sample to check for compliance under the adulterated food section of the Federal Food, Drug, and Cosmetic Act. The shipment consisted of 550 nylon weave bags, each containing eight - 11 pound cloth bags (sewn closed) of hulled, white grain rice. Examination of the rice at the FDA District Laboratory revealed the presence of live and dead maize weevil adults, *Sitophilus zeamais* Motschulsky (Curculionidae); sawtoothed grain beetle adults, larvae, and pupae, *Oryzaephilus surinamensis* (Linnaeus) (Cucujidae); red flour beetle adults and pupae, *Tribolium castaneum* (Herbst) (Tenebrionidae); and *Trogoderma* sp. dermestid adults and larvae. The *Trogoderma* larvae were initially identified as *T. granarium* Everts (khapra beetle) by the authors using Kingsolver's (1991) key to dermestid beetles. As a professional courtesy, FDA immediately contacted the local USDA-APHIS-PPQ entomologist at the Baltimore Port Office and the specimens were hand delivered for positive confirmation.

(Continued on page 46)

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[1] Received June 10, 1997. Accepted July 1, 1997.

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CAMELOBAETIDIUS VARIABILIS (EPHEMEROPTERA: BAETIDAE), A NEW SPECIES FROM TEXAS, OKLAHOMA AND MEXICO[1]

N. A. Wiersema[2]

ABSTRACT: *Camelobaetidius variabilis*, new species, is described from larvae and from male and female adults. This species is common in the creeks and rivers of the hill country region of Texas and is also known from Oklahoma, and Nuevo Leon and Tamaulipas, Mexico. Characters are presented to separate the larvae of this species from *C. similis* and other related species.

Lugo-Ortiz and McCafferty (1995) presented a taxonomic review of the North and Central American species of the genus *Camelobaetidius* Demoulin. As a result of their study, many previously accepted species were found to be variants of more widespread species and two new species were described, namely *C. kondratieffi* Lugo-Ortiz & McCafferty and *C. similis* Lugo-Ortiz & McCafferty.

In 1996 specimens were collected by the author from the Guadalupe River in Texas that exhibited tarsal claw denticulation not typical of the only nominal species, *C. mexicanus* (Traver and Edmunds), reported in Texas (Allen and Chao 1978, Henry 1986, McCafferty and Davis 1992, McCafferty and Provonsha 1993, Lugo-Ortiz and McCafferty 1995). Upon further examination it was observed that these specimens had gills or osmobranchia on the pro- and mesothoracic segments. The presence of coxal gills on the middle coxae was previously unreported in this genus. *Camelobaetidius similis* described from Guerrero, Mexico, as well as other species known from Peru, do have thoracic gills on the prothorax. After examination of many specimens contained in my collection and the collection at the Brackenridge Field Laboratory of the University of Texas at Austin it became evident that this was an undescribed species. W. P. McCafferty and C. R. Lugo-Ortiz (Purdue University, West Lafayette, Indiana) confirmed that this was a previously undescribed species and that the larvae differed from *C. similis* by size and tergal patterning as well as other differences. The adults of *C. similis* are presently unknown. This new species is described here from the larvae and the adult male and female stage as *Camelobaetidius variabilis*, new species.

All specimens were collected by the author and reside in the author's personal collection (NAW) unless otherwise indicated. Institutions housing the

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[1] Received April 26, 1997. Accepted May 28, 1997.

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other materials used in this study and acronyms are as follows: Brackenridge Field Laboratory, University of Texas at Austin (BFL), Purdue Entomological Research Collection (PERC), University of North Texas Entomology Museum (UNTEM), and the United States National Museum of Natural History (USNM). Life stage and material abbreviations are as follows: L-larvae, M-adult male, F-adult female E- larval exuvia slide mounted in Euparal.

Camelobaetidius variabilis, NEW SPECIES

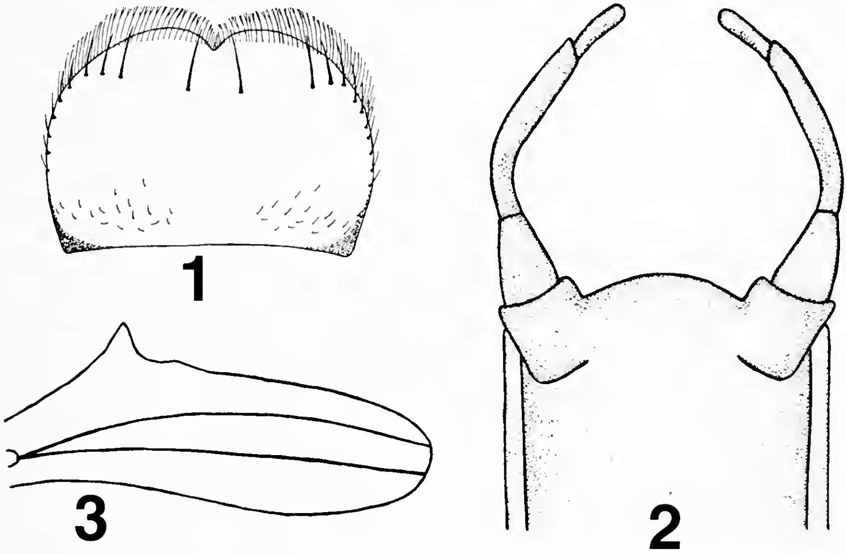
(Figs. 1-4)

Larva. (in alcohol) Body length: 5.6-7.0 mm; caudal filaments: 2.4-3.2 mm. Head: Coloration pale with area along coronal and frontal sutures pale olive-brown. Vertex pale olive-brown. Ocelli black. Turbinate portion of eyes in males reddish brown to orange-yellow, lateral lobes black. Antennae pale; sensilla not apparent. Labrum (Fig. 1) sclerotized posterolaterally, with one submedial and two to three submarginal simple setae on each side; intermediate setae absent. Right mandible 3 + 1 + 3 denticles; tuft of simple setae between prostheca and molar. Left mandible 3 + 1 + 3 denticles with short, broad process at base of molar. Maxillae robust; maxillary palps extending to galealacinia; palpal segment 2 broad about 0.5-0.75 length of segment 3. Labium robust; palpal segment one long; segment two shorter than one, with four to five simple setae dorsally and broad, rounded distal projection; segment three rounded apically, with numerous fine, simple setae; glossae with 10-11 simple setae medially, three to four dorsally and four to five laterally; paraglossae with five to six simple setae dorsally and two rows of simple setae distally. Thorax: Color pale to olive-brown with distinct pattern in live larvae (Fig. 4), faint in perserved specimens. Sterna pale to pale yellowish. Osmobranchia present on for- and midcoxae. Legs pale; femora rounded and often darkened distally with numerous fine, long, simple setae dorsally and pale olive-brown area medially. Tibiae armored ventrally with short, robust, simple setae; tarsi distinctly darken distally with row of short, simple setae ventrally with distal 2-3 about 1.5-2 times the length of preceding setae. Tarsal claws with 5-9 denticles (rarely 9, see discussion) similar to Figs. 13, 15 & 16 in Allen and Chao (1978). Abdomen: Color pale olive-brown; Terga with olive-brown coloration faint on segments 4-5, 7 and posterior half of 10, with prominent submedian oblique markings and often a round pale area medially on each segment. Gills on segments 1 & 7 small and without tracheation; those on segments 2-6 usually with very little or no tracheation. Paraprocts with seven to eight spines. Caudal filaments pale, often darken distally with numerous, fine, simple setae. Median caudal filament subequal in length to cerci.

Adult Male. (in alcohol) Body length excluding cerci: 5.6-6.2 mm; forewings: 5.6-6.0 mm; hindwing: 1.0 mm; cerci: 8.8-9.2 mm. Body brownish tan, darkest at head, thorax, and abdominal terga 7-10. Head: Turbinate portion of eyes orange-yellow, semi-elliptical, well separated and slightly divergent. Antennae pale. Thorax: Pronotum darker laterally. Legs pale. Wing veins and membrane hyaline. Hindwings as in Fig. 3. Abdomen: Terga distinctly darker than sterna. Terga brownish tan with segments 2-6 paler than segments 1 & 7-10. Usually darker laterally giving the appearance of a wide pale median line dorsally. Tracheation along pleura usually prominently darkened, but sometimes only faintly darkened. Sterna pale. Genitalia pale and as in Fig. 2. Cerci usually entirely pale, but sometimes with dark articulation in basal segments.

Adult Female. (in alcohol) Body length excluding cerci: 5.6-6.2 mm; forewings: 5.8-6.2 mm; hindwing: 1.0 mm; cerci 7.0-7.5 mm. Body coloration as in male with terga distinctly darker than sterna. Abdominal segments 2-6 not distinctly paler than segments 1 & 7-10, due to presence of eggs. Hindwing as in Fig. 3. Legs and cerci light tan.

Diagnosis. The larvae of *C. variabilis* are most similar to *C. similis* but can be separated from it by having a single thread-like gill on the midcoxae as well as forecoxae, labral setation lacking intermediate setae (as in Fig. 1), and tergal patterning (as in Fig. 4). In addition, *C. variabilis* also differs from *C. similis* by different mandibular denticulation and a greater number of marginal spines of the paraprocts, but these latter difference are of inconsistent diagnostic value. The larvae of *C. variabilis* are also very similar to *C. mexicanus* and



Figs. 1-3. *Camelobaetidius variabilis*, n. sp.: 1. Labrum, dorsal view. 2. Male genitalia, ventral view. 3. Left hindwing.

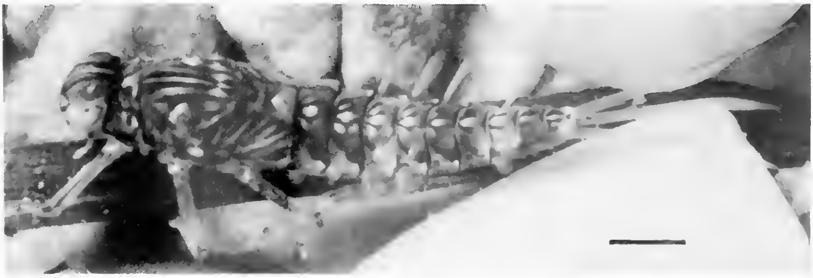


Fig. 4. Live male larva of *Camelobaetidius variabilis*, n. sp. from Devils River, Texas. Scale bar equals 1 mm. Photograph C.R. Nelson.

C. waltzi McCafferty, and in fact share similar labral shape and setation patterns. However, *C. variabilis* is easily separable by the presence of the coxal gills discussed above. In addition, *C. variabilis* is further separable from *C. waltzi* by having a rounded second segment of the labial palps, whereas *C. waltzi* has a medially pointed second segment of the labial palps. The larvae of *C. waltzi* also tend to have short, broad maxillary palps but this feature is of inconsistent diagnostic value. *Camelobaetidius warreni* is also similar to *C. variabilis* with respect to size and tarsal claw denticulation, but *C. warreni* lacks coxal gills and has labral setation with intermediate setae as in Fig. 6 Lugo-Ortiz and McCafferty (1995).

Using the most recent key (Lugo-Ortiz and McCafferty 1995), the larvae of *C. variabilis* will key as *C. similis*. The following added couplet can be used to separate the larvae of these two species at that point in the Lugo-Ortiz and McCafferty key.

Couplet to separate larvae *C. variabilis* from *C. similis*

1. Coxal gills present on forecoxae only; labral setation as in Fig. 5 in Lugo-Ortiz and McCafferty (1995) .... *similis*
1' Coxal gills on fore and middle coxae; labral setation as in (Fig. 1 herein) ...... *variabilis*

According to Traver and Edmunds (1968) only *Dactylobaetis* sp. B described from Metlac (Vera Cruz?), Mexico and *C. warreni (C. zenobia* and *C. cepheus* were synonymized with *C. warreni* in Lugo-Ortiz and McCafferty 1995), are the only species known in the adult stage in North and Central America which possess a darker terga than sterna. Adult males of *D.* sp. B can be separated from *C. variabilis* by having semi-opaque abdominal segments 2-6 with tracheae not darkened and large turbinate eyes that are contiguous dorsally. I have found no reliable characters for the separation of adults of *C. warreni* from *C. variabilis*.

Known distribution. USA: Oklahoma, Texas; MEXICO: Nuevo Leon, Tamaulipas.

Material examined. HOLOTYPE: Male larva, USA: TEXAS: Williamson Co., Georgetown, San Gabriel River, riffles below San Gabriel Park, 20 Jan 1997 (USNM). ALLOTYPE: Female larva, same data and deposition as holotype. PARATYPES: One male and one female larvae same data as holotype (PERC). ADDITIONAL PARATYPES: Three male and five female larvae, USA: TEXAS: Comal Co., Guadalupe River about 11 mi., below Canyon Dam, 09 Nov 1996, same deposition as holotype.

Other Material Examined. USA: TEXAS: Comal Co., Guadalupe River about 12.5 mi., below Canyon Dam, 16 Feb 1997 (8M, 3F, 4E); same location as before, but 21 Feb 1997 (7M, 2F). USA: TEXAS: COMAL CO., Guadalupe River about 11mi. below Canyon Dam, 17 Feb 1997 (L); same location as before, but 21 Mar 1997 (10 M, 3F). USA: TEXAS: Travis Co., Austin, Little Walnut Creek at Cameron Rd., 25 Mar 1997 (L); same location as before but 12 Apr 1997 (L). USA: TEXAS: WILLIAMSON CO., Tejas Camp, unnamed creek flowing into San Gabriel River, 19 Dec 1996 (L). USA: TEXAS: BASTROP CO., McKinney Roughs, Colorado River at Wilbarger Bend. 23 Nov 1996 (L). USA: TEXAS: VAL VERDE CO., Devils River, Dolan Falls Preserve. 27-29 Oct 1996 (L). USA: TEXAS: Edwards Co., Nueces River, Barksdale, Hwy 55, 15 Mar 1993 C.R. Nelson, K.D. Alexander & S.M. Stringer (L; BFL). USA: TEXAS: Val Verde Co., Dolan Creek upstream from Devils River, 19 Mar 1993. C.R. Nelson, K.D. Alexander & S.M. Stringer (L; BFL). USA: TEXAS: Val Verde Co., Devils River at Dolan Falls Preserve, above falls, 13 Nov 1993 C.R. Nelson, K.D. Alexander & S.M. Stringer (L; BFL). USA: TEXAS: TRAVIS CO., Walnut Creek at I-35, 06 June 1995 (L); same data but Bull Creek near Spicewoods Spring Road, 12 May 1995 (L). USA: OKLAHOMA: Murray Co., Davis, Honey Creek at Turner Falls Park, 14 Oct 1993, P.F. Wagner (2M, 3F, L; UNTEM). MEXICO: NUEVO LEON: Pobillo River at St. Hwy 115, near Linares, 15 May 1995, D.E. Baumgardner & B.C. Henry (L; UTEM). MEXICO: NUEVO LEON: Pilon River at unnamed road, across from General Teran, off St. Hwy 35, 15 May 1995, D.E. Baumgardner & B.C. Henry (L; UTEM). MEXICO: TAMAULIPAS: Branch of Chihue River at Hwy 101, ca. 12 mi S of Juamave, between kilo marker 91 & 92; 17 May 1995, D.E. Baumgardner & B.C. Henry (L; UTEM).

Etymology. The specific epithet is a Latin word meaning changeable. It is a reference to the apparent changeability in tarsal claw denticulation in early instars of this species and possibly the genus as a whole, see discussion.

DISCUSSION

Tarsal claw denticulation is variable in this species, but it most commonly exhibits 5-6 denticles, with 7-8 being less common. Of the approximately 300 larvae and exuvia examined by the author, one exuvia had 9 denticles on the tarsal claw of one of the metathoracic legs. Due to the variability in tarsal claw denticulation this character will not be useful in separating this species from the known species with 10 or less denticles on their tarsal claws unless specimens are collected in series.

A life history study of *C. variabilis* has been conducted by Paul Wagner (Virginia Tech), and he has indicated to me that in early instars of this species there is a greater number of denticles per tarsal claw than is seen in the later instars and that a reduction in the number of denticles occurs within the first few instars. Similar observations in tarsal claw development have been made in species within the Family Heptageniidae, (see Traver and Edmunds 1968, pg. 638; Ide 1935).

In Allen and Chao (1978) *C. mexicanus* was reported in Texas for the first time as *Dactylobaetis mexicanus* (see McCafferty and Waltz 1990 for discussion on nomenclature change). The authors also presented a brief description of these specimens, in which they stated that the tarsal claw denticulation was of the *warreni* type 5-8 denticles. The original description of *C. mexicanus* found in Traver and Edmunds (1968) states that the tarsal claws of *C. mexicanus* have 5-6 denticles, this feature was also found to be consistent by Lugo-Ortiz and McCafferty (1995) in their review. This, along with the general tergal patterning described by Allen and Chao (1978), suggests to me that their specimens were in actuality *C. variabilis*. This also calls into question many of the previous reports attributed to *C. mexicanus* in Texas.

Camelobaetidius mexicanus was reported in Oklahoma for the first time by Reisen (1975) from Honey Creek in Murray County. I have examined specimens from this location provided to me by P.F. Wagner (Virginia Tech) that are clearly *Camelobaetidius variabilis*.

ACKNOWLEDGMENTS

I would like to thank C. R. Nelson (University of Texas at Austin) for his suggestions and critique of the manuscript and for allowing me access to The Brackenridge Field Laboratory of the University of Texas at Austin (BFL). I would also like to thank P. F. Wagner (Virginia Tech) and D.E. Baumgardner (Aberdeen Proving Ground, Maryland) for loan of specimens. I would finally like to express my appreciation to W. P. McCafferty and C. R. Lugo-Ortiz (Purdue University, West Lafayette, Indiana) for all their assistance and for their continual work towards Ephemeroptera systematics which made this description possible.

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NEWLY REPORTED AND LITTLE KNOWN MAYFLIES (EPHEMEROPTERA) OF TEXAS[1]

N. A. Wiersema[2]

ABSTRACT: Ten species are newly reported for Texas along with new distributions for little known mayfly species in Texas. *Baetis armillatus, B. bimaculatus, B. dubius, Labiobaetis frondalis, Procloeon rufostrigatum, P. viridoculare, Ephemerella dorothea, Leptophlebia cupida, L. intermedia* and *Ephoron album* are reported in Texas for the first time.

Lugo-Ortiz & McCafferty (1995) presented the results of a biogeographic study of mayfly fauna and a checklist of 76 nominal species reported for Texas. Recent revisionary work (Henry 1993), a status change (Lugo-Ortiz & McCafferty 1994), new reports (Baumgardner et al. 1997) and a new species description (Wiersema 1998) raised this number to 94 nominal species reported for Texas.

Recent collections in the Big Thicket and Hill Country areas of Texas and examination of the author's personal collection revealed several species of mayflies previously unreported for Texas with new distributions for little known species. Collection records reported here raise the number of nominal species reported for Texas to 104 and cast doubt on the validity of a previous report of *Ephemerella inermis* Eaton.

All specimens were collected by the author and reside in the author's personal collection unless otherwise indicated. Institutions housing the other materials used in this study and acronyms are as follows: Purdue Entomological Research Collection (PERC) and the Burian Ephemeroptera Collection (BEC). New state records are marked with an asterisk (*). Life stage and material abbreviations are as follows: L-larvae, M-adult male, F-adult female, rM-reared adult male, rF-reared adult female.

BAETIDAE

Apobaetis indeprensus Day

New Collection Records. WILLIAMSON CO., Georgetown, San Gabriel River at San Gabriel Park, 07 Oct 1995 (2M, 1F).

Remarks. This species was first reported in Texas by McCafferty & Davis (1992). There was some hesitation by those authors in reporting their larval specimens as *A. indeprensus* because the larval stage of *A. etowah* (Traver) is unknown. The adult specimens I collected clearly are *A. indeprensus*. This species is now known to occur in the Balconian and Texan biotic provinces in Texas (Lugo-Ortiz and McCafferty 1995).

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******Baetis armillatus*** McCafferty & Waltz
Collection Records. MONTGOMERY CO., New Caney, Caney Creek at US 59, 04 Jan 1997 (L); 08 Mar 1997 (L); 10 Mar 1997 (L). MONTGOMERY CO., New Caney, Peach Creek at FM 1485, 16 June 1997 (L, 7M, 1F, 1rM, 1rF). AUSTIN CO., San Bernard River at I-10, near Sealy, 20 May 1997 (L, 1rM).
Remarks. This species appears to be widely distributed across the eastern half of the country, and is also known from Ontario, Alberta, (Berner & Pescador 1988) and has recently been reported in Colorado in the West (McCafferty et al. 1993).

******Baetis bimaculatus*** (Berner)
Collection Records. MONTGOMERY CO., New Caney, Caney Creek at US 59, 08 Mar 1997 (L); 10 Mar 1997 (L). MONTGOMERY CO., New Caney, Peach Creek at FM 1485, 16 June 1997 (L, 2rM, 4rF).
Remarks. This species was described in Berner (1946) from adults and larvae collected in Florida and is currently known also from Alabama, Georgia, Mississippi, and South Carolina (Berner & Pescador 1988). The larval specimens collected on June 16 1997 agree well with Berner's description of this species with one exception, the first as well as the seventh pair of gills are suffused with reddish brown pigmentation. The collection of this species in Texas extends its known range westward.

******Baetis dubius*** (Walsh)
Collection Records. COMAL CO., Guadalupe River about 11-12 miles below Canyon Dam, 16 Feb 1997 (L, 1M); same data but about 7-8 miles below Canyon Dam, 16 Sept 1996 (1M). COMAL CO., Sattler, Guadalupe River about 4-5 miles below Canyon Dam, 08 Feb 1997 (L). HAYS CO., Blanco River at Post Road, near Kyle, 14 Apr 1997 (1M); 16 Apr 1997 (3M); 19 Apr 1997 (L, 1rM, 1rF), L (PERC); 20 Apr 1997 (L, 1F); 24 Apr 1997 (L, 1M), 1M (PERC); 05 May 1997 (L, 1rM, 1rF). WILLIAMSON CO., Georgetown, San Gabriel River at San Gabriel Park, 28 Apr 1997 (2F); 19 May 1997 (L, 1rM, 1rF).
Remarks. This species is widely dispersed throughout the eastern half of North America (Burks 1953; McCafferty & Waltz 1990) and the collection of this species in Texas extends its known range westward.

Labiobaetis dardanus (McDunnough)
New Collection Records. HAYS CO., Blanco River at Post Rd., near Kyle, 14 Apr 1997 (L); 16 Apr 1997 (L); 19 Apr 1997 (L); 24 Apr 1997 (L, 1rM, 2rF). TRAVIS CO., Austin, Colorado River at Hwy 183, 22 Sept 1996 (1F).
Remarks. This species has been reported in the Austroriparian biotic province by Baumgardner et al. (1997). The data reported here place this species in the Balconian province as well.

******Labiobaetis frondalis*** (Traver)
Collection Records. NEWTON CO., Nichols Creek Hwy 87, 30 Dec 1996 (L). MONTGOMERY CO., New Caney, Peach Creek at FM 1485, 05 Jan 1997 (L); 16 June 1997 (L, 3rM, 4rF). MONTGOMERY CO., New Caney, Caney Creek at US 59, 08 Mar 1997 (L); 10 Mar 1997 (L), 26 May 1997 (L, 1rM, 1rF).
Remarks. This species is widely distributed across the eastern half of North America (Morihara & McCafferty 1979).

Labiobaetis propinquus (Walsh)
New Collection Records. SAN JACINTO CO., Winters Bayou at Hwy 150, 10 mi. SW of Cold Springs, 23 Dec 1996 (L). MONTGOMERY CO., New Caney, Caney Creek at US 59, 26 May 1997 (L, 3rM, 2rF).

Remarks. This species was first reported in Texas by McCafferty & Davis (1992) from the San Bernard River which borders Colorado and Austin County, near the eastern limits of the Texan biotic province. Lugo-Ortiz & McCafferty (1995) listed this primarily eastern species as existing in the Texan and Austroriparian provinces, but gave no distribution in the Austroriparian province. The data reported here place this species in the Austroriparian province.

Paracloeodes minutus (Daggy)
New Collection Records. TRAVIS CO., Austin, Colorado River at Hwy 183 bridge, 22 Sept 1996 (6F). TRAVIS CO., Austin, Bull Creek near Spicewood Springs Rd., 12 Oct 1996 (2F). MONTGOMERY CO., New Caney, Peach Creek at FM 1485, 16 June 1997 (L, 1rM, 3M, 1F).
Remarks. *Paracloeodes minutus* was first reported in Texas by McCafferty & Davis (1992) and is currently known to occur in the Austroriparian, Kansan, and Texan biotic provinces (Lugo-Ortiz & McCafferty 1995). The Travis County data listed here extends its known range in Texas into the Balconian biotic province.

Procloeon rufostrigatum (McDunnough)
Collection Records. MONTGOMERY CO., New Caney, Caney Creek at US 59, 26 May 1997 (1rF).
Remarks. *Procloeon rufostrigatum* is known from Manitoba, New Brunswick, Ontario and Quebec in Canada and Illinois, Kentucky, Maryland, Michigan, Minnesota, Pennsylvania, and Wisconsin in the United States (Lowen & Flannagan 1992). The discovery of *P. rufostrigatum* in southeast Texas significantly extends its known range southward.

Procloeon viridoculare (Berner)
Collection Records. HAYS CO., Blanco River at Post Rd., near Kyle, 14 Apr 1997 (L); 19 Apr 1997 (18M); 20 Apr 1997 (49M, 1F); 24 Apr 1997 (52M), 2M (PERC); 05 May 1997 (larva). AUSTIN CO., San Bernard River at I-10, near Sealy, 20 May 1997 (L, 1rM). MONTGOMERY CO., New Caney, Caney Creek at US 59, 26 May 1997 (L). MONTGOMERY CO., New Caney, Peach Creek at FM 1485, 16 June 1997 (L, 3F, 2rM, 1rF), 1rM, 1F and L (PERC).
Remarks. This species is currently known from Alabama, Florida, Georgia, Mississippi and South Carolina (Berner & Pescador 1988, Unzicker and Carlson 1982: p. 3.85) and was recently reported in Michigan and Pennsylvania (Waltz & Munro 1996). The discovery of this species in the Balconian, Texan and Austroriparian provinces in Texas extends its known range westward.

BAETISCIDAE

Baetisca obesa (Say)
New Collection Records. MONTGOMERY CO., New Caney, Caney Creek at US 59, 27 Dec 1996 (L); 04 Jan 1997 (L).
Remarks. This species was first reported in Texas by Lewis (1986) as occurring in the Neches River drainage system in the Austroriparian province. The data reported here place *Baetisca obesa* in the San Jacinto River drainage system within the Austroriparian province as well.

EPHEMERELLIDAE

Ephemerella dorothea* *Needham
Collection Records. MONTGOMERY CO., New Caney, Peach Creek FM 1485, 05 Jan 1997 (L); 08 Mar 1997 (L, 2rM, 2rF); 10 Jan 1997 (L, 4rM, 3rF), 2rM, 1rF and L (PERC).
Remarks. The adult specimens I reared vary somewhat from published descriptions of this species (McDunnough 1931, Traver 1935, Burks 1953, Allen & Edmunds 1965) in that male genitalia are reminiscent of *E. inermis* Eaton, a western mountainous species. Larvae of the eastern *E. dorothea* and western *E. inermis* are also very similar morphologically, however the Texas larvae are clearly of the *dorothea* type, possessing coarse vermiform cuticular stippling typical of *E. dorothea* but not *E. inermis*. Adult variation may be a result of genetic drift in a

fringe population and there is little doubt the two species are closely related, if not sister species (pers. comm. W. P. McCafferty). Baumgardner et al. (1997) reported *E. inermis* from Texas based on one larva apparently collected in the Balconian province in which the date and collector where unknown. The farthest east *E. inermis* is known to occur are the headwaters of the Pecos and Rio Grande Rivers in New Mexico and its presence in Texas does not fit any biogeographic patterns (pers. comm. W.P. McCafferty). In light of this information and the presence of *E. dorothea* in East Texas, it is assumed that the *E. inermis* report is the result of a misidentification of *E. dorothea.*

Eurylophella doris (Traver)
New Collection Records. SAN JACINTO CO., Winters Bayou at Hwy 150, 23 Dec 1996 (L). MONTGOMERY CO., New Caney, Caney Creek at US 59, 27 Dec 1996 (L). NEWTON CO., Trout Creek at Hwy 87, 30 Dec 1996.(L). MONTGOMERY CO., New Caney, Peach Creek at FM 1485, 05 Jan 1997 (L). NEWTON CO., Cow Creek at Hwy 87, 14 Mar 1995, D. Hulsen & C. Mcduffie (L).
Remarks. This species has been reported in Texas by Baumgardner et al. (1997). Using the key of Funk & Sweeny (1994), specimens from Texas have morphological characteristics of *E. doris* as opposed to the closely related *E. temporalis* (broader fore femora, and longer posteral-lateral projections of the 2nd and 3rd abdominal segments).

HEPTAGENIIDAE

Stenonema exiguum Traver
New Collection Records. AUSTIN CO., San Bernard River at I-10, near Sealy, 03 Feb 1997 (L). MONTGOMERY CO., New Caney, Caney Creek at US 59, 27 Dec 1996 (L); 04 Jan 97 (L); 05 Jan 1997 (L, 14rM, 12rF). MONTGOMERY CO., New Caney, Peach Creek FM 1485, 05 Jan 1997 (L); 10 Mar 1997 (L, 1M).
Remarks. This species has been known from the Austroriparian biotic province (Lugo-Ortiz & McCafferty 1995, Bednarik & McCafferty 1979) and the collection record listed here from Austin County extends its known distribution into the Texan biotic province.

Stenonema terminatum (Walsh)
New Collection Records. BELL CO., Lampasas River at FM 1123 14 Dec 1996 (L); Same data as previous but at Dice Grove Rd., 14 Dec 1996 (L). COMAL CO., Guadalupe River about 11 mi. below Canyon Dam, 7 Dec 1996 (L). HAYS CO., Blanco River at Post Rd., near Kyle, 24 Apr 1997 (1F). MONTGOMERY CO., New Caney, Caney Creek at US 59, 27 Dec 1996 (L); 04 Jan 1997 (L); 05 Jan 1997 (L, 10rM, 8rF). MONTGOMERY CO., New Caney, Peach Creek at FM 1485, 05 Jan 1997 (L); 10 Mar 1997 (4M, 1rF).
Remarks. This species has been known from the Austroriparian and Balconian biotic provinces (Lugo-Ortiz & McCafferty 1995). The collection of this highly variable and widespread species (Bednarik & McCafferty 1979) in the Texan province (Bell County data) was expected.

ISONYCHIIDAE

Isonychia arida (Say)
New Collection Records. MONTGOMERY CO., New Caney, Caney Creek at US 59, 04 Jan 1997 (L); 08 Mar 1997 (L); 10 Mar 1997 (L). MONTGOMERY CO., New Caney, Peach Creek at FM 1485, 05 Jan 1997 (L); 08 Mar 1997 (L, 2rM, 3rF); 10 Mar 1997 (L, 3rM, 2rF).
Remarks. This species is currently being reported in Texas by Baumgardner et al. (1997). The data reported here represent a new county record.

LEPTOPHLEBIIDAE

Leptophlebia cupida (Say)
Collection Records. NEWTON CO., Trout Creek at Hwy 87, 30 Dec 1996 (3rM, 1rF), 1rM and 1rF (BEC).

Remarks. *Leptophlebia cupida* was found cohabiting with *L. intermedia* (Traver) in Trout Creek. This genus is being revised by Dr. Steve Burian, Southern Connecticut State University, who provided confirmations. Besides *L. intermedia* (see below), the only other species of this genus known for Texas is the distinctive *L. bradleyi* (Needham).

Leptophlebia intermedia (Traver)
Collection Records. NEWTON CO., Trout Creek at Hwy 87, 30 Dec 1996 (8rM, 4rF), 2rM and 1rF (BEC).
Remarks. This species is widely distributed across the eastern half of North America.

Paraleptophlebia volitans (McDunnough)
New Collection Records. MONTGOMERY CO., New Caney, Caney Creek at US 59, 04 Jan 1997 (L); 08 Mar 1997 (L, 2rM, 1rF); 10 Mar 1997 (L). MONTGOMERY CO., New Caney, Peach Creek at FM 1485, 10 Mar 1997 (L).
Remarks. This species has been known from Quebec (McDunnough 1924) to Florida and west into Louisiana, and it was recently reported in Texas by Baumgardner et al. (1997). The data reported here represent a new county record.

POLYMITARCYIDAE

Ephoron album (Say)
Collection Records. MONTGOMERY CO., New Caney, Peach Creek at FM 1485, 16 June 1997 (2F).
Remarks. *Ephoron album* is a common western and midwestern species (McCafferty 1994) and Texas represents the southern limit of its known range.

ACKNOWLEDGMENTS

I would like to express my appreciation to the following individuals: W.P. McCafferty (Purdue University) for confirmation and discussion of the *Ephemerella dorothea* specimens as well as further assistance. S.K. Burian (Southern Connecticut State University) for confirmation of the *Leptophlebia* specimens. C.R. Nelson (University of Texas at Austin) for loan of specimens and for all his assistance. D. Hulsen for the loan of specimens. B.C. Kondratieff (Colorado State University) for some helpful pre-manuscript advice. D.E. Baumgardner and J.H. Kennedy (University of North Texas) for providing me a copy of their manuscript.

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REDESCRIPTION OF *NERTHRA PRAECIPUA* (HETEROPTERA: GELASTOCORIDAE) FROM CHILE[1]

J. T. Polhemus[2], T. Cekalovic K.[3]

ABSTRACT: *Nerthra praecipua*, known previously from the holotype female, has been rediscovered in Chile. The species is redescribed, supplementing the incomplete original description of the damaged female holotype. This species belongs to the *Nerthra alaticollis* group, which occurs in Australia and Chile.

Nerthra praecipua Todd was described by Todd (1957) from a unique female in the Reed Collection (acquired by C. J. Drake, now housed in the National Museum of Natural History, Washington, D. C.) that had been badly damaged by dermestids, rendering a complete description impossible. A single additional female has been collected by the junior author on Chiloe Island, Chile, providing the first definitive locality and permitting further description of the species. It is held in the J. T. Polhemus Collection (JTPC).

Nerthra praecipua Todd

Nerthra praecipua Todd, 1957:151, Fig. 9 (Holotype, female, Chile, Reed Collection, now in USNM); Todd, 1961:472 (checklist).

Supplemental description to that of Todd (1957).

Female: Length 8.10 mm; width of pronotum 5.50 mm; width of abdomen 6.02 mm.

General color stramineous, with scattered dark markings on veins of hemelytra, head, median lobe of pronotum, scutellum; depressions on head, median lobe of pronotum, fuscous to piceous; anterior 2/3 of lateral margins of abdominal tergites III–VI dark; scutellum with lateral tumescence fuscous, anterolateral angles piceous. Thoracic venter mostly stramineous, mesosternum medially mostly piceous except median anterior margin and medial protuberance; abdominal venter mostly dark, with scattered yellowish markings, laterally and distally lighter. Legs stramineous, with fuscous markings; fore femora broadly infuscated, with fascia at distal 2/3; middle and hind femora with fascia at basal 1/3, irregular annulus at distal 2/3, distal extreme, fuscous; tibia dark distally.

Structural characters: Head excavate anteriorly, without apical tubercle but with small apical protuberance, with superapical and lateral tubercles (Fig. 4), set with clavate setae, ocelli absent. Pronotum with median lobe raised, sculptured, set with scattered short clavate setae. Abdominal tergites sinuate, extending laterally beyond hemelytra (see Todd, 1957, fig. 9), with groups of moderate-length clavate setae on posterolateral angles. Hemelytra without membrane, partially fused, with thin medial line of demarcation between hemelytra, set with short clavate setae along lateral margins; network of veins more extensive than depicted by Todd (loc. cit.).

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[1] Received March 15, 1997. Accepted May 15, 1997.

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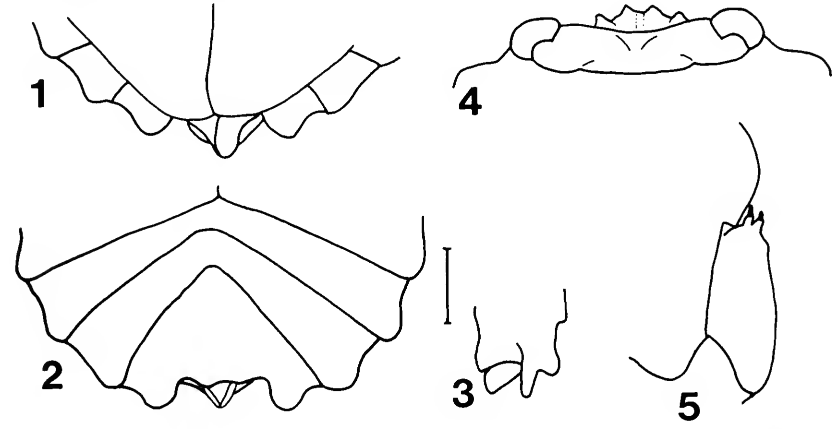
Fore femur with edge of anterior dilation forming about a 50° angle with posterior edge; anterior trochanter with two black-tipped denticles (Fig. 5).

Abdominal sternites almost symmetrical (Fig. 2); ovipositor lobes slightly asymmetrical, located posterodorsally (Figs. 1, 3).



Figures 1 - 5. *Nerthra praecipua* Todd, female. (scale bar - 1.0 mm). 1 – 3. Abdominal terminalia. 1. dorsal view. 2. ventral view. 3. lateral view. 4. Head, dorsal view. 5. Anterior trochanter, with black-tipped denticles anteriorly.

Material examined. 1 female, Chile, Chiloe Island, Puente la Caldera, 41° 40' S, 74° 02' W, 15 Feb. 1996, T. Cekalovic K. (JTPC).

Comparative notes. *N. praecipua* does not resemble any other South American species, and is the only American member of the *N. alaticollis* group. It is the only American species with sternite VII prolonged posteriorly and lacking emargination, with the female genital structures located dorsally. In Todd's (1960) key to Australian species of *Nerthra*, *N. praecipua* drops at couplet 3 because it lacks ocelli; thus, in this regard, it is unique in the *alaticollis* group. Todd (loc. cit.) stated that species of the *alaticollis* group have an apical tubercle, but in *N. adspersa* (Stål) and *N. stali* (Montandon) it is no more than a small apical protuberance, similar to that of *N. praecipua*.

Habitat. The habitat in which the single specimen was collected is surrounded on all sides by forest, situated in hills of moderate altitude. The vegetation is native and semihumid. The trunks and limbs of trees in various states of decay are covered with mosses, lichens, and adhering ferns of the genus *Hymenophyllum*. The vegetative community is a typical damp *Nothofagus* forest.

The specimen was separated from a sample of humus (TC-427) by means of a Berlese funnel, in company with various arachnids and insects including Peloridiidae (Coleorrhyncha: *Peloridora* sp.).

Zoogeography. *N. praecipua* provides another link between the hemipteran faunas of Austral South America and Australia. Concerning *N. praecipua*, Todd (1957) stated that "The projecting median portion of the last abdominal sternite and general appearance would seem to indicate that this species is most closely related to the species of the *alaticollis* group found in Australia." This is an interesting observation (supported by independent investigations by JTP) because Chile and adjacent austral Argentina are Gondwanan in origin, and several diverse groups found there are phylogenetically linked to New Zealand, Australia, and New Guinea (e.g. mayflies, Edmunds, 1975; Aradidae, Isoderminae, Monteith, 1982:649; Peloridiidae, Evans, 1981; *Nothofagus*, Ash, 1982:355).

The projecting abdominal sternite VII of females and dorsal location of the female genital structures is a synapomorphy for the clade comprising the *Nerthra alaticollis*, *laticollis*, *elongata*, and *rugosa* groups established by Todd (1955, 1960). The *laticollis* group occurs in Australia and Melanesia (mainly Solomon Islands and New Guinea), the *elongata* and *alaticollis* groups occur on Australia, but the latter also on Chile. The *rugosa* group has only a few species that occur on various islands and continental land masses, and apparently all are halophilous and are rarely if ever found far from the seashore.

The associated Peloridiidae, a hemipteroid family of almost exclusively flightless bugs (only one species with rare macropters), is of interest because of its association with, and zoogeographical parallels to, flightless *Nerthra* species. The primary ecological difference between them is that peloridiids are primarily cool-adapted moss inhabitants not yet found on New Guinea, whereas the flightless *Nerthra* are mostly warm-adapted litter inhabitants that are absent from New Zealand. Evans (1981:395) speculated that peloridiids will be found in the *Nothofagus* forests of New Guinea.

ACKNOWLEDGMENTS

We thank D. A. Polhemus and R. T. Schuh for their constructive reviews. Support for this research was provided in part by grant BSR-9020442 from the National Science Foundation, Washington, D. C. This research was carried out as an adjunct faculty member of Colorado State University. We thank these organizations for their continued support of research into the systematics and zoogeography of aquatic Heteroptera.

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SCIENTIFIC NOTE

AN UNUSUAL OCCURRENCE OF CADDISFLIES (TRICHOPTERA: PHRYGANEIDAE) IN A PENNSYLVANIA POPULATION OF THE PURPLE PITCHER PLANT, *SARRACENIA PURPUREA*

R. Hamilton IV[2], R. L. Petersen[2], R. M. Duffield[2,3]

While studying the contents of one hundred and four leaves collected from a population of purple pitcher plants in Christner-Bog, Somerset County, Pennsylvania, on March 13, 17, and 22, 1996, five caddisfly larvae were recovered. Three larvae were alive in their cases, one larva was dead in a case, and one was dead and covered by a fungus identified as a species of *Saprolegnia* (Saprolegniaceae) (Coker, 1923). The larvae were identified as belonging to the genus *Oligostomis* (Phryganeidae). Adult caddisflies collected in the same site in May 1996, were identified as *Oligostomis ocelligea* (Walker). This is the first report of *Oligostomis* larvae in pitcher plants. The presence of this caddisfly is probably related to the flooding of the habitat during the late winter and early spring.

Purple pitcher plants are carnivorous plants, usually found in nitrogen-deficient, *Sphagnum*-dominated bogs or swamps. A wide variety of species of insects and other arthropods are associated with the pitcher plant. These invertebrates can be classified as regular inhabitants, prey, occasional associates, or plant herbivores (Rymal and Folkerts, 1982). Caddisfly larvae have been reported in pitcher plants (Brower and Brower, 1971; Cresswell, 1991), yet it is not clear what their presence signified.

The water level in wetlands can rise significantly after snow melt or rain, submerging the pitcher plant leaves. This would permit aquatic organisms to move inside and/or on top of the leaves. Pittman et al. (1996) proposed that aquatic predators may gain entrance to the pitchers during periods of high water and flooding, and feed on the inhabitants. While it is possible caddis larvae may have inadvertently entered the pitcher plant leaves due to flooding, we suggest that the larvae recovered in this study entered the pitcher plant leaves in search of food. *Oligostomis*

(Continued on page 50)

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A NEW SPECIES OF *SYMPHITONEURIA* (TRICHOPTERA: LEPTOCERIDAE) FROM SABAH, MALAYSIA [1]

Trond Andersen[2], Jolanda Huisman[3]

ABSTRACT: *Symphitoneuria sabaensis* n. sp. from Sabah (Borneo), East Malaysia is described and figured as male and female imago. The species is the second *Symphitoneuria* to be described from outside the Australian biogeographical region. A key to the adult males of *Symphitoneuria* is provided.

The genus *Symphitoneuria* was described by Ulmer (1906) for *Notanatolica exigua* (McLachlan). Later, Mosely (1936) described the genus *Loticana* for *Notanatolica opposita* (Walker), at that time only known from the female. Banks (1939) suggested that *Loticana* was a synonym of *Symphitoneuria*, an opinion formally confirmed by Mosely and Kimmins (1953). *Symphitoneuria* is characterized by the male forewing venation in which the media and cubitus are fused with the lower margin of the discoidal cell. In the female the wing venation is normal, and the hind wings are similar in both sexes. The male genitalia, however, closely resemble those found in the genus *Triplectides* Kolenati.

In his study on the phylogeny and classification of the longhorned caddisfly family Leptoceridae, Morse (1981) included *Symphitoneuria* in the tribe Triplectidini of the subfamily Triplectidinae. The phylogeny of Triplectidinae was outlined by Morse and Holzenthal (1987), but they did not resolve the phylogeny of *Triplectides* sensu lato, and were inclined to regard the various monophyletic lineages identified as subgenera only. By suggesting the alternative, that *Symphitoneuria*, *Lectrides* Mosely in Mosely and Kimmins, *Symphitoneurina* Schmid, and *Triplectidina* Mosely, presently considered separate genera, apparently evolved from within *Triplectides*, the latter genus would be rendered paraphyletic. As implied by Morse (1989) further studies on the taxonomy, morphology and zoogeography of the *Triplectides* complex are essential to resolve this problem.

Including the new species described here, the genus *Symphitoneuria* now comprises seven species. With the exception of *S. dammermanni* Ulmer, all previously described species appear to be restricted to the Australian biogeographic region (Morse, 1989). *Symphitoneuria dammermanni* was described by Ulmer (1951) from the Sumba Islands, Indonesia, just west of Weber's line. Ulmer (1906) recorded females of *S. opposita* from Sulawesi (Celebes). Later,

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ENT. NEWS 109(1): 37-46, January & February, 1998

Martynov (1931) reported a male of this species (as *Notanatolica opposita*), also from Sulawesi, but did not describe it, even though the male of *S. opposita* was not known at that time. Banks (1913) further recorded *S. opposita* (as *Notanatolica opposita*) from the Philippines. Neboiss (1977) listed *S. opposita* from Sulawesi, but Morse (1989) suggested that these records might be misidentifications of *S. dammermanni* or the specimens might belong to some yet undescribed species. With the distribution of *S. opposita* in doubt, the description of *S. sabaensis*, n. sp., from Sabah (Borneo) confidently extends the known range of the genus further into the Oriental biogeographic region.

The material treated here was collected by the junior author during several trips to Sabah, Sarawak and Brunei between 1986 and 1990. Habitats collected ranged from lowland to montane (50 to 3300 m a.s.l.) primary forest types.

MATERIAL AND METHODS

The material was collected predominately with light traps and the specimens were preserved in 70% alcohol. Methods used in preparing, examining, and illustrating genitalia are those commonly used in the study of Trichoptera. The terminology is adopted from Morse and Neboiss (1982). Measurements are reported as total lengths, antennae length is given as the longest measured. Measurements are given as ranges, followed by the mean when more than three measurements were taken, and (in parentheses) by the number of specimens measured.

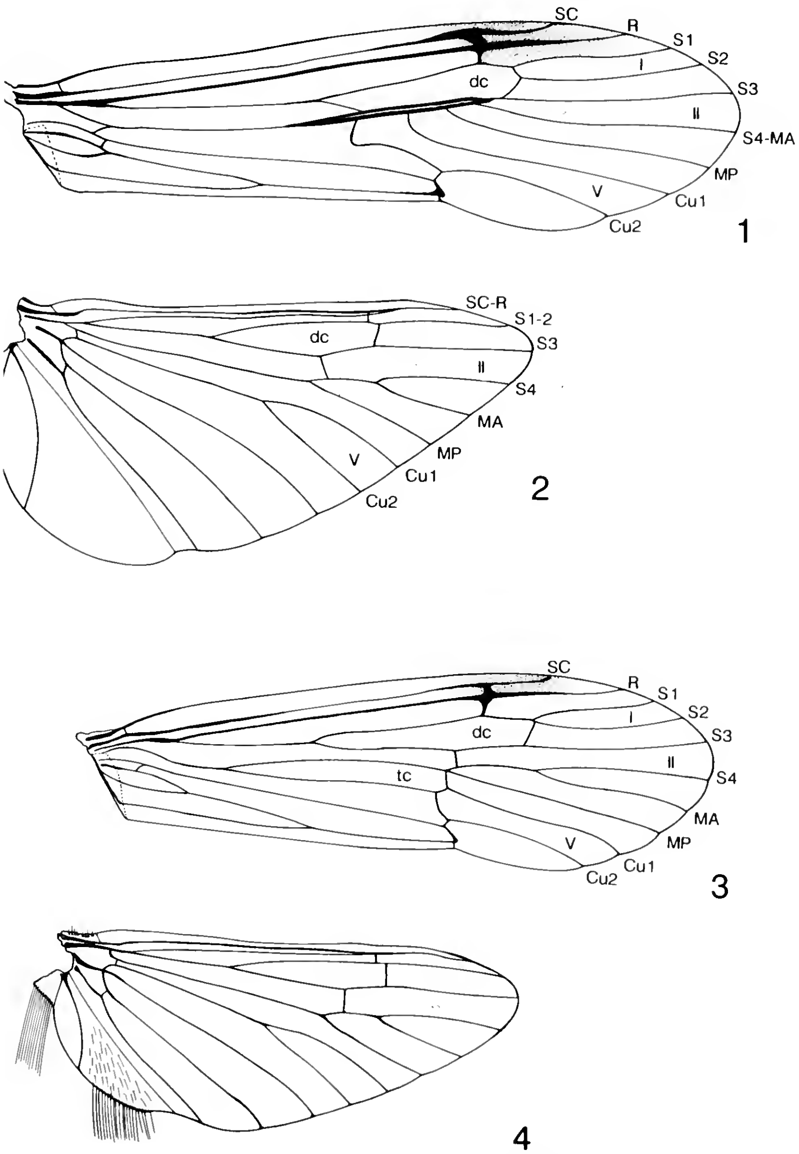
The holotype and paratypes of *Symphitoneuria sabaensis* n. sp. are deposited in the Nationaal Natuurhistorisch Museum (formerly Rijksmuseum van Natuurlijke Historie), Leiden, The Netherlands (RMNH); paratypes are also deposited in the University of Minnesota Insect Collection, St. Paul, Minnesota, USA (UMSP), the National Museum of Natural History, Smithsonian Institution, Washington, USA (USNM), and in the Museum of Zoology, University of Bergen, Norway (ZMBN).

Symphitoneuria sabaensis, Andersen and Huisman, NEW SPECIES

Figs. 1-16

Adult male (n=10, if not otherwise stated). Forewing length 8.8-10.9, 10.0 mm; hindwing length 6.0-7.8, 7.2 mm. Eye 0.43-0.56, 0.51 mm wide. Antennae at least 35.2 mm long including 0.45-0.52, 0.48 mm long antennal scape. Maxillary palp segment lengths (in mm): 0.42-0.52, 0.46; 0.61-0.72, 0.67; 0.71-0.84, 0.76; 0.37-0.47, 0.42; 0.72-0.85, 0.81. Color (in alcohol) yellowish brown.

Wings (Figs. 1-2). Forewing with crossvein sc-r broadened, and stigma present; apical forks I, II, and V present, i.e. forks of S_{1+2}, S_{3+4}, and Cu_{1+2}; fork I reaching basally beyond S; discoidal cell short and broad, slightly shorter than its stem, and nearly as broad as fork II; thyridial cell vestigial, veins M and Cu seemingly forming single, thick, composite longitudinal vein with S_{3+4} for apical five-sevenths of discoidal cell, with five veins, S_3, S_4 + MA, MP, Cu_1, and Cu_2, arising



Figures 1-4. ***Symphitoneuria sabaensis*** **n. sp. wings. 1. Male forewing. 2. Male hindwing. 3. Female forewing. 4. Female hindwing.**
Abbreviations: Cu = cubitus, dc = discoidal cell, MA = anterior media, MP = posterior media, R = radius, S = sector, SC = subcosta, tc = thyridial cell; I, II, V = primary apical cells, or "forks", I, II, and V.

from it; Cu_2 recurved about 100° basally, and arising from composite vein slightly basally to where S_{3+4} joins the composite vein; nygma faint, rectangular, present in fork II. Hindwing shorter and broader than forewing; apical forks II and V present; fork V originating about one-half of distance between origin of discoidal cell (fork of S) and fork of M; nygma faint, rounded, present in fork II.

Genitalia (Figs. 5-9). Segment IX narrow, subrectangular. Superior appendage about three-fifths as long as tergum X, narrow, setose, in dorsal view broader with rounded apex; with small lobe mesally at base bearing one strong seta. Tergum X about as long as inferior appendage; in lateral view with distinct step-like elevation middorsally and narrow apical portion projecting caudad; in dorsal view rounded, deeply cleft apically, with broadly rounded projections laterally, single to partly double row of 6-9, 8 (5) setae dorsally on each side; and 6-10, 9 (5) sensilla apically; with transverse reinforcing band ventrally at base of cleft and lateral, diagonal reinforcing ridge internally towards base. Inferior appendage with broad base, dorsally slightly convex; in ventral view with posteromesal corner rounded, forming nearly straight angle (90°); subbasally bearing few, long setae ventrolaterally; apicodorsal lobe rounded apically, setose, slightly shorter than harpago, with accessory projection mesally bearing 4-5, 5 (5) strong, spine-like setae, longest 0.064-0.076, 0.069 (5) mm long; in ventral view harpago slender, slightly sinuous, with apex hooked mesad; basoventral lobe curved caudad, setose, about one-third as long as inferior appendage. Phallus subcylindrical with slightly sinuous sides; ejaculatory duct narrow, conspicuous; phallotremal sclerite about half as long as tubular portion of phallus.

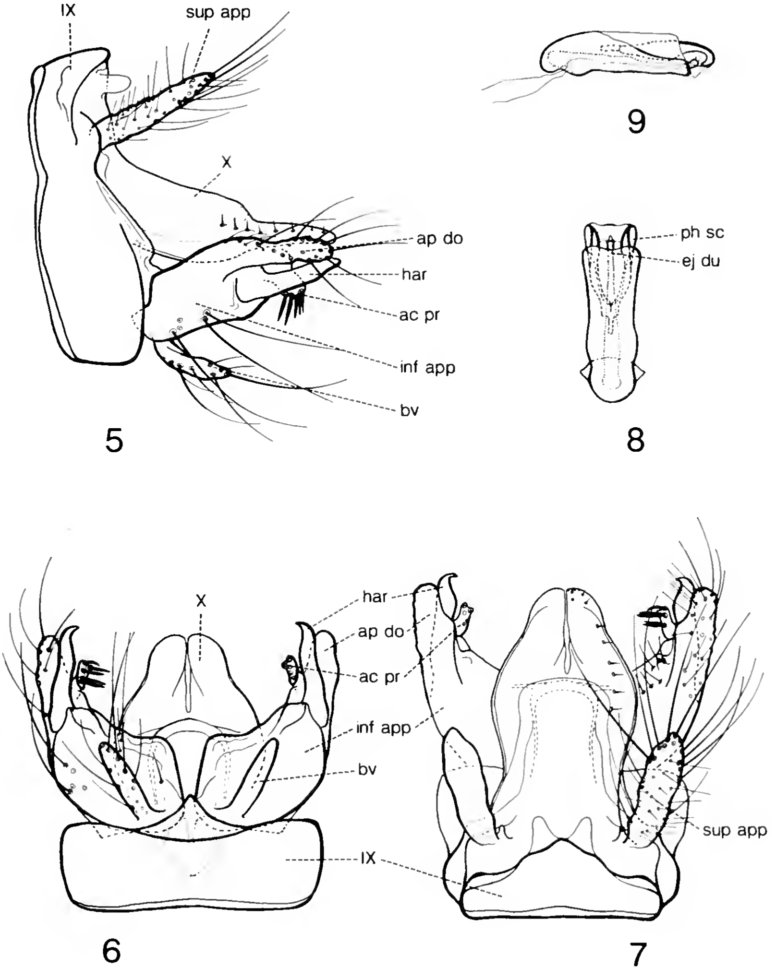
Adult female (n=10, if not otherwise stated). Forewing length 8.9-9.9, 9.4 mm; hindwing length 6.5-7.7, 7.2 mm. Eye 0.45-0.50, 0.47 mm wide. Antennae at least 27.9 mm long including 0.40-0.48, 0.45 mm long antennal scape. Maxillary palp segment lengths (in mm): 0.43-0.52, 0.47; 0.60-0.72, 0.68; 0.71-0.84, 0.79; 0.40-0.45, 0.42; 0.76-0.92, 0.85. Color (in alcohol) as in male.

Wings (Figs. 3-4). Forewing with crossvein sc-r broadened and stigma present; apical forks I, II, and V present; fork I sessile; discoidal cell long, subequal to thyridial cell in length; nygma faint, rectangular, present in fork II. Hindwing shorter and broader than forewing; apical forks II and V present; fork V long, originating about one-third of distance between origin of discoidal cell (fork of S) and fork of M; nygma faint, rounded, present in fork II.

Genitalia (Figs. 10-14). Abdominal segment VIII with sternum narrow, triangular, setose; in ventral view with posterior margin broadly rounded. Segment IX with tergum broad; pleuron with distinct, rounded corner laterally. Dorsal setose lobe narrow, triangular, attached along ventral surface; in dorsal view broadly rounded to subtriangular; with short, triangular semimembranous sensilla-bearing process, bearing one or occasionally two setae. Lamella with longitudinal striae on ventral surface; with double to triple row of slightly curved setae along posterolateral margin; apparently flexible both in posterior and in ventral direction, when in dorsal, (open) position narrowly triangular in lateral view (Fig. 10), in dorsal view subrectangular and pointing posterolaterad (Fig. 13); when turned more ventrad, (closed position), subtriangular with broadly rounded apex in lateral view (Fig. 11), in dorsal view rounded, pointing posteriad (Fig. 14); in some specimens apex turned further ventrad, (fully closed position), overlapping, forming roof-shaped hood. Gonopod plate apparently somewhat flexible, with straight or convex ventral margin in lateral view; in ventral view with posterior margin subrectangular, with small, rounded, median excavation. Spermathecal sclerite oval, broadly rounded anteriorly; in lateral view slightly curved, subrectangular; in all spent females twisted or positioned askew.

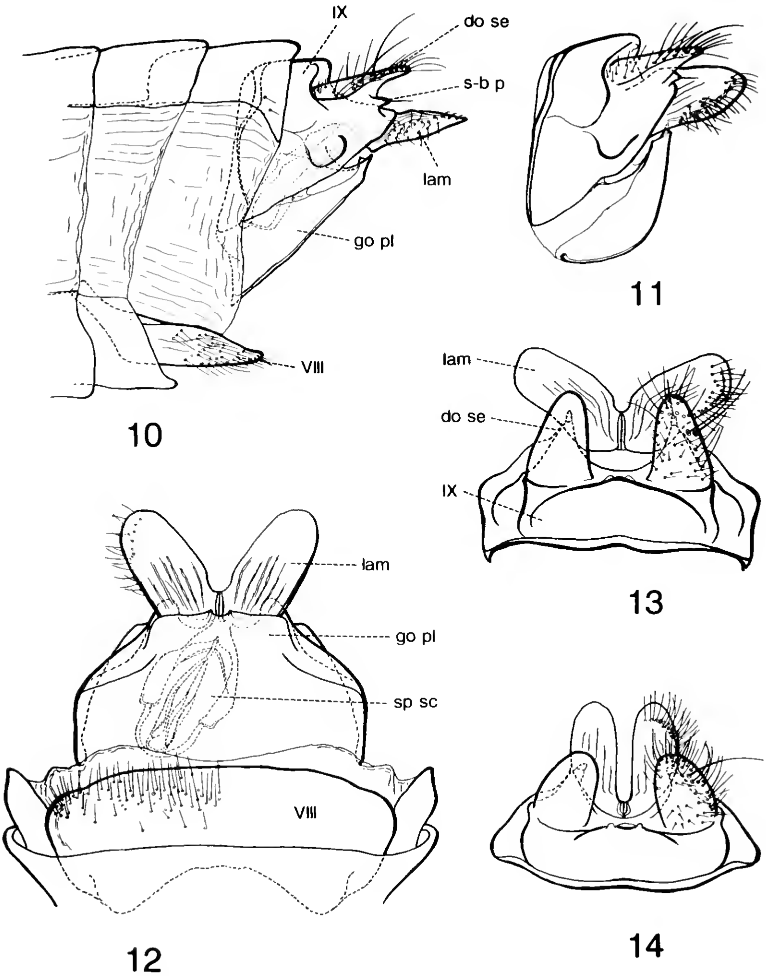
Egg mass (Figs. 15-16). Consisting of strings of eggs apparently glued together with transparent secretion, with scattered long setae, probably originating from the wing fringe, encrusted in the surface. Outline oval or slightly ovoid, with one side rounded, other side flatter with distinct groove where next layer of eggs begin. Egg mass 2.19-2.62 (2) mm long, 1.87-1.89 (2) mm wide, and 1.34-1.38 (2) mm thick.

Larva and pupa. Unknown.

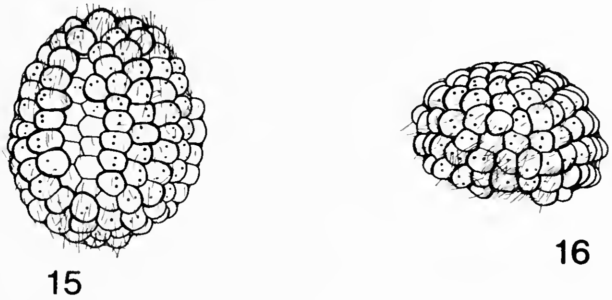


Figures 5-9. *Symphitoneuria sabaensis* n. sp. male genitalia. 5. Lateral. 6. Ventral. 7. Dorsal. 8. Phallus, ventral. 9. Phallus, lateral.

Abbreviations: ac pr = accessory projection of apicodorsal lobe of inferior appendage, ap do = apicodorsal lobe of inferior appendage, bv = basoventral lobe of inferior appendage, ej du = ejaculatory duct, har = harpago, inf app = inferior appendage, IX = segment IX, ph sc = phallotremal sclerite, sup app = superior appendage, X = tergum X.



Figures 10-14. ***Symphitoneuria sabaensis*** **n. sp. female genitalia. 10. Lateral, with lamella in open position. 11.** Lateral, with lamella in closed position. 12. Ventral. 13. Dorsal, with lamella in open position. 14. Dorsal, with lamella in closed position.
Abbreviations: do se = dorsal setose lobe, go pl = gonopod plate, IX = segment IX, lam = lamella, s-b p = sensilla-bearing process, sp sc = spermathecal sclerite, VIII = sternum VIII.



Figures 15-16. *Symphitoneuria sabaensis* n. sp. egg mass. 15. Ventral (flat side). 16. Lateral (blunt end).

Type material. HOLOTYPE: ♂, Malaysia, Sabah, Long Pa Sia area E of kampong, 25.xi-8.xii.1987, 1000 m a.s.l., Malaise trap 4, C. van Achterberg (RMNH). PARATYPES: 1 ♂, Long Pa Sia, riverbank near airstrip, 04°25'N 115°43'E, 1000 m a.s.l., 21.x.1986, J. Huisman (UMSP); 5 ♀, Long Pa Sia, airstrip, 04°24'N 115°43'E, 1000 m a.s.l., 16.iv.1987, at light, J. Huisman & J. van Tol (RMNH 3 ♀, NMNH ♀, ZMBN ♀); 1 ♀, Long Pa Sia, 04°25'N 115°43'E, 1000 m a.s.l., 1. xii.1987, J. Huisman & C. van Achterberg (UMSP); 4 ♀, Long Pa Sia, airstrip, 04°24'N 115°43'E, 1000 m a.s.l., 7.xii.1987, at light, J. Huisman (RMNH); 1 ♂, Sapulut, kampong, roadside, 4.v.1987, 04°42'N 116°29'E, 290 m a.s.l., at light, J. Huisman (ZMBN); 5 ♂, 4 ♀, 7 km S Nabawan, near old airstrip, pond, 14.xi.1987, 05°02'N 116°27'E, 400 m a.s.l., at light, J. Huisman & R. de Jong (RMNH); 1 ♂, 2 ♀, 11 km S Nabawan, pond on roadside, 15.xi.1987, 04°57'N 116°27'E, 400 m a.s.l., at light, J. Huisman & R. de Jong (UMSP); 1 ♂, 1 ♀, 12.5 km S Nabawan, on road to Kg. Pamuntariah, 1st bridge, 16.xi.1987, 04°57'N 116°27'E, 400 m a.s.l., at light, J. Huisman & R. de Jong (RMNH ♂, ZMBN ♀); 3 ♂, Kundassang kampong, Sg. Liwagu, on bridge, 23.viii.1986, 06°00'N 116°34'E, at light, J. Huisman (UMSP 2 ♂, ZMBN ♂); 1 ♂, 1 ♀, Kundassang kampong, Sg. Liwagu, on bridge, 23.xi.1986, 06°00'N 116°34'E, 1185 m a.s.l., J. Huisman (NMNH ♂, UMSP ♀).

Etymology: named after Sabah, the northeastern part of the Island of Borneo, using the Latin suffix *-ensis*, denoting place, locality or country of origin.

KEY TO MALES OF *SYMPHITONEURIA*

1 Apicodorsal lobe of inferior appendage with setose, accessory projection mesally 2
1' Apicodorsal lobe of inferior appendage lacking setose, accessory projection mesally 6
2 Tergum X about as long as inferior appendage; fork I in forewing sessile 3
2' Tergum X distinctly longer than inferior appendage, in dorsal view triangular, pointed, with deeply cleft apex; fork I in forewing with short stem (Mosely and Kimmins, 1953: 260, figs. 180-181) .... *S. exigua* (McLachlan)
3 Forewing with discoidal cell short and broad, with crossvein r-s reaching discoidal cell in distal one-fifth; fork V in hindwing long, originating distinctly closer to base than fork of M 4

3' Forewing with discoidal cell long and narrow, with crossvein r-s reaching discoidal cell about two-thirds from base; fork V in hindwing short, originating about the same distance from base as fork of M (Mosely and Kimmins, 1953: 263, fig. 183) .... *S. opposita* (Walker)
4 Tergum X in dorsal view with apex rounded to bluntly triangular 5
4' Tergum X in dorsal view with apex subtruncate (Morse, 1989: 207, fig. 2) .... *S. dammermanni* Ulmer
5 Tergum X in dorsal view gradually widened basally, with apex bluntly triangular; accessory mesal projection of apicodorsal lobe of inferior appendage with more than 6 spine-like setae (Neboiss, 1987: 140, fig. 40) .... *S. ampla* Korboot
5' Tergum X in dorsal view with broadly rounded and projecting sides and rounded apex; accessory mesal projection of apicodorsal lobe of inferior appendage with 4-5 strong spine-like setae (Figs. 5-7) .... *S. sabaensis* n. sp.
6 Inferior appendage with harpago fused almost entirely to apicodorsal lobe, basoventral lobe not forked (Mosely and Kimmins, 1953: 268, fig. 187) .... *S. wheeleri* Banks
6' Inferior appendage with harpago free, basoventral lobe forked (Neboiss, 1986: 222, figs. 38-40) .... *S. licmetica* Neboiss

DISCUSSION

The male wing venation of *S. sabaensis* most closely resembles that of *S. ampla* Korboot and *S. dammermanni*, especially in the comparatively short and broad forewing discoidal cell and the long hindwing fork V. However, it differs from both in having Cu_2 arising from composite vein slightly basally to where S_{3+4} joins the vein. The setose mesal accessory projection on the apicodorsal lobe of the inferior appendage of the male genitalia, groups *S. sabaensis* with *S. ampla, S. dammermanni, S. exigua,* and *S. opposita.* It can be distinguished, however, from all known species of *Symphitoneuria* by the rounded apex and broadly rounded and projecting sides of tergum X.

The female of *S. sabaensis* can be separated from other described females except *S. exigua* in having the posterior margin of the gonopod plate subrectangular, with a small, rounded, median excavation. However, *S. exigua* appears to have the posterior margin of sternite VIII with a shallow, broadly V-shaped, median excision, while the posterior margin in *S. sabaensis* is evenly rounded.

Biology. Little seems to be known about the ecology and habitat requirements of most of the *Symphitoneuria* species. St Clair (1994) described the larvae of *S. exigua* and stated that it is usually found in small, sluggish, often turbid lowland streams and swamps. According to Illies (1969) *S. ampla* appeared to be the most abundant Trichoptera species in Lake Pinde and Lake Aunde at about 3,600 m a.s.l. on Papua New Guinea. The present specimens were taken in localities ranging from 290 to 1185 m a.s.l., mostly along fast flowing rivers, but also close to stagnant blackwater pools.

In some genera of Triplectidini the females carry egg masses at the tip of their abdomen (see e.g. St Clair, 1993). Korboot (1963) studied the life history of *S. exigua,* figuring and describing the egg mass as spherical and covered in a layer of mucilage. The egg mass was dropped by the female from a height of 3 to 4 inches into the water. Although none of the females of *S. sabaensis* n. sp. had their egg masses still attached when studied, the females apparently carry the egg mass between sternum VIII and the gonopod plate. Sternum VIII appears to be movable and a cavity is formed in the pleural region of segment VIII. Setae probably originating from the wing fringe and imbedded in the egg mass were seen inside the cavity in several of the females. The apparent flexibility of the lamella, which allow for movement in both posterior and ventral directions, might also be an adaptation for manipulation of the egg mass.

ACKNOWLEDGMENTS

The senior author wants to express his gratitude to Ralph Holzenthal and the University of Minnesota for making it possible for him to spend his sabbatical at the Minnesota Insect Collection, and to the University of Bergen for financial support.

The junior author received financial support for the field work in Sabah from Uyttenboogaart-Eliasen Foundation, Melchior Treub Foundation, and the National Museum of Natural History in Leiden. In Sabah, the staff of Kinabalu National Park was very supportive particularly Anthea Lamb-Phillips and Fui-Lian Inger-Tan; Jan van Tol, Cees van Achterberg and Rienk de Jong participated in the fieldwork.

We both want to thank Ralph Holzenthal and John C. Morse for all support and useful comments on the manuscript.

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(continued from page 20)

The Basmati rice was immediately detained by FDA after live insects were found and the presence of khapra beetle suspected. Once the larvae found in the rice were positively confirmed as khapra beetle by USDA, the rice shipment was fumigated with methyl bromide under USDA supervision. A reconditioning plan was proposed by the importer to salvage the rice, but it was subsequently refused. After no further response by the consignee, the shipment was issued a notice of refusal and was ordered to be exported or destroyed under U.S. Custom's supervision.

A personal communication with J. F. Cavey, Entomologist, USDA-APHIS-PPQ in Riverdale, MD, provided additional records of khapra beetle interceptions into the United States. He stated that within the last five years, 35 interceptions of khapra beetle by USDA-APHIS-PPQ officers were recorded at ports of entry into the United States, with the majority of these interceptions occurring in Texas, Georgia, and California. Ours is the only record of the khapra beetle found entering Baltimore, MD during this time.

ACKNOWLEDGMENTS

We thank Susan Broda-Hydorn, Identification Specialist, USDA-APHIS-PPQ, Baltimore, MD for her confirmation of our identifications and Joseph F. Cavey, Entomologist, USDA-APHIS-PPQ, Riverdale, MD, for his contribution of unpublished data on khapra beetle interception records by the USDA into the U.S. since October, 1992.

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A NEW SPECIES OF *TOMOCERUS (S.S)* (COLLEMBOLA: TOMOCERINAE) FROM CHINA[1]

Y-T. Ma[2] K. A. Christiansen[3]

ABSTRACT: A new Chinese species, *Tomocerus cheni*, from China is described. It is similar to the Japanese *T. cuspidatus*, Börner 1909, but differs in body color, unguiculus and other features.

Nearly 50 species have been described in the genus *Tomocerus (s.l.)*; however, only 12 species were described or reported from China: *Tomocerus (Tomocerina) minutus* Tullberg 1876 from Shanxi and 11 species in the genus *Tomocerus (s.s.)*: 4 from Tibet (*monticolus, obsculus, parvus* and *zayensis* Huang and Yin 1981), 2 from Yunnan (*varius* Folsom 1899 and *folsomi* Denis 1929), *caputiviolaceus* Lee 1975 and *cuspidatus* Börner 1909 from Taiwan, *kinoshitai* Yosii 1954 from Hunan, *ocreatus* Denis 1948 from Zhejiang, and *sibiricus* Reuter 1891 from Hebei. A new species of the subgenus *Tomocerus (s.s.) cheni*, from Anhui Province, is described here.

Tomocerus (S.S.) cheni, NEW SPECIES

Color: Background color pale yellow with purplish blue pigment. Head dark with irregular pale spots; eye patches dark. Antennal segments I, IV and basal part of III pigmented, II and most distal part of III pale. Thoracic segments and anterior margin of abdominal segment I irregularly pigmented. Abd. V & VI sometimes with a few scattered pigment patches. Base of coxae with dark pigment. Tibiotarsus with scattered pigment (Fig. 1).

Head: Antennae short, respectively 0.5-0.8 and 2.7-3.1 times as long as body and Cephalic diagonal; ratios of Ant. I-IV = 1.0/1.4-2.0/4.5-7.3/1.2-2. Eyes 6+6, A & B largest, E & F smallest (Fig. 2). Labral setae 4/5,5,4, marginally with 4 recurving spinules. Head capsule anteriorly with 2,4 large setae, posteriorly with 43-54 small setae (Fig. 3).

Body: Thoracic macrochaetae and bothriotricha as shown in Fig. 4. Trochanteral organ not clearly seen. Unguis rather slender; a pair of well developed pseudonychia 1/3-1/2 as long as inner edge of unguis; inner teeth 5-7, 5-7 & 5-6 respectively on legs I-III. Unguiculus lanceolate with 1 outer tooth and 1-2 inner teeth. Tenent hair well developed, as long as inner edge of unguis, apex spatulate (Fig. 5). Tibiotarsus with numerous pointed smooth setae in different sizes; ventral side with 3-4(5), 6(4,8), 6-8 large blunt spinelike setae respectively on legs I-III (Fig. 6).

Abdominal macrochaetae and bothriotricha on segments I-V as shown in Fig. 4. Tenaculum unscaled with 4+4 teeth, corpus with 8-12 smooth setae (Fig. 7). Ventral tube scaled, posterior face with numerous smooth setae in different sizes, anterior face not clearly seen, lateral flap with about 70 smooth setae in different sizes (Fig. 8). Ratios of manubrium/dens/mucro = 2.8-4/5-5.6/1. Manubrium laterally with a row of large ciliate setae on each side, these setae more strongly tapered near tip; dorsally with 2 longitudinal bands (setaceous stripes, Yosii 1967) of numerous weakly ciliate to striate, acuminate setae in different sizes, about 20 of them very

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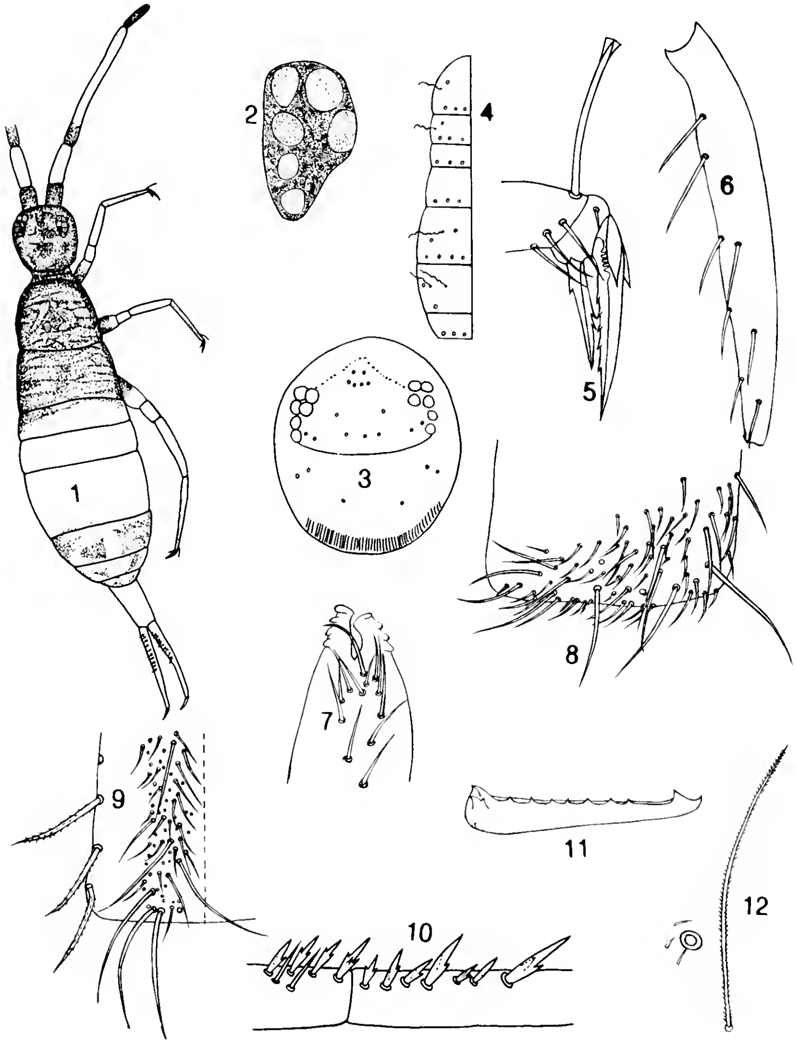
ENT. NEWS 109(1): 47-50, January & February, 1998



Tomocerus cheni, All figures of type specimens. Fig. 1. Habitus; 2. Eyes of left side; 3. Cephalic chaetotaxy; 4. Chaetotaxy of body; 5. Hind foot complex; 6. Large setae of hind tibiotarsus; 7. Tenaculum; 8. Lateral flap of ventral tube; 9. Left half of distal part of manubrium (dorsal view); 10. Dental spines; 11. Mucro; 12. Setulae at base of macrochaeta and bothriothrix.

large; no scales present between setaceous bands (Fig. 9). Dental spines as 4(3)-5/3(2)-5,1,2(1,4),1; heavy chestnut brown and each with 2(3) secondary teeth (spinules) near base. 1-2 (rarely 3) small, finely ciliate, spiny setae present interior to basal dental spines (Fig. 10). Mucro elongate with numerous ciliate setae; outer dorsal lamella with 5-7 intermittent teeth; outer basal tooth with a corner toothlet; apical and anteapical teeth subequal (Fig. 11). Upper anal flap of Abd. VI with 7 large, striate primary setae arranged in an irregular transverse row.

Scales brownish, hyaline and heavily striated. Each trunk macrochaeta surrounded by 3-6 setulae, bothriotricha without setulae at base (Fig. 12).

Size: Maximum length 3.6 mm.

Type materials Holotype: ♀, China: Anhui Province, Yellow Mt., VII-16-1990, leaf litter in deciduous forest and in moss, collection number 8223.

Paratypes: 7 ♀♀, same data as holotype, collection numbers 8223 & 8213

Other locality: 1 ♀, Anhui: Jinzhai County: Tiantangzhai Park, collection number 8306. All specimens will be deposited in the Department of Biology, Nanjing University.

Etymology: This species is named after Prof. Jian-xiu Chen in the Department of Biology, Nanjing University, whose help was essential.

DIAGNOSIS

The large manubrial dorsal setae ("principal setae" of Yosii 1967) are acuminate in *T. cheni* sp. nov. rather than blunt. This species is very similar to *T. cuspidatus* Börner 1909; however, it differs from the latter as shown below:

	cheni	*cuspidatus**	*cuspidatus***
Maximum body length	3.6	6.0	6.5
Scales on tenaculum	absent	present	?
Blunt "principal" setae on manubrium	absent	2+2,1	?
Spinules on dental spine	2(3)	3-6	3-5

* sensu Yosii 1967
** sensu Lee 1975
? unknown

ACKNOWLEDGMENTS

We would like to express our thanks to Mr. Liu Ren-hua who inked all the final drawings for the present paper. Thanks are also given to Prof. Byung-Hoon Lee and Prof. Jian-xiu Chen for their great help to this work. This work was published with a grant from Grinnell College.

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(continued from page 36)

is primarily a predator, then secondarily an herbivore and detritivore (Wiggins, 1984). The internal environment of the pitcher plant leaves offers live larvae of other species, plant materials, and numerous decomposing remains. Analysis of the larval gut contents revealed numerous pieces of insect cuticle that may have been consumed while the larvae were inside the pitchers.

ACKNOWLEDGEMENTS

We would like to thank the U.S.D.A.-Forest Service (Eastern Region), especially Keith Jensen and Martin MacKenzie for partial support during the course of this project. We also thank Dr. Oliver S. Flint, Jr. (Department of Entomology, Smithsonian Institution, Washington, D.C.) for helpful suggestions. R. Hamilton is supported in part by a fellowship from a National Science Foundation Graduate Traineeship in Plant Biology (GER 9354916). Voucher specimens are held in the Department of Biology, Howard University, Washington, D.C. (RMD). Ecological report #5.

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TOMOCERUS (*s.s.*) *SPINULUS* (COLLEMBOLA: ENTOMOBRYIDAE), A NEW SPECIES OF CHINESE SPRINGTAIL[1]

J-X. Chen[2], K. A. Christiansen[3]

ABSTRACT: A new Chinese species, *Tomocerus spinulus*, from Anhui Province China is described here. It is closest to the Pakistan species *T. asoka* Yosii, 1965 and the Japanese species *T. viridis* Yosii, 1967.

Nearly 50 species have been described in the genus *Tomocerus* s.l.; however, only 12 species were described or reported from China: *Tomocerus (Tomocerina) minutus* Tullberg 1876 from Shanxi and 11 species in the genus *Tomocerus* (s.s.; 4 from Tibet (*monticolus, obsculus, parvus,* and *zayensis* Huang and Yin 1981), 2 from Yunnan (*varius* Folsom 1899 and *folsomi* Denis 1929), *caputiviolaceus* Lee 1975, *cuspidatus* Borner 1909 from Taiwan, *kinoshitai* Yosii 1954 from Hunan, *ocreatus* Denis 1948 from Zhejiang, and *sibiricus* Reuter 1891 from Hebei. A species of the subgenus: *Tomocerus (s.s.) spinulus*, is described here.

Tomocerus (s.s.) spinulus, NEW SPECIES

Color: background pale yellow with purplish blue pigment. Head with pale, scattered pigment on anterior margin between antennae. Eye patches dark. Lateral sides of Ant. I & II pale purplish blue; Ant. III gradually darker from base to apex. Ant. IV totally dark. Pattern as shown in Fig. 1. Distal half of tibiotarsus with pale, scattered pigment.

Head: Eyes 6+6, A & B larger, others subequal. Antennae up to 1.3 mm long; ratio of antenna/cephalic diagonal: 2.9/1 to 3.2/1; average segment ratios: 1-4 = 1/1.2-1.6/6.67-7.67/1-1.4. Head capsule with 2,4 anterior setae and about 40 small setae in a transverse row at posterior margin (Fig. 2). Labral setae 4,5,5,4 with 4 marginal recurving spinules (Fig. 3).

Body: Thorax with dorsal chaetotaxy and bothriotricha as in Fig. 4. Unguis rather slender; a pair of well developed pseudonychia, about 0.25-0.35 as long as inner edge of unguis; inner teeth 5-6 on all 3 pairs of legs. Unguiculus lanceolate with 1 inner tooth. Tenent hair well developed and spatulate, about as long as inner edge of unguis (Fig. 5). Tibiotarsus with numerous pointed smooth setae in different sizes, and legs I-III respectively with 3-4, 4-6, 6-8 apically tapered spine-like setae on ventral side (Fig. 6). Trochanteral organ reduced with 1/1 smooth setae (Fig. 7).

Abdominal segments 1-5 with dorsal chaetotaxy and bothriotricha as in Fig. 4. Tenaculum unscaled, corpus with 4-7(9)* smooth setae (Fig. 8). Ventral tube scaled, anteriorly with 18 smooth

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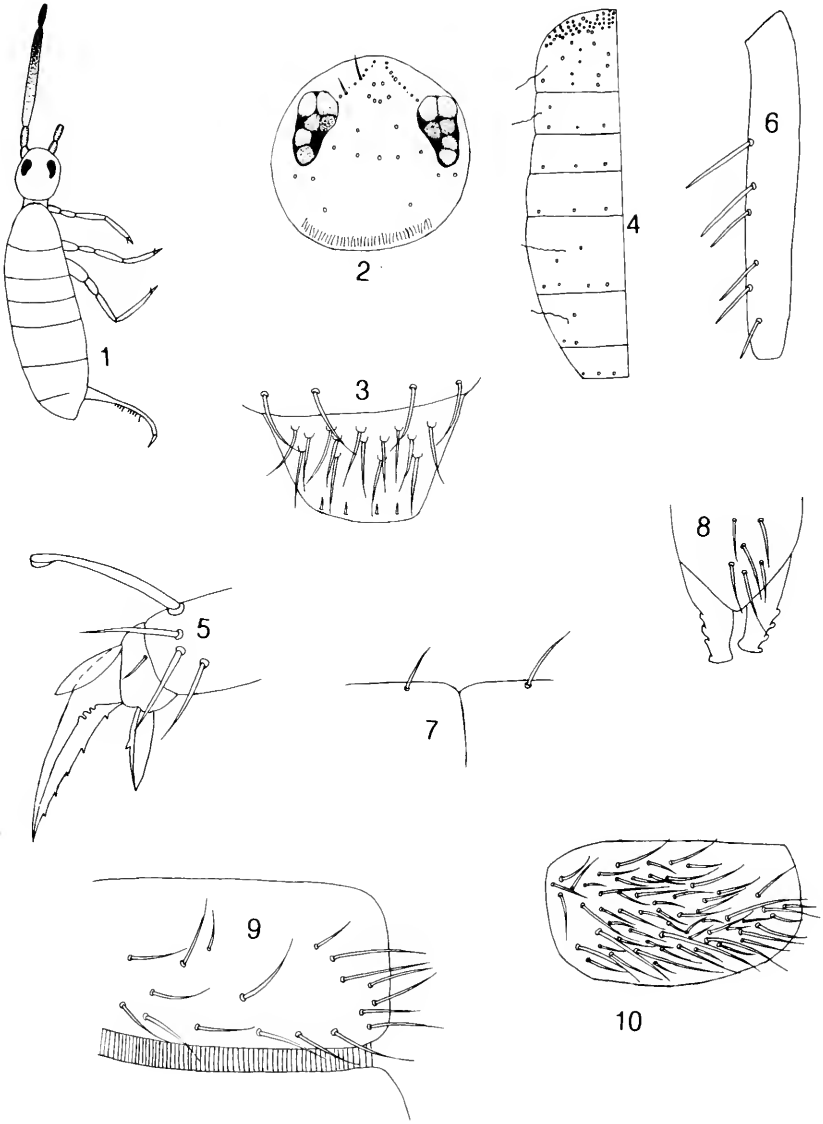
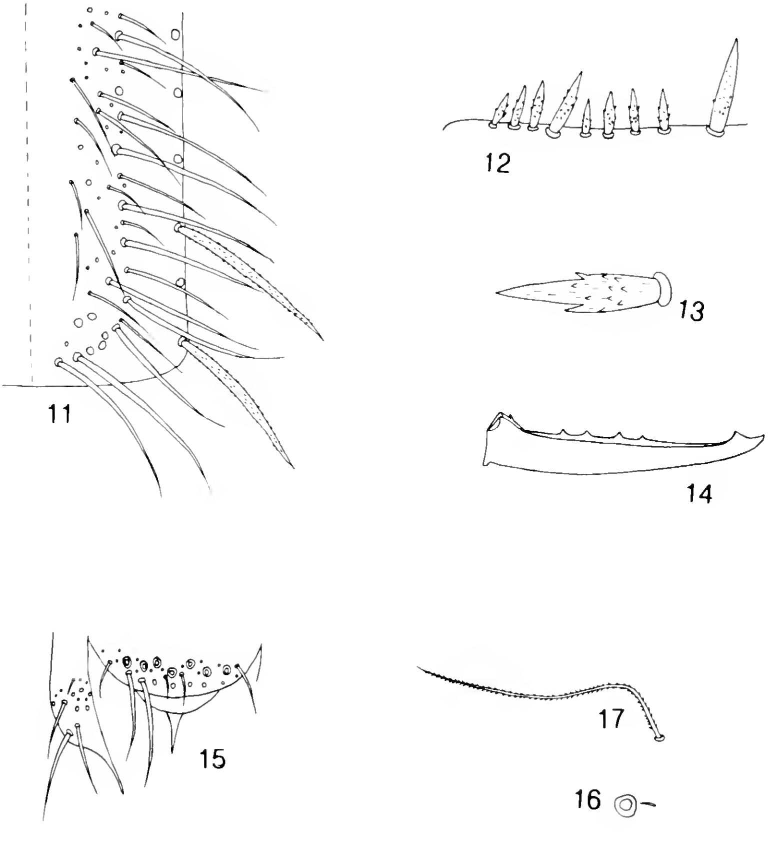
* Numbers in parentheses represent unusual conditions.



Tomocerus spinulus. All figures of type specimens. 1. Habitus; 2. Head, 3. Labrum, 4. Chaetotaxy of body, 5. Hind claw, 6. Hind tibiotarsus, 7. Trochanteral organ, 8. Tenaculum, 9. Anterior face of ventral tube, 10. Lateral flap of ventral tube.



Tomocerus spinulus. All figures of type specimens. 11. Distal part of manubrium (dorsal view), 12. Dental spines, 13. Single dental spine, 14. Mucro, 15. Upper anal valve of Abd. VI, 16. Microsetae at base of macrochaeta, 17. Bothriothrix.

setae (holotype) on each side (Fig. 9), posteriorly with numerous smooth setae in different sizes; lateral flap with about 60 smooth setae in different sizes (Fig. 10). Ratios of manubrium/dens/ mucro = 2.3-3.0/3.3-4.0/1.0. Manubrium with a longitudinal band of lateral setae on each side and 2 longitudial bands of setae on dorsal side; lateral setae large, weakly ciliated, gradually tapering but more strongly tapering and pointed distally; each dorsal band of setae consists of numerous setae in different sizes, those in outer row and at distal part very large; all setae very weakly ciliate to striate and pointed; no blunt "principal setae" present; scales present between longitudinal bands of setae (Fig. 11). Dental spines dark chestnut brown, formula 4(3)/4(3)-5,I, each with many tiny teeth (spinules) (Fig. 12 & 13). Dentes without inner differentiated swollen scales or outer spine-like setae. Mucro elongate, with numerous ciliate setae; outer dorsal lamella bearing 3-6 intermediate smaller teeth; outer basal tooth with a corner toothlet; apical and anteapical teeth subequal (Fig. 14). Dorsal anal valve of Abd. VI with 7 large setae arranged in an irregular transverse row (Fig. 15). Body scales brownish, hyaline and heavily striate. Each body macrochaeta surrounded by 0(1-2) setulae (Fig. 16). Bothriotricha not surrounded by setulae (Fig. 17).

Size: Maximum body length 2.7 mm.

Etymology: The name of this species is derived from the Latin spinula = spines. It refers to the numerous spinules on dental spines.

Type materials. Holotype: male, China: Anhui Province, Yellow Mt., VII-16-1990, collection numbers 8220 & 8221. Jian Xiu Chen coll. Deposited in the Department of Biology, Nanjing University.

Paratypes: 10 females & 4 males, same data as Holotype.

DIAGNOSIS

This species bears some similarity to the widespread *T. ocreatus* but can easily be distinguished by the much finer denticulations on the dental spines, the smaller number of tenacular setae and the unguis shape. It also resembles the Korean species *jesonicus* Yosii 1967 and *spinistriatus* Lee 1975 as well as the Tibetan species *zayuensis* Huang and Li 1981 but may be readily separated as shown below:

Character	*spinulus*	*jesonicus*	*spinistriatus*	*zayuensis*
Dental spines	4(3)/4(3)-5,I	5-6/5-6,I,1,I	5-6,I/6-7,I	3,3/3-4,II
Tenaculum setae	4-7 (9)	15	1	?
Unguiculus tooth	+	-	+	-

*Tomocerus spinulus** is much more similar to the Pakistan species *T. asoka* Yosii & Ashraf 1965 & Japanese species *T. viridis* Yosii 1967. It shares features such as the structure of claw and the number of dental spines; however, it differs from them in the body color and the features listed in the following table.

	SPECIES		
Character	*spinulus*	*asoka*	*viridis*
Spinules on dental spines	tiny but numerous	absent	absent except on distalmost spine
Thick spine-like setae on tibiotarsi	3-4, 4-6, 6-8	?	5, 5, 5
Tenacular setae	4 - 7 (9)	15	2
Maximum body length (in mm.)	2.7	5.0	2.0

*Found in leaf litter in a deciduous forest.

ACKNOWLEDGMENTS

We would like to thank Mr. Ma Yi-tong in the Department of Biology of Nanjing University, whose help was essential for this work. Publication of this work was made possible by a grant from Grinnell College.

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SPECIES DISTINCTION IN ABDOMINAL PIGMENTATION PATTERNS BETWEEN FEMALES OF *DROSOPHILA MELANOGASTER* AND *D. SIMULANS*, FROM A SPANISH POPULATION[1]

Karel Th. Eisses[2,3], Mauro Santos[2]

ABSTRACT : The sibling species *Drosophila melanogaster* and *D. simulans* coexist in natural conditions. Whereas males are easily recognizable by their genital arches, females were considered to be indistinguishable but for their eye sizes. In many papers separate female counts were omitted because of this difficult characteristic. However, the abdominal pigmentation pattern was found to be different between the two species in a Spanish population. The discrimination of the females based on pigmentation differences was checked by electrophoresis and found to be very reliable.

Since the discovery of Sturtevant (1919) that *Drosophila melanogaster* has a closely resembling sibling species *D. simulans*, both species are known to be cosmopolitan and coexistent (Lachaise et al., 1988). In some population screens the authors make no effort to distinguish the females of the two species, and only mention their grand total (Tantawy & Soliman, 1967; references in Lachaise et al., 1988). Most often, research starts with isofemale lines and checking their progeny in which the males of the two species are distinguishable due to different genital arches (Burla, 1951; Coyne, 1983; Sturtevant, 1919). Based on measurements of eye sizes of *D. melanogaster* and *D. simulans*, it is possible to make a distinction between the females (Burla, 1951; Gallo, 1973; McNamee & Dytham, 1993) but it is a painstaking job when large numbers of flies have to be examined. Okada (1956) described a way of discrimination based on differences in egg guides, but this character also necessitates much practice to distinguish the two species. A high number (up to 45 %) of misqualifications of *D. melanogaster* have been reported, based on different eye size definitions (McNamee & Dytham, 1993 and references therein).

We used flies captured in traps in Carboneras (Almería, Spain) to see if a way of morphological distinction by abdominal pigmentation differences (Gallo, 1973) might be applicable in our population of *D. melanogaster* and *D. simulans*. Eye size was used as the character to separate the species, but we also checked the pigmentation of the sixth tergite to see whether a useful correlation existed.

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Females emerging from *Opuntia ficus-indica* fruits were primarily discriminated by the pigmentation pattern of the sixth tergite. All flies deemed *D. melanogaster* were subjected to electrophoresis for other reasons (Eisses and Santos, 1997).

MATERIALS AND METHODS

Flies were captured with mashed banana traps during five days in the Carboneras area (Almería, Spain; 37°00'N; 1°53'W) and locations nearby (Eisses and Santos, 1997). *Opuntiaficus-indica* fruits (prickly pears) were put in trays in a semi-abandoned *O. ficus-indica* plantation and left for almost seven days in the field. After recollection, the fruits were placed in glass jars, and emerging flies were aspirated. Captured and emerged flies were checked for *D. melanogaster* morphology and frozen at -29 °C until electrophoresis.

ADH is a diagnostic enzyme between *D. melanogaster* and *D. simulans* because of clearly distinctive bands in gel electrophoresis (Eisses, Van Dijk & Van Delden, 1979).

RESULTS

The apparent *D. melanogaster* females trapped in the *O. ficus-indica* plantation near Carboneras were separated from *D. simulans* by eye size only, whereas flies from the other locations were separated at the species and sex level by eye size and genital arches. After electrophoresis the number of misqualifications of *D. melanogaster* was calculated (Table I A). Almost 21 % of the female flies turned out to be *D. simulans* (Table I A 1). For females and males together a general misqualification of 11 % was obtained (Table I A 2).

Table I. Number of flies initially separated as *D. melanogaster* and percentage of misqualifications based on electrophoresis of flies trapped in banana baits in a semi abandoned *O. ficus-indica* plantation (A 1) and other locations close to Carboneras (A 2), and of flies emerging from *O. ficus-indica* fruits collected at the plantation (B).

Method of distinction	No. initially separated as *D. melanogaster*	% actually determined as *D. simulans*
'A 1 Eye size	226 females	20.8
2 Eye size / Genital arch	437 females / males	11.0
B Pigmentation of 6th tergite and eye size	1078 females	1.68 ± 0.26*
Genital arch	1092 males	0.64 ± 0.034

*Empirical Standard Deviation

Flies emerging from *O. ficus-indica* fruits were separated primarily by the morphological distinction of the pigmentation pattern of the sixth tergite (Fig. 1) and in cases of doubt the eye size was examined as well. Approximately equal numbers of female and male flies were checked by each of us. After checking the flies with electrophoresis, the average percentage of misqualifications of the females was calculated to be 1.68 % ±0.26. This is in the same order as misqualifying male flies (Table I B).

The most important difference between *D. melanogaster* and *D. simulans* females is the black pigmentation of the sixth tergite, which runs to the ventral margin in *D. melanogaster*, whereas the pigmentation border line in *D. simulans* makes an angle with the tergite margin. It forms a continuous line with the pigmentation border line in the seventh tergite (Fig. 1 a). In contrast with an apparently monomorphic *D. simulans*, we observed large variation in abdominal pigmentation patterns in this natural population of *D. melanogaster* and also in some laboratory strains (Fig. 1 b - i).

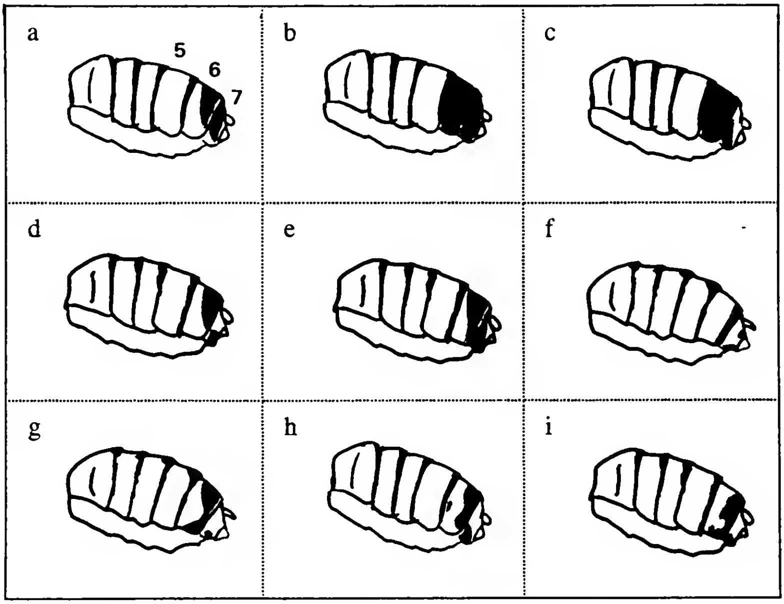

Figure 1. Pigmentation patterns of the 6th and 7th tergite of *D. simulans* (a) and *D. melanogaster* (b - i). Within *D. melanogaster* variation was present in wild type populations and in homozygous or isogenic laboratory strains Groningen SSN (b) and Groningen FFF (d). None of the *D. melanogaster* strains was monomorphic.

We have demonstrated that distinction between females of a natural population of *D. melanogaster* and *D. simulans* in Spain can be made in an easy and reliable way. As similar observations have been made on females from a Brazilian population (Gallo, 1973) and from a midwestern U.S. population (Thompson, Hisey & Woodruff, 1979) it might be generalized to more populations of *D. simulans*. It seems worthwhile to excavate information about other *D. simulans* populations with respect to female abdominal pigmentation of the sixth tergite to establish whether or not *D. simulans* is world wide monomorphic for this character in contrast to *D. melanogaster* (Robertson, Briscoe & Louw, 1977; David, Capy & Gauthier, 1990). Robertson, Briscoe and Louw (1977) described the focus *fap* (female abdomen pattern) to be residing on the extreme tip of the 3L chromosome, with some effects from the fourth chromosome. This might be the reason why the *D. melanogaster* Groningen-FFF strain, used as a reference in electrophoresis, showed a pigmentation pattern in the sixth tergite like *D. simulans* (Fig. 1 d). This strain is partly homozygous for the second chromosome and the third chromosome.

ACKNOWLEDGMENTS

Montse Peiro is thanked for helping with electrophoreses of the flies and Albert Kamping (University of Groningen) for providing the Groningen reference strains of *Drosophila melanogaster*. Prof. Wim Scharloo and Dr. Agustí Galiana are thanked for their comments on an earlier draft. This work was funded by Contract No. CHRX-CT92-0041 from the Commission of the European Communities, and grant PB-0843 from the DGICYT (Spain) to A. Eontdevila.

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CURTIS W. SABROSKY

The American Entomological Society deeply regrets the recent passing of Dr. Curtis W. Sabrosky, a friend and Honorary Member of the Society. Although a long time member of the Entomological Society of Washington, DC, in recent years, following his move to Medford Leas, Medford, NJ, Curtis regularly attended meetings of the American Entomological Society.

Because Curtis was honored in 1982 in a "festschrift" (Vol. 10) edition of the Memoirs of the Entomological Society of Washington, only a brief notice is now planned by the Washington Society, together with publication of a complete bibliography of his entomological contributions.

– H.P.B.

SYNONYMIC NOTES ON SOME OF THOMSON'S NEW WORLD DOLICHOPODIDAE (DIPTERA)[1]

Daniel J. Bickel [1]

ABSTRACT: Types of four New World Dolichopodidae described by C.G. Thomson (1869) from material gathered during the voyage of the Swedish frigate *Eugenie* were examined. Three new synonyms are established. *Dolichopus lamellicornis* is a senior synonym of *Hygroceleuthus afflictus*. Of three overlooked species described by Thomson from Puna, Ecuador, *Chrysotus ochropus* is redescribed and regarded as a senior synonym of *C. flavipalpus*, *Psilopus zonatulus* is a junior synonym of *Condylostylus longicornis*, and *Psilopus pleuralis*, known only from the female type, is referred to the *Condylostylus caudatus* group.

While completing a faunal study of the Galápagos Dolichopodidae (Bickel & Sinclair, in press), I had the opportunity to examine some New World dolichopodid types described by C.G. Thomson, 1869 from material gathered during the voyage of the Swedish frigate *Eugenie* (see Persson, 1971 for an authoritative account of the collecting localities). Some of these species had been overlooked in revisions of New World dolichopodid genera, and/or had been omitted from major catalogues. Three of the species proved to be synonyms. These matters are discussed below.

Dolichopus lamellicornis Thomson.

Dolichopus lamellicornis Thomson, 1869: 511.
Hygroceleuthus afflictus Osten Sacken 1877: 313. **NEW SYNONYM.**

Dolichopus lamellicornis was overlooked in the principal revision of North American *Dolichopus* (Van Duzee, et al., 1921) and subsequently was listed under "Unplaced Species of Dolichopodidae" in the Catalog of the Diptera of America North of Mexico (Foote, et al., 1965).

The lectotype of *Dolichopus lamellicornis*, here designated, is a female, bearing the labels: "California/ Kinb./Type". The body length of the lectotype is 6.0 mm, not 7.0 mm as stated in Thomson's description.

I used the key to female Nearctic *Dolichopus* (Van Duzee & Curran, 1934) and the specimen was confidently identified as the widespread western North American *Dolichopus afflictus* (Osten Sacken), an identification substantiated by the description in Van Duzee, et al., 1921. Although the lectotype of

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Dolichopus lamellicornis bears a locality label with only the word "California", the ship's records note that the only Californian port of call was San Francisco, from July 3 to August 11, 1852, and the specimen probably was collected in vicinity of that city. The type locality of *D. afflictus* is San Rafael, Marin County, adjoining San Francisco Bay.

Osten Sacken 1877, in his description of *Hygroceleuthus afflictus* (*Hygroceleuthus* is a synonym of *Dolichopus*) thought that on the basis of Thomson's description, *D. lamellicornis* was possibly the female of the species. He reasoned that if Thomson's female specimen had an indentation on hind wing margin similar to that of male *D. afflictus*, then the two species possibly were conspecific, especially since both sexes of the related species *D. crenatus* had indented hind wing margins. Since Thomson's description did not note any wing indentation, Osten Sacken therefore considered them to be different species. Therefore, it is noted here that the wing of the *Dolichopus lamellicornis* female lectotype does have a marginal indentation at the apex of vein CuA, as has been described for female *D. afflictus.*

The following three species were collected at Puna, an island in the Gulf of Guayaquil, Ecuador, and are not listed in the "Catalogue of the Diptera of the Americas south of the United States" (Robinson, 1970), nor in any other recent Diptera catalog. Becker (1922a: 220) thought that the locality "Puna" given in Thomson's descriptions was Puma (*sic.*), India, and therefore he listed one of the species, *Psilopus zonatulus* (as *Condylostylus zonatulus*) in his monograph on the Indo-australian fauna. None of the three species appears in his treatment of the New World Dolichopodidae (Becker, 1922b).

Chrysotus ochropus Thomson.

Chrysotus ochropus Thomson, 1869: 505.
Chrysotus flavipalpus Van Duzee, 1930: 76. **NEW SYNONYM.**

The lectotype, here designated, is a male in fair condition bearing the labels "Puna/ Kinb./Type". A diagnosis based on the holotype is given below, and the species is placed in synonymy with *Chrysotus flavipalpus* Van Duzee, described from San Bartolome, Lima, Peru. In the following diagnosis, the relative lengths of the podomeres are representative ratios, not measurements, and for each leg are given in the following formula and punctuation: trochanter + femur; tibia; tarsomere 1/ 2/ 3/ 4/ 5; the abbreviations (MSSC) means "male secondary sexual character(s)," the non-genitalic characters found only on the male body.

Diagnosis: Male: length: 2.0 mm; wing: 1.7 x 0.6 mm.

Head: vertex and frons metallic blue-green with some grey pruinosity; pairs of strong diverging ocellars, strong verticals, and short postverticals present; eyes almost joined across face-clypeus, but separated by narrow band of grey pruinose cuticle; palp yellow; proboscis brown; scape and most of pedicel yellow; distalmost pedicel and first flagellomere brown; first flagellomere subtriangular with apical arista; ventral postcranium with pale postorbitals.

Thorax: mostly obliterated by pin, but metallic green with bronze reflections; setae black; lateral scutellar setae about 1/4 the length of medians.

Legs: coxa I yellow; coxae II and III brown; remainder of legs mostly yellow; coxae I and II with pale anterior setae; coxa III with strong brownish lateral seta; leg I: 2.7; 2.3; 1.0/ 0.6/ 0.3/ 0.2/ 0.3; femur I in distal half with row of 7 projecting brown pv setae (MSSC); tibia I with crestlike row 12-15 pale ventral hairs which are longer than normal vestiture, and which continue as row of short pale hairs on tarsus I (MSSC); leg II: 3.2; 2.8; 1.2/ 0.5/ 0.4/ 0.3/ 0.3; femur II with group of 4-5 brown subapical pv setae (MSSC?); tibia II with very strong ad and much weaker pd near 1/4, and with weak offset ad and pd setae near 1/2, and with strong ventroapical seta; leg III: 3.5; 3.7; 1.0/ 0.8/ 0.4/ 0.3/ 0.3; femur III with 3-4 long brownish av and pv setae from 1/2 to 3/4 (MSSC), and in apical quarter with very strong av seta followed distally by weaker seta; tibia III with ad and pd setal pairs at 1/5 and 1/2, and with some short dorsal setae.

Wing: hyaline; R_{4+5} and M parallel to apex; CuAx ratio: 0.3; lower calypter yellow with fan of brownish setae; halter yellow.

Abdomen: metallic blue-green with bronze reflections, and covered with short brownish vestiture; hypopygium with dark brown capsule and yellow cercus.

Remarks: *Chrysotus ochropus* is now known from coastal Ecuador and Peru. It is closely related to *C. brevicornis* Van Duzee, found in the Galápagos, Central America and Mexico. Both species have a similar overall description and coloration, and have similar leg setation: pv setae on femur I (MSSC), tibia I with row of pale ventral hairs (MSSC), similar tibia II setation, femur III with long brownish pv setae from 1/2 to 3/4 (MSSC). They belong in the *picticornis* group (see Bickel & Sinclair, in press, for further discussion).

Condylostylus longicornis (Fabricius)

Musca longicornis Fabricius, 1775: 783.
Psilopus zonatulus Thomson, 1869: 509. **NEW SYNONYM**
Condylostylus zonatulus (Thomson) [Becker, 1922a: 220].

The lectotype of *Psilopus zonatulus*, here designated, is a female bearing the labels "Puna/ Kinb./Type". It is conspecific with *Condylostylus longicornis* (Fabricius), agreeing in every detail with this common and widespread New World species. The earlier synonyms and distribution of this species are discussed in Bickel (1994: 108).

It should be noted that *Psilopus zonatulus* Thomson is also a junior homonym of the Palearctic *Psilopus zonatulus* Zetterstedt, 1843, a valid species in the genus *Sciapus* (see Meuffels & Grootaert, 1990).

Condylostylus pleuralis (Thomson).

Psilopus pleuralis Thomson, 1869: 510.

Psilopus pleuralis is known only from the female lectotype, here designated, which bears the labels the labels "Puna/ Kinb./ Type". It was referred to *Condylostylus* in Bickel (1994: 107).

This species clearly belongs in the widespread New World group of species centered around *Condylostylus caudatus* (Wiedemann) (see Becker, 1922b and Van Duzee, 1927). However, females in this group cannot be accurately identified. Previously, *C. caudatus* itself was thought to be widespread throughout both North and South America, but both Van Duzee (1927) and Robinson (1970, 1975) regard most of the tropical records as being that of *C. graenicheri* (Van Duzee) or some other related species. Without further study, it is premature to make a decision, but *C. pleuralis* is possibly a senior synonym of *C. graenicheri* (Van Duzee) or *C. barbatus* (Aldrich), or a junior synonym of two other South American *caudatus* group species, *C. anceps* (Wiedemann) and *C. smaragdulus* (Wiedemann). Unfortunately, both Wiedemann species are described from females and remain unidentifiable. Until the entire New World *caudatus* group is revised, there will be uncertainty regarding names. The large number of old species based on unidentifiable females is regrettable, especially since they have the potential to become senior synonyms of subsequent well-described species.

ACKNOWLEDGMENTS

I thank Bert Viklund of the Naturhistorika Riksmuseet, Stockholm, for kindly making the Thomson material available to me. F.C. Thompson, United States National Museum, Washington, D.C., and C.E. Dyte, University of Reading, England, refereed the manuscript and provided valuable comments.

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DRY WEIGHT OF FRESH AND PRESERVED SPIDERS (ARANEIDA: LABIDOGNATHA)[1]

Robert L. Edwards[2], Wendy L. Gabriel[3]

ABSTRACT: Data on the dry weight for 19 taxa (suborder Labidognatha) of fresh and preserved spiders are presented. The variation in weight at length for individual species is also provided. With the notable exception of the genus *Tetragnatha*, Family Tetragnathidae, the Family Theridiidae, and most of the genera of the Family Thomisidae, the families examined are similar to one another in their weight-length relationships and are not readily separable on that basis. Dry weight can be approximated using either the weight of fresh specimens or preserved material. The 'typical' spider, based on the material examined, increases in length faster relatively than it increases in weight, and dry weight decreases relative to fresh weight as length increases.

With the exception of the papers by Clausen, 1983, that included data on fresh and dry weight-length relationships for nine species (five families), and Breymeyer, 1967, for three species of the family Lycosidae, there is very little general information available on the dry weight of spiders. This report serves to increase the information available on spider weight and explores the degree of difference between taxa from the weight-length perspective.

MATERIAL AND METHODS

The bulk of preserved material was collected in 1989 and 1990 in the Frances Crane Wildlife Management area, Hatchville, Falmouth Township, Barnstable County (Cape Cod), Massachusetts, in connection with another study (Edwards 1993). Collection details are provided therein. All were preserved in 75% denatured ethanol and all had their alcohol replaced at least once, typically within 48 hours of collection. The total length was measured from the clypeus to the distal end of the abdomen using an ocular micrometer for specimens <12 mm in total length and vernier calipers for those >12 mm. The total length, as described above, was measured to the nearest 0.1 mm, and the specimens damp dried on absorbent paper before weighing. Obviously distorted specimens were not used. In those cases where the pedicel had elongated, the separation of the thorax from the abdomen was measured and the total measurement corrected accordingly.

The fresh material for this study was collected in the months of June through September, 1996, from the same area and habitats as the preserved material with one exception. The collection of *Leucauge regnyi* Simon, Family Tetragnathidae, was made in Puerto Rico in September, 1996. All collections were

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made in the afternoon, the spiders were immobilized in an ethyl acetate collecting jar, identified and measured that day, refrigerated overnight at 3° C, and weighed the following day on a Mettler A200 balance, accurate to 1 mg. Following this, the material was oven-dried at a temperature of 40° C for seven days. To check the efficacy of the drying regime, three samples of 50 or more mixed species samples were dried for an additional seven days, with the greatest additional loss of weight observed of less than 3% in all cases. Specimens of all species used in this study have been deposited in the United States National Museum.

RESULTS AND DISCUSSION

The families, genera, number of individuals weighed, and the range of total lengths are provided in Table 1. A total of 2,315 measurements of fresh, dry fresh, and preserved specimens representing 78 genera and 17 families were made (Table 1). Note in Fig. 1 that the various taxa are identified with the first four letters of the taxon as listed in Table 1.

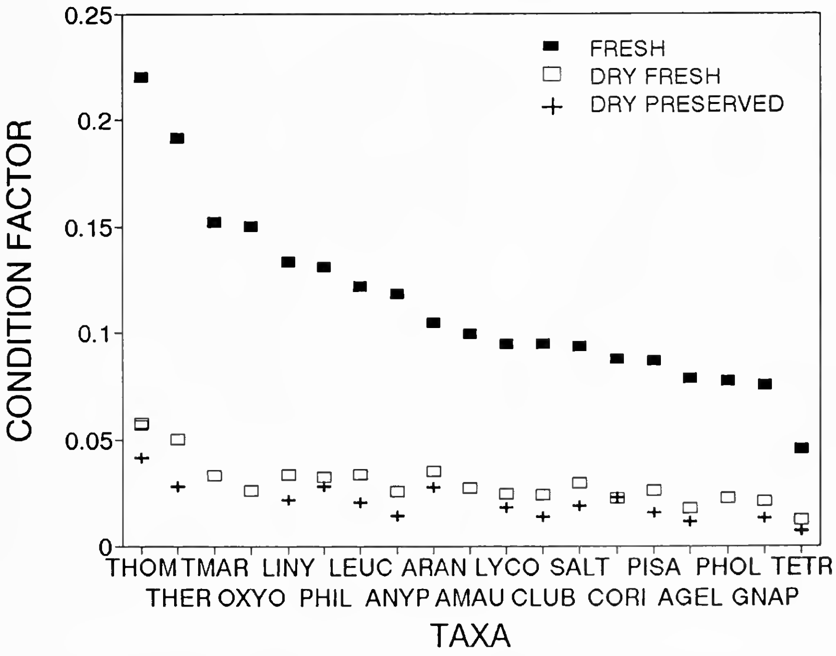

Figure 1. Condition factors for the taxa listed in Table 1, using the equation $k = (aL^b) / L^3$. The taxa are identified using the first four letters of each taxon. There are values for each treatment (fresh, dry fresh, dry preserved) with the exception of AMAU, TMAR, PHOL, and OXYO, for which there was no dry preserved data available.

The log transformed least squares equation, *ln weight = ln a + b (ln length)*, was used to estimate weight (mg) at length (mm). The statistical parameters are provided in Table 2. The coefficient of determination (r^2) ranged from 0.743 (Oxyopidae, dry fresh) to 0.985 (Corinnidae, fresh). Averages, minimum, and maximum values are listed for all parameters. The average values for coefficient *ln a* (intercept) varied considerably and were greatest (-1.976) for fresh and least for dry preserved specimens (-3.580), while the average values for exponent *b* (slope) varied relatively little, from 2.739 for dry preserved to 2.800 for dry fresh specimens (Table 2).

The number of individuals and genera obtained for each family varied considerably (Table 1). It is clear from the statistical parameters presented in Table 2 that there was little difference in the weight-length relationships between taxa. To compare weight at length using different taxa, while taking into consideration the differing length ranges over which the parameters were estimated, we calculated the condition factor for each taxon, $k = (aL^b) / L^3$ (L = mid-point of lengths (mm) in sample, *a* = Exponent *ln a*) and the results shown in Fig. 1. Of the 19 taxa the genus *Tetragnatha* Latreille (Tetragnathidae), the family Theridiidae, and the rotund crab-like members of the family Thomisidae (genera *Xysticus* C. L. Koch, *Ozyptila* Simon, *Misumena* Latreille, *Misumenops* F.O.P.-Cambridge, and *Misumenoides* F.O.P.-Cambridge) stand apart from the rest. The genus *Tmarus* Simon, family Thomisidae, is relatively slender (less crab-like and rotund), differing in this respect from the other genera of the family Thomisidae listed above and is plotted separately (TMAR). Similarly, the less elongate genera *Leucauge* White, and *Pachygnatha* Sundevall, family Tetragnathidae, differ in body form from the elongate members of the genus *Tetragnatha* and are also plotted separately (LEUC). The uniqueness of *Tetragnatha* was noted by Greenstone, et. al. 1985.

Breymeyer (1967) in a study concerning the dry weight of preserved spiders reported that alcohol dissolves and extracts some parts of spider bodies. This appears to be the case in this study as well. It is worth noting that undried specimens preserved in denatured alcohol weigh considerably more than fresh material (Edwards 1996). Clausen (1983, p. 143-144) noted that "the ratio of dry over wetweight increases with decreasing size of specimens", and suggested that "With decreasing size, the exocuticle may make up a relatively greater part of the animal's weight because of the relatively greater surface. And, there may be a minimum thickness of the cuticle, which, in effect, will give the same result." To test Clausen's (op. cit.) suggestion further, the entire data set available was examined by treatment, i.e. fresh, dry fresh and dry preserved. The statistical parameters for each treatment are provided in Table 3. The percent of fresh weight for dry fresh and dry preserved material is shown in Fig. 2. The results are consistent, for the average spider, with the observations of Clausen (op. cit.), with the caveat that more than the cuticle is un-

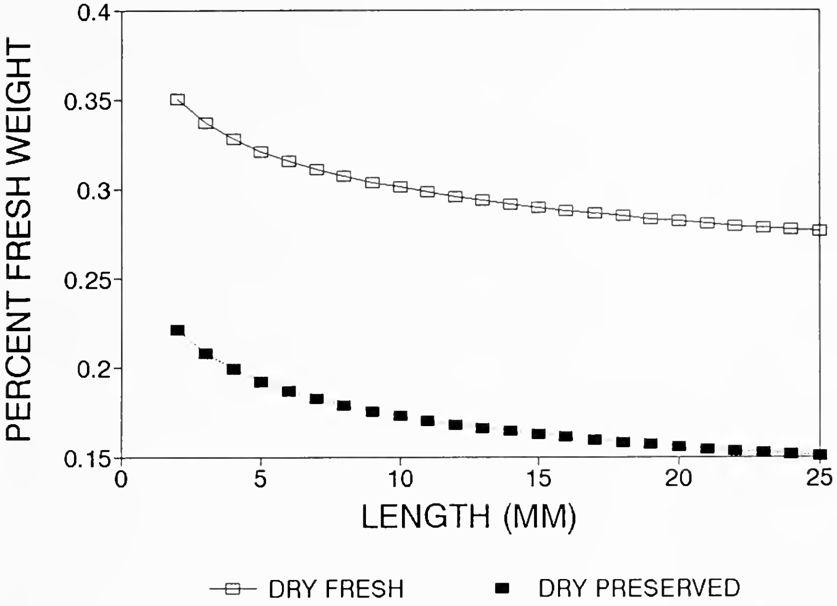

Figure 2. Percent of fresh weight represented by dry fresh weight and dry preserved weight, based on average data for each treatment (Table 3).

doubtedly involved since drying does not reduce the specimens to the cuticle only. Other tissues are involved which may also vary in the degree to which they are present in different taxa.

The variability seen in individual species in the ratio of dry weight to fresh weight was examined for 11 species collected in October and November, 1996. The individual species collections were each made within an hour in restricted localities to reduce environmental variabilities as much as possible. The collections were treated and analyzed as described earlier (see Table 4). On average the ratio of dry to fresh weight was 0.314 ± 0.038, varying from 0.250 to 0.390. The average slope (*b*) of dry on fresh weight was slightly in excess of 1 with two notable exceptions, that of *Pardosa lapidicina* (b = 1.224) and *Phidippus clarus* (b = 1.537). The average intercept (*ln a*) values for these two species were also well in excess of the average value, -2.015 and -3.161 respectively. Both of these collections were of immature individuals that would have matured the following year, although the *Tmarus angulatus* collection, also of immature individuals due to mature the following year, did not have a similar departure from the average values. The average r^2 for the weight-length regressions of these species was 0.892 for fresh and 0.864 for dry fresh.

For studies requiring precision, e.g. those of a single or a set of closely related species, it would be best to use a sclerotized part of the body such as the head capsule, to reduce the problems associated with measurement error (cf. Jocque 1981). Whatever method is used, it is obvious that the weight of individual spiders is highly variable.

In one survey (Edwards 1993) over 12,000 specimens were collected. Many of these were archived against the future. It was encouraging to find out that preserved material also served the purpose of realistically estimating dry weight.

Table 1. Fresh and preserved spiders examined. Number of individuals = n, number of genera = genera, lengths (mm) included in sample = range. Family Tetragnathidae is subdivided into the genus *Tetragnatha* and a second category of rounder body forms, including the genera *Leucauge* and *Pachygnatha*, listed as *Leucauge*. The family *Thomisidae* includes all genera sampled except the genus *Tmarus* which is listed separately.

	Fresh			Fresh, dry			Preserved, dry		
Taxon	n	genera	range	n	genera	range	n	genera	range
Agelenidae	66	5	4.5 - 19.1	29	1	7.4 - 19.1	52	3	3.7 - 16.5
Amaurobiidae	27	1	4.0 - 14.1	26	1	4.0 - 14.1			
Anyphaenidae	28	4	2.7 - 7.6	31	4	3.2 - 7.8	33	3	3.6 - 9.2
Araneidae	90	4	2.7 - 21.2	84		2.7 - 20.5	56	9	2.3 - 14.8
Clubionidae	30	4	2.3 - 8.8	26	3	2.5 - 11.1	19	5	2.0 - 9.0
Corinnidae	20	1	2.2 - 8.6	10	1	3.2 - 11.2	19	1	2.3 - 7.1
Gnaphosidae	82	5	2.8 - 10.1	43	5	3.4 - 9.4	34	5	3.2 - 11.6
Linyphiidae	60	9	1.5 - 5.5	43	5	2.5 - 5.4	56	9	2.0 - 6.5
Lycosidae	92	11	1.5 - 16.8	85	9	4.0 - 16.8	53	11	2.6 - 13.5
Oxyopidae	23	1	4.2 - 7.3	42	1	4.2 - 7.5			
Philodromidae	25	3	2.0 - 9.0	31	3	2.9 - 12.5	39	3	2.0 - 6.6
Pisauridae	16	2	5.5 - 19.3	16	2	4.0 - 11.1	25	1	2.1 - 12.0
Pholcidae	26	1	2.3 - 8.5	26	1	2.3 - 10.8			
Salticidae	83	6	2.3 - 10.1	86	9	3.4 - 10.8	49	6	2.2 - 9.0
Tetragnathidae									
Tetragnatha	58	1	2.5 - 11.0	42	1	3.0 - 10.2	31	1	2.4 - 8.5
Leucauge	49	2	2.5 - 7.6	52	2	2.8 - 7.6	32	2	1.5 - 7.1
Theridiidae	73	7	1.5 - 8.3	55	8	3.0 - 8.2	40	5	1.7 - 6.3
Thomisidae	52	5	1.9 - 8.6	52	3	2.6 - 8.2	41	4	1.6 - 9.1
Tmarus	28	1	4.3 - 6.4	29	1	3.0 - 8.2			
Totals	928	78		808	69		579	68	

Table 2. Statistical parameters for spider weight-length equations (*ln weight ug = ln a + b (ln length mm*), for fresh, dry fresh and dry preserved material. No. of individuals = n, standard error = SE., coefficient of determination = r^2, exponent of *ln a* = Exp *ln a*.

Fresh specimens

Taxon	n	*a* ± SE	*b* ± SE	r^2	Exp *ln a*
Agelenidae	66	-1.657 ± 0.325	2.553 ± 0.113	0.888	0.191
Amaurobiidae	27	-2.303 ± 0.150	2.999 ± 0.077	0.984	0.100
Anyphaenidae	28	-1.697 ± 0.186	2.514 ± 0.116	0.948	0.183
Araneidae	90	-1.726 ± 0.374	2.746 ± 0.066	0.952	0.178
Clubionidae	30	-1.928 ± 0.212	2.636 ± 0.113	0.951	0.145
Corinnidae	20	-2.002 ± 0.111	2.595 ± 0.074	0.985	0.135
Gnaphosidae	82	-2.492 ± 0.237	2.930 ± 0.098	0.918	0.083
Linyphiidae	60	-2.766 ± 0.260	2.647 ± 0.108	0.919	0.171
Lycosidae	92	-1.746 ± 0.277	2.695 ± 0.080	0.926	0.174
Oxyopidae	23	-1.706 ± 0.147	2.571 ± 0.209	0.878	0.182
Pisauridae	16	-2.963 ± 0.207	3.272 ± 0.177	0.961	0.052
Philodromidae	25	-1.707 ± 0.233	2.740 ± 0.135	0.947	0.181
Pholcidae	26	-2.453 ± 0.154	2.905 ± 0.076	0.984	0.086
Salticidae	83	-2.403 ± 0.248	3.027 ± 0.071	0.957	0.090
Tetragnathidae					
Tetragnatha	58	-2.268 ± 0.240	2.431 ± 0.113	0.892	0.103
Leucauge	49	-1.966 ± 0.237	2.853 ± 0.127	0.915	0.140
Theridiidae	73	-1.456 ± 0.222	2.839 ± 0.071	0.958	0.233
Thomisidae	52	-1.447 ± 0.199	2.945 ± 0.086	0.959	0.229
Tmarus	28	-1.860 ± 0.108	2.743 ± 0.177	0.903	0.156
Average		-1.976 ± 0.199	2.771 ± 0.110	0.938	0.148
Minimum		-2.963 ± 0.108	2.431 ± 0.066	0.878	0.052
Maximum		-1.447 ± 0.374	3.272 ± 0.209	0.985	0.233
Dry fresh specimens					
Agelenidae	29	-4.504 ± 0.326	3.184 ± 0.308	0.798	0.011
Amaurobiidae	26	-4.045 ± 0.221	3.198 ± 0.119	0.968	0.018
Anyphaenidae	31	-2.652 ± 0.231	2.406 ± 0.214	0.813	0.070
Araneidae	84	-2.401 ± 0.368	2.615 ± 0.077	0.934	0.091
Clubionidae	26	-3.722 ± 0.265	2.999 ± 0.139	0.951	0.024
Corinnidae	10	-3.896 ± 0.165	3.054 ± 0.175	0.975	0.020
Gnaphosidae	43	-3.584 ± 0.329	2.845 ± 0.198	0.835	0.028
Linyphiidae	43	-2.761 ± 0.260	2.530 ± 0.209	0.830	0.060
Lycosidae	83	-3.253 ± 0.271	2.804 ± 0.093	0.917	0.039
Oxyopidae	42	-3.473 ± 0.269	2.905 ± 0.270	0.743	0.031
Pisauridae	16	-3.107 ± 0.178	2.743 ± 0.182	0.942	0.045
Philodromidae	31	-2.643 ± 0.388	2.617 ± 0.196	0.860	0.071
Pholcidae	26	-3.460 ± 0.462	3.354 ± 0.181	0.953	0.014
Salticidae	86	-3.330 ± 0.289	2.904 ± 0.120	0.875	0.036
Tetragnathidae					
Tetragnatha	42	-2.350 ± 0.285	1.914 ± 0.158	0.785	0.095
Leucauge	52	-3.253 ± 0.272	2.920 ± 0.163	0.866	0.039

Taxon	n	*a* ± SE	*b* ± SE	r^2	Exp *ln a*
Theridiidae	55	-3.436 ± 0.317	3.229 ± 0.177	0.863	0.032
Thomisidae	52	-2.414 ± 0.329	2.741 ± 0.147	0.874	0.089
Tmarus	29	-3.043 ± 0.203	2.790 ± 0.195	0.884	0.048
Average		-3.228 ± 0.278	2.829 ± 0.175	0.871	0.046
Minimum		-4.504 ± 0.165	1.914 ± 0.077	0.743	0.011
Maximum		-2.350 ± 0.388	3.229 ± 0.308	0.975	0.095
Dry preserved specimens					
Agelenidae	52	-5.380 ± 0.375	3.386 ± 0.145	0.916	0.005
Anyphaenidae	33	-3.284 ± 0.267	2.482 ± 0.224	0.798	0.037
Araneidae	56	-3.607 ± 0.484	3.004 ± 0.138	0.898	0.027
Clubionidae	19	-3.356 ± 0.253	2.458 ± 0.146	0.943	0.035
Corinnidae	19	-2.946 ± 0.222	2.463 ± 0.122	0.960	0.053
Gnaphosidae	34	-4.380 ± 0.297	3.011 ± 0.193	0.883	0.053
Linyphiidae	56	-3.308 ± 0.288	2.646 ± 0.120	0.900	0.037
Lycosidae	53	-3.542 ± 0.294	2.772 ± 0.088	0.951	0.029
Pisauridae	25	-3.643 ± 0.307	2.744 ± 0.101	0.970	0.026
Philodromidae	39	-2.801 ± 0.363	2.474 ± 0.213	0.784	0.061
Salticidae	49	-4.139 ± 0.280	3.109 ± 0.124	0.931	0.016
Tetragnathidae					
Tetragnatha	31	-3.590 ± 0.371	2.182 ± 0.181	0.833	0.028
Leucauge	32	-3.589 ± 0.378	2.796 ± 0.183	0.886	0.028
Theridiidae	40	-2.952 ± 0.280	2.553 ± 0.133	0.906	0.052
Thomisidae	41	-3.184 ± 0.210	3.001 ± 0.087	0.968	0.041
Average		-3.580 ± 0.311	2.739 ± 0.147	0.902	0.032
Minimum		-5.380 ± 0.210	2.182 ± 0.087	0.784	0.005
Maximum		-2.801 ± 0.484	3.386 ± 0.224	0.970	0.061

Table 3. Statistical parameters for spider weight-length equations for all available material by treatment. Equation and table headings as in Table 2.

Treatment	n	*ln a* ± SE	*b* ± SE	r^2	Exp. *ln a*
Fresh	928	-1.874 ± 0.447	2.733 ± 0.031	0.891	0.153
Dry fresh	808	-2.857 ± 0.436	2.637 ± 0.039	0.847	0.057
Dry preserved	579	-3.279 ± 0.537	2.581 ± 0.046	0.829	0.038

Table 4. Variability in ratio of dry weight/fresh weight, based on collections of eleven species made at one time in restricted localities. Number of specimens = n, lengths (mm) in sample = Range (mm), dry weight/fresh weight = d/f, coefficent = *ln a*, exponent = *b*, coefficient of determination = r^2, Remarks as follows: Immature only = 1, late preadult and adult ♀♀ = 2, late immature and adult ♂♂ and ♀♀ = 3, and all stages = 4.

Mean									
Species		n	Range (mm)	d/f ± SE	Range d/f	*ln a*	*b*	r^2	Remarks
Agelenidae.	*Agelenopsis pennsylvanicus* (C.L.K.)	29	7.4-19.1	0.311 ± 0.029	0.251 - 0.370	-1.313	1.031	0.984	3
Amaurobiidae.	*Callobius bennetti* (Blackwall).	18	4.0-14.1	0.265 ± 0.038	0.194 - 0.327	-1.608	1.093	0.993	4
Araneidae.	*Argiope trifasciatus* (Forskål)	18	12.1-20.5	0.334 ± 0.030	0.281 - 0.405	-1.608	0.889	0.968	2
Lycosidae.	*Pardosa lapidicina* Emerton	23	4.9- 7.5	0.270 ± 0.033	0.223 - 0.323	-2.015	1.224	0.921	1
Oxyopidae.	*Oxyopes salticus* Hentz	16	4.2- 7.3	0.319 ± 0.023	0.297 - 0.368	-1.299	1.058	0.978	3
Pholcidae.	*Pholcus phalangioides* (Fuesslin)	26	2.3- 8.5	0.313 ± 0.044	0.258 - 0.400	-1.109	0.973	0.987	4
Salticidae.	*Phidippus clarus* Keyserling	20	6.1- 8.4	0.295 ± 0.048	0.222 - 0.391	-3.161	1.537	0.985	1
Tetragnathidae.	*Leucauge regnyi* Simon	39	2.8- 7.6	0.292 ± 0.048	0.208 - 0.379	-1.399	1.058	0.953	4
Tetragnathidae.	*Tetragnatha versicolor* (Walck.)	26	3.4- 9.5	0.389 ± 0.049	0.303 - 0.514	-0.946	1.004	0.937	4
Theridiidae.	*Achaearanea tepidariorum* (C.L.K.)	23	2.9- 8.3	0.299 ± 0.053	0.194 - 0.409	-1.309	1.030	0.972	4
Thomisidae.	*Tmarus angulatus* (Walck.)	22	4.2- 5.9	0.367 ± 0.022	0.316 - 0.401	-1.137	1.053	0.972	1
Means				0.314 ± 0.038	0.250 - 0.390	-1.536	1.058	0.966	

ACKNOWLEDGMENTS

The assistance of Eric and Annabel Edwards in the field was greatly appreciated. The comments and suggestions of Jess Zimmermann, University of Puerto Rico, Los Piedras, and Stan Sady, Massachusetts General Hospital, Boston, who kindly critiqued the initial manuscript were most helpful. We thank the two anonymous reviewers for their comments and suggestions. Nancy McHugh, Northeast Fisheries Center, Woods Hole, kindly made laboratory facilities available.

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OBSERVATIONS OF INTERACTIVE BEHAVIOR IN *PARANDRA GLABRA* (COLEOPTERA: CERAMBYCIDAE)[1]

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ABSTRACT: The first observed behavioral interactions for a species of Parandrinae (Coleoptera: Cerambycidae) are reported. Two sets of observations between males and females of *Parandra glabra* were made under artificial conditions: 1) individual male/female interactions; 2) interactions of multiple males in the presence of each female. Results of individual interactions indicate consistent patterns of behavior including antennation, mandibulation, genitalic exsertion, mounting, and dorsal-oblique mating posture. Males display aggression in first encounters with females, but subsequent antennation leads to mounting and copulation attempts. When more than one male is present with a female, these behavioral categories are directed toward other males more frequently than to the female.

Intraspecific interactions in longhorn beetles can range from violent, indiscretionary encounters to complex, deliberate engagements, but the literature contains few descriptions of these. Most observations are simply noted in more expansive papers concerning other biological or systematic issues. Michelsen (1966) focussed on interactive behavior when he provided the most detailed and widest coverage for behavior (especially with regard to courtship and copulation) in longhorned beetles. He provided data on species representing four different subfamilies of longhorns (Aseminae, Spondylinae, Lepturinae, Cerambycinae). His behavioral observations were placed into 25 categories and a wealth of additional anecdotal information was included. Other references are restricted to fewer (usually one) species and often are much more general: Webster (1904) made interesting observations on *Oberea ulmicola* Chittenden (Lamiinae); Goldsmith (1987a, 1987b, 1989) examined mating systems of three species, *Trachyderes mandibularis* Dupont, *Perarthrus linsleyi* (Knull), and *Stenaspis verticallis arizonicus* Casey (all Cerambycinae); Hughes (1981) examined mating behavior in *Monochamus scutellatus* (Say) (Lamiinae); Piper (1977) discussed mating behavior in *Hippopsis lemniscata* (Fabricius) (Lamiinae); Chemsak (1965) commented on habits of *Oeme costata* LeConte (Cerambycinae); Chemsak and Linsley (1971) observed mating behavior in *Rosalia funebris* Motschulsky (Cerambycinae); and Wang, et al. (1990) looked at the complex mating behavior of *Paraglenea fortunei* Saunders (Lamiinae). This study on *Parandra glabra* (DeGeer) represents the first information on behavior in Parandrinae.

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MATERIALS AND METHODS

This study was undertaken at Monteverde Biological Reserve, Monteverde, Costa Rica. Three males and three females of *Parandra glabra* (DeGeer) were collected at lights, measured, and their date of collection noted. Measurements were taken of the total body length (from the base of the mandibles to the apex of the elytra; body width (distance between elytral humeri); length of mandibles (from the base to farthest point along medial axis) for correlation analyses. These data are listed in Table 1.

Table 1. Data for specimens of *Parandra glabra* (DeGeer) used in this study.

Specimen code (sex/#)	Length	Width	Mandible length	Date of Capture
M1	29 mm	9.5 mm	5.0 mm	22/May/1993
F2	31 mm	9.5 mm	3.0 mm	22/May/1993
M3	30 mm	10.0 mm	5.0 mm	23/May/1993
F4	28 mm	9.0 mm	2.5 mm	25/May/1993
F5	32 mm	10.5 mm	3.0 mm	28/May/1993
M6	32 mm	10.0 mm	6.0 mm	30/May/1993

Specimens were marked on the base of the right elytron with an indelible black-ink marker. The beetles were simply coded with the number of the collection, "1-6". The beetles were kept separately in a small plastic container which was equipped with plastic dividers creating twelve separate holding cells. Damp wood was placed in each cell with the beetles.

After several days of observing the beetles, their highest activity appeared to be at night, from 22:00 - 02:00. Formal observations were made during this period under low light conditions. Although specimens were strongly phototaxic to acute sources of light, low and diffuse lighting did not appear to alter their behavior.

Two sets of investigations were made. The first involved nine pair comparisons of behavior between each male and female. The last focussed on interactive behavior when each female was placed with all three males. Each combination was observed for 20 minutes.

RESULTS

Observations: one on one male/female interactions

Noted behaviors included antennation, mandibulation, genitalic exsertion, genitalic contact with substrate, mounting, and copulation. The number of incidents (or merely presence/absence) of these behavioral activities for each 20 minute observation period is indicated in Table 2.

Antennation and mandibulation

Males and females each opened their mandibles widely after initial contact. In most cases, the male relaxed and closed his mandibles after antennation of the female. In two instances, males bit the females upon initial contact but this was never repeated after further antennation.

Genitalic exsertion and substrate contact

In most cases, after prolonged antennation of the terminal abdominal segments of the female, the males exserted their genitalia partially or distended the region between the last two ventrites. This occurred an average of 2.9 times per male for each 20 minute observation period. In most cases the males would rub their genitalia on the substrate (the wood, container bottom, or container side) and in several cases on the female (the prothorax, mandibles, or elytra). It was distinctly obvious that muscular control of the genitalia, directing it downward, was being affected, and in most cases, the males would reverse walking direction several times during this behavior, rubbing the genitalia back and forth.

Mounting

Mounting of the female occurred an average of 2.2 times for each 20 minute observation period. In two pair combinations it did not occur. Both of these instances involved female #2, the only female not observed to copulate. Mounting usually occurred after contact with the female and antennation by the male, usually around her terminal abdominal segments. Usually in this scenario the females continued walking, somewhat oblivious to the male antennation. The male would then follow the female, maintaining contact and would mount her. In many cases, mounting would occur from the side as the female became "trapped" in a corner or against the piece of wood. This method was similar to that observed commonly in *R. funebris* (Cerambycinae) (Chemsak and Linsley, 1971). In some cases, after head-to-head contact between the pair, the male climbed on top of the female opposite her orientation, and in some cases, exserted his genitalia so it contacted her mandibles and prothorax. Often, a mounting involved probing by the male genitalia in search of the female's. The ratio of mountings to copulations was 4:1.

Copulation

Copulation is here defined as a visible, sustained contact between male and female genitalia. Transfer of sperm to the female could not be determined and thus was not a criterion for this category. Copulations were observed in four of the nine pair combinations. In one pair combination (male #1; female #5), copulation occurred twice during the twenty minute observation period. Copulations ranged in duration from 50 to 240 seconds, averaging 101 seconds. I interrupted a copulation in one instance as I was attempting to document it with a photograph. In every instance, despite preliminary mounting orientation, copulations occurred with the male atop the female in a slightly oblique position (ca. 30° from female central axis). The males extended their terminal abdominal segments outward and probed with their genitalia for the female genital opening. The males did not forcibly extrude the female ovipositor as has been witnessed in other longhorn species (Michelsen, 1966). In many other longhorn species, Michelsen (1966) observed the male to actually leave the female's dorsum during copulation and in many cases face the opposite direction. During four of the five copulations, the female showed motility. In the one copulation where the female remained stationary (the second copulation of male #1 and female #5), pulsation of the male occurred about 45 times (about once every 5.5 seconds). This pulsation behavior was also noted in *R. funebris* by Chemsak and Linsley (1971). They witnessed this to last from 30 to 60 seconds and occur about once every four seconds. During this time the female remained motionless during the four-minute copulation. Interestingly, four of the five copulations involved female #5; female #2 had no copulations; and female #4 had only one.

Observations: all males in presence of individual females

For each of the three females, all three males together were placed with her and their actions were observed for about 20 minutes. Copulation was never observed in any of the three sets of observations; genitalic exsertion and rubbing on other males was observed in the presence of each female; same-sex mounting was observed in each combination; and a few instances of aggression between males was observed.

Female #2
All three males contacted and mounted one another. Antennation of another male's sternites by each male was observed. Two instances of aggression were observed (male #6 biting male #1; male #6 biting male #3). Genitalic exsertion among the males was common during their juxtaposition, and they often rubbed their genitalia on one another. Mounting of the female occurred only once (by male #6); otherwise attention by males was directed toward other males.

Female #4
The same behaviors as above were noted with the addition of the following: male #6 was seen rubbing his genitalia on the container. For a few minutes, all the males were in contact with the female and began mounting one another with their genitalia exserted.

Female #5
Little attention was given to her as the males continued to mount and congregate with one another.

DISCUSSION

Because of the artificial conditions of this study and the small sample size of individuals, interpretation and generalization of the observations is made with caution. No correlations between size and exhibited behavior were evident from this study. Antennation seems to play an important role in the identification of females by males. Although observations of antennation were focussed on and biased toward males, it is evident that antennae are used to a greater extent by males than females. Obvious female antennation subsequent to a male encounter was rarely observed. Based on the rapidity in which males determined females by antennal contact (and then relaxed their mandibles and aggressive behavior), the antennae may have a great sensitivity to some chemical exudate of the female. Once the male established the presence of the female, subsequent contacts were the stimulus for his genitalic exsertion. In many of these instances, the male would rub his genitalia on the substrate and/or female. Based on observations of this behavior in both sets of experiments, it is possible that the male may be secreting some chemical, perhaps as a stimulus to cause the female to be receptive for copulation or as a chemical indicator of his presence to other males.

Further study, both in natural conditions and with individual, laboratory reared specimens, is essential to understand the observations and interpretations presented herein. The phenomena of sperm precedence, male and female pheromones, body and mandible size correlations to mating success, and average number of mountings for each copulation or number of copulations required for successful sperm transfer, are interesting questions that may be addressed upon further study of the Parandrinae.

Table 2. Summary of behaviors expressed by *Parandra glabra* (DeGeer) during the individual male/female pair combinations. A = antennation; MA = mandibulation; GE = genitalic exsertion; GS = rubbing of genitalia on substrate; MO = mounting; C = copulation. For each category, numbers indicate number of observations of behavior, except for antennation which occurred numerous times in all pairs and is simply indicated with a checkmark. Duration of the five copulations is measured in seconds.

Pair code (sex/# X sex/#)	A	MA	GE	GS	MO	C
M1XF2	√	0	1	1	0	0
M1XF4	√	0	4	2	3	1 (50s)
M1XF5	√	0	4	1	5	2 (65s & 240s)
M3XF2	√	1	3	1	2	0
M3XF4	√	0	2	0	1	0
M3XF5	√	0	5	3	4	1 (60s)
M6XF2	√	1	2	1	0	0
M6XF4	√	0	1	0	1	0
M6XF5	√	1	4	1	4	1 (90s)

ACKNOWLEDGMENTS

I thank the Department of Entomology (University of Kansas) for providing funds for fieldwork in Costa Rica. M. Greenfield provided logistical support for this work. I thank T. A. Erwin, D. G. Furth, R. S. Hanley, A. S. Konstantinov, A. L. Norrbom, and M. A. Solis for helpful suggestions on this manuscript.

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US ISSN 0013-872X
VOL. 109 MARCH & APRIL, 1998 NO. 2

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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SMITHISTRUMA MEMORIALIS (HYMENOPTERA: FORMICIDAE), A NEW SPECIES OF ANT FROM THE KENTUCKY CUMBERLAND PLATEAU[1]

Mark Deyrup[2]

ABSTRACT: A new species of dacetine ant, *Smithistruma memorialis*, is described. It was found on top of a ridge on the Cumberland Plateau in Kentucky. This species is distinguished from other North American species of *Smithistruma* by its short, erect, unmodified hairs on the occiput, body and legs. It appears to be a member of the *pulchella* group of *Smithistruma*. It is named in honor of the late William L. Brown, Jr., who greatly advanced our knowledge of dacetine ants.

The genus *Smithistruma* was described in 1948 by a pioneer of ant systematics, the late William L. Brown, Jr., and his revision of the Nearctic species (1953) was so competent that it still serves well, almost 45 years after its publication. The species described below is dedicated to Dr. Brown, in gratitude for his original work in bringing order to our knowledge of dacetine ants, and making the systematics and biology of these ants accessible to other naturalists. This was only one of Dr. Brown's many contributions to myrmecology, biogeography, and evolutionary biology.

Smithistruma includes about 104 described species (Bolton 1995). There are probably additional species to be discovered, as these ants are small (workers about 2 mm long), slow-moving, and usually hidden in leaf litter, rotten wood, or soil. Even in the eastern United States, where the cryptic ant fauna is relatively well known, there are a number of species that are rare in collections, and it is still possible to find undescribed species.

Smithistruma memorialis Deyrup, NEW SPECIES

Diagosis. Distinguished from all other Nearctic *Smithistruma* by the presence of abundant, erect, unmodified hairs on the occiput, body and legs, and the lack of reclinate widened hairs in these areas (Fig. 1). The clypeus is similar to that of S. *missouriensis* (M. R. Smith) in shape and arrangement of enlarged hairs.

Description. Holotype worker. Measurements in mm: Total length: 1.98; head length: 0.51; maximum head width: 0.40; length of alitrunk: 0.46.

Features described below as in Fig. 1. Head with preocular laminae not continuing the outline of the occipital lobes, so outline of head in frontal view not cuneiform. Mandible in lateral view not tapering, but abruptly decurved at tip; mandibular diastema conspicuous at full closure;

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[1] Received June 25, 1997. Accepted August 1, 1997.

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mandibles with four principle teeth in the subapical series, the second largest, the first next largest, the fourth next largest, the third smallest. Clypeus with the apex rounded and thickened, central area of clypeus minutely reticulate, completely bare, slightly raised and diamond shaped; each side of clypeus with three small spoon-shaped hairs on the edge of the basal external corner, two large, spoon-shaped, anteriorly directed hairs on the anterior margin, at points about one-fifth and one half the distance to the apex, a large, spoon-shaped, posteriorly directed submedian hair, and two small, submarginal, submedian spoon-shaped hairs. Antennal scapes with enlarged, erect, untapered hairs on the inner margin as follows: one subbasal, directed slightly toward the apex of the scape, a series of four or five in descending size, more or less evenly spaced, directed slightly toward the base of the scape. Frontal area with small, sparse, inconspicuous, medially directed, reclinate spoon-shaped hairs. Occiput with sparse, erect, straight, blunt hairs, no especially elongate or widened hairs on the lateral margins of the occiput. Upper part of head finely reticulate as in other members of the *pulchella* group, with inconspicuous, sparse, longitudinal rugae.

Pronotum finely reticulate dorsally, sparsely and evenly covered with erect hairs, no elongate or otherwise distinctive hairs in the humeral area, smooth and shining laterally, convex in profile. Remainder of alitrunk with dorsum finely reticulate, with a few erect hairs, lateral areas smooth and shining. Propodeal teeth short, broad, infradental carinae narrow, evenly concave. Legs, including tarsi, with sparse, suberect hairs, without reclinate enlarged or spatulate hairs, no outstanding elongate curved or crimped hairs on the apical third of the mid or hind tibiae or basitarsi.

Petiole finely reticulate dorsally, with sparse suberect hairs, infrapetiolar lamina narrow, without a basal lobe or extension, spongiform process small, in lateral view not extending to lower margin of petiole. Postpetiole with dorsal suberect hairs, lower spongiform process small, not extending down past upper half of basal face of first sternite of gaster. Gaster with sparse, short erect hairs on dorsal surface, long dorsal hairs absent.

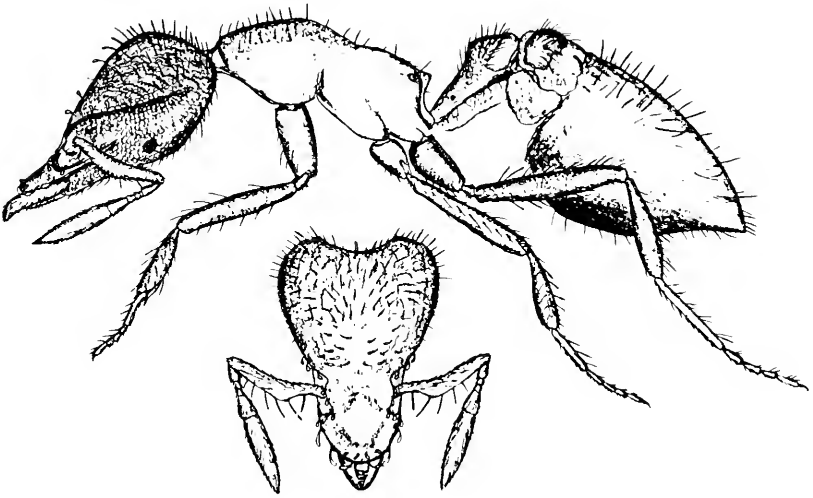

Figure 1. *Smithistruma memorialis*, new species

Paratype female. Measurements in mm: Total length: 2.45, head length: 0.68, maximum head width: 0.47, length of alitrunk: 0.57.

Usual queen modifications present: ocelli present, compound eyes large, alitrunk modified for flight. Otherwise, queen resembles worker, including abundant short, erect hairs on dorsum of thorax, gaster and legs. This vestiture distinguishes this specimen from queens of other dacetine species.

Paratypes. Paratype material is 61 workers and one queen.

Collecting data for type material. All type material shares the same data: KENTUCKY: Laurel Co., Daniel Boone National Forest, Bald Rock picnic area; 23 March 1997; collected by Stephen and Mark Deyrup. Habitat open, grassy, with low herbs, scattered large pines. Nest with holotype worker, allotype queen, and 53 workers found (by Stephen) in a small chamber in clay soil a few centimeters below the surface near the base of a large pine, near the restrooms; 8 workers from a small soil sample about three meters away. Other ants with nearby nests were: *Aphaenogaster tennesseensis* (Mayr) (dealate queen), *Brachymyrmex depilis* Emery, *Leptothorax pergandei* Emery, *Mornomorium minimum* (Buckley), *Paratrechina faisonensis* Forel, *Ponera pennsylvanica* Buckley, *Prenolepis imparis* (Say), *Smithistruma pulchella* (Emery) (dealate queen), *Solenopsis carolinensis* (Forel).

Deposition of type material. Holotype, allotype, 12 paratypes: Museum of Comparative Zoology, Harvard University, Cambridge, Mass.; 6 paratypes: National Museum of Natural History, Smithsonian Institution, Washington, D.C.; 6 paratypes; The Natural History Museum, London; 6 paratypes: Los Angeles County Museum of Natural History; 6 paratypes: Florida State Collection of Arthropods, Gainesville, Fla.; 3 paratypes, collection of Lloyd Davis, Gainesville, Fla.; 3 paratypes: Collection of Mark DuBois, Washington, Ill.; 3 paratypes, collection of William MacKay, El Paso, Tex.; remaining specimens in the collection of the Archbold Biological Station, Lake Placid, Fla.

Etymology. The specific epithet, translated "of remembrance," dedicates this species to Bill Brown in place of the more usual patronym. For some years Bill Brown had held an antipathy toward patronyms. His main objection, as far as I can tell, was that patronyms often honor people who have only the most trivial association with the species bearing their name, and in the worst cases could be assigned to stoke the egos of sponsors or patrons. I do not think these objections would apply in the case of an honoree who had made great and lasting contributions to our knowledge of a genus, especially when the name is applied posthumously. Nevertheless, I am respecting his feelings by avoiding a direct patronym.

DISCUSSION

Myrmecologists who deal with dacetines in general and with *Smithistruma* in particular place a well-justified faith in the taxonomic value of the elaborations of the clypeus and mandibles as species-specific character states. In the absence of any plausible theories explaining the remarkable diversity of these features, it is easy to develop an illogical feeling that their biological function is also associated with species recognition, like the modified palps and facial hairs that distinguish certain male dolichopodid flies in their courtship antics. In *S. memorialis* we see a species that might never have been recognized on the basis of its clypeal structure, which is similar to that of the variable species *S. missouriensis* (Fig. 3). This is a useful, if somewhat worrisome reminder that in *Smithistruma* the shape of the clypeus and the pattern of its pilosity could remain constant in a group of related species.

Smithistruma memorialis clearly belongs in Brown's *pulchella* group, along with *missouriensis, reflexa,* and *cloydi. Smithistruma memorialis* (Fig. 1), *reflexa* (Fig. 2), and *missouriensis* have mandibles that in lateral view are broad and abruptly decurved in their apical third, while the mandibles *of pulchella* (Fig. 4) and *cloydi* (Fig. 5) are slender and tapering. *Smithistruma pulchella*

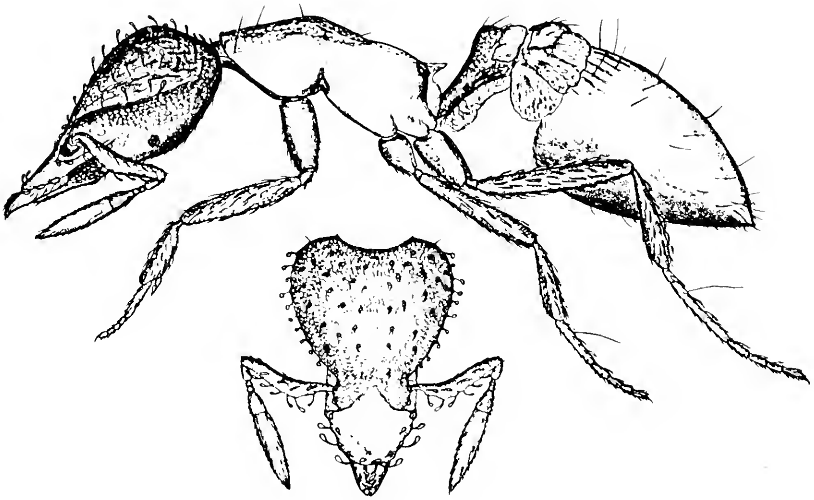

Figure 2. *Smithistruma reflexa* (Wesson and Wesson)

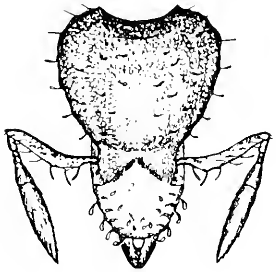

Figure 3. *Smithistruma missouriensis* (Smith)

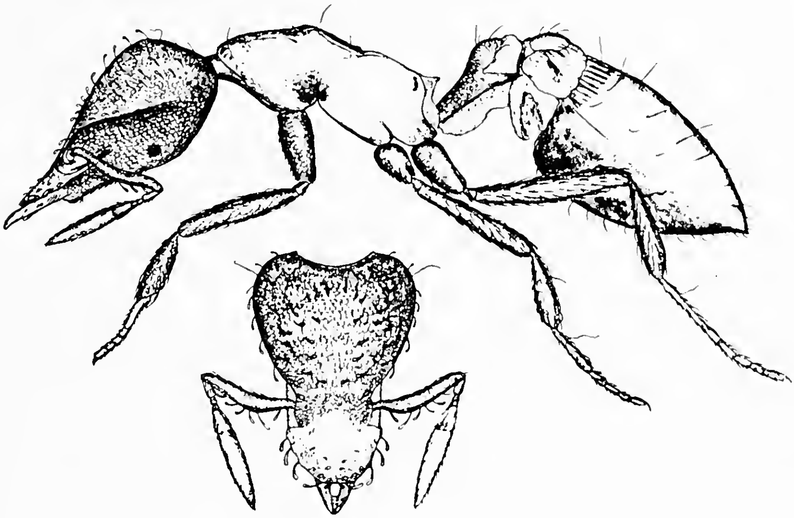

Figure 4. *Smithistruma pulchella* (Emery)

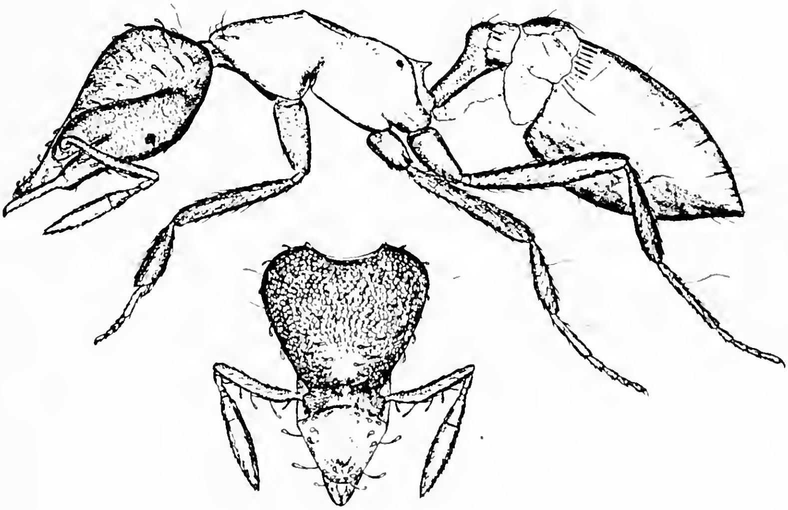

Figure 5. *Smithistruma cloydi* Pfitzer

and *cloydi* differ markedly in the shape of the clypeus and in the number and arrangement of clypeal hairs (Figs. 4, 5). *Smithistruma reflexa* and *missouriensis* are distinguished by differences in the orientation of clypeal hairs (Figs. 2, 3), a character that is somewhat variable, and *reflexa* could be a junior synonym of *missouriensis* (Brown 1953); the small series of *missouriensis* that I have studied appears virtually identical to *reflexa* in lateral view. In Brown's 1953 key, *memorialis* keys to *missouriensis* (second half of couplet 23), but is easily distinguished by its bristling hairs. Now that it is clear that species recognition in this complex may depend on more than clypeal hairs, other structural characters should be examined more closely, and we should be cautious in synonymizing species.

The described native species of *Smithistruma* in the southeastern U. S. now number 24, and there are at least two additional undescribed species (Deyrup and Cover, MS in preparation), bringing the known species from the region to 26. Southeastern North America is therefore a major center of diversity for the genus, and Brown (1953) suggested that this fauna is most closely related to that of Asia, rather than to the Neotropical fauna, as had been suggested earlier. Ward (1988) described three species from relict warm mesic areas in the southwestern U.S. This pattern closely matches the distribution of relict concentrations of warm temperate arcto-tertiary flora (Raven and Axelrod 1978). The genus *Smithistruma*, therefore, appears to be our only clear example among the ants of a diverse assemblage left over from the gloriously speciose warm temperate forests of the Miocene. Most of the known species of North American *Smithistruma* are quite widely distributed through the mixed deciduous forests of the Middle Atlantic states, south through north Florida, and west into the more mesic woodlands of eastern Texas. If, however, the genus *Smithistruma* in North America mirrors the distribution of arcto-tertiary flora, there are probably some species confined to isolated habitat types in the southern Appalachians. The species described here, found on top of a ridge on the Cumberland Plateau, could represent such a species.

It seems appropriate to place *memorialis* in Brown's genus *Smithistruma*, even though there are some indications that this genus may disappear in a small implosion of dacetine genera. Unfortunately, Bill Brown will not be around to offer his comments. In a general way, he felt that some changes were necessary: in a recent (2 February, 1997) letter he stated, "...there is no doubt that generic slaughter is overdue." However, he also wrote, in the same letter, "...I hate to see all the names go down, and I'll be watching." As most contemporary myrmecologists know, Bill Brown thought that defining a genus on a strictly phyletic basis could lead to a foolish nomenclature. Paraphyletiphobia was not one of his afflictions. In his address at the 1987 meeting of the Entomological Society of America, he publicly expressed the opinion that superspecific names, such as the names of genera, are inevitably derived by an exercise of judgement, and these judgements should be openly informed by ecology and convenience, as well as by phylogenetics. He strongly objected to examples of supposedly objective phyletic nomenclature that were really derived from the secret manipulation of an arcane analysis. I wish I could remember all his much more humorous private comments at this convention. There was one particularly funny comparision of some cladistic taxonomy to astrology, in which all the character states and accomplishments of life are subsidiary to, and mystically influenced by, the exact moment of separation from the mother.

Within the narrow confines of a paper describing one species of dacetine ant, I have tried to touch on the extreme importance of Bill Brown to our understanding of the systematics and biogeography of this group. I would not want to leave the impression that the study of dacetines will falter; for some years the tremendously talented and energetic Barry Bolton of The Natural History Museum, London, has been carrying on the work of large-scale revisions of dacetines. What we have lost is the presence of the man, fantastically knowledgeable, honest, critical, humorous, creative and intuitive, who could inspire both nervousness and relief when he said, "I'll be watching."

ACKNOWLEDGMENTS

I am proud to acknowledge our son Stephen as the collector of the large nest series of *Smithistruma memorialis* I also thank the custodians of the Daniel Boone National Forest for watching over the beautiful and diverse habitats of the area, where I am sure that many more undescribed species of interesting insects will be found.

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A NEW SPECIES OF *APHAENOGASTER* (HYMENOPTERA: FORMICIDAE) FROM UPLAND HABITATS IN FLORIDA

Mark Deyrup[2], Lloyd Davis[3]

ABSTRACT: *Aphaenogaster umphreyi*, n. sp., is described from sandy uplands of peninsular Florida. It appears to be closely related to *A. fulva* Roger. The new species, which may be entirely subterranean in habits, is characterized by unusually small eyes, coarse sculpture, short propodeal spines, and unusually small hind tibial spurs.

The genus *Aphaenogaster* tends to accumulate taxonomic problems. A number of species show conspicuous variation between populations, within populations, and even within colonies, while camouflaged in this tangle of intraspecific variation are cryptic species that can only be detected by the most sophisticated methodology, such as that used by Umphrey (1996) for the *A. rudis* group. One species that emerged some time ago from the taxonomic thicket is *A. fulva* Roger, which, once divested of the set of "varieties" that are now recognized as the *rudis* group, seemed to be a single, easily recognized species (Creighton, 1950). It now appears that there is a second species that shares most of the features previously ascribed solely to *fulva*. Fortunately, since this species is rare, or at least difficult to find, it is unlikely to have been the basis of many (if any) published records of *fulva*.

Aphaenogaster umphreyi, Deyrup and Davis, NEW SPECIES

Figure 1

Description: Holotype worker measurements (mm): head length (anterior edge of clypeus to occiput) 1.15; head width (above eyes): 0.95; malar space (= distance from lower edge of eye to mandible in lateral view): 0.38; length of eye: 0.15; distance from propodeal spiracle to tip of propodeal spine: 0.31.

In frontal view, head with convex vertex; coarse reticulate rugae covering dorsum and sides of head, including occiput; venter of head with prominent carinae diverging from midline. Mandible, antenna, and clypeal area resembling those of *fulva* (cf. Figs. 1 and 2).

Mesosoma with strongly raised rugae on the pronotum, mesonotum, and propodeum, these rugae zigzagging, not smoothly undulating, except less elevated and more undulating on pronotal disc. Propodeal spine short, compared to that of *fulva* (Fig. 2), strongly upturned, approaching a right angle with long axis of propodeum. Legs generally similar to *fulva*, including transverse ridges on front coxae, except hind and middle tibial spurs reduced, shorter than width of basitarsus on respective legs.

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ENT. NEWS 109(2) 88-94, March & April, 1998

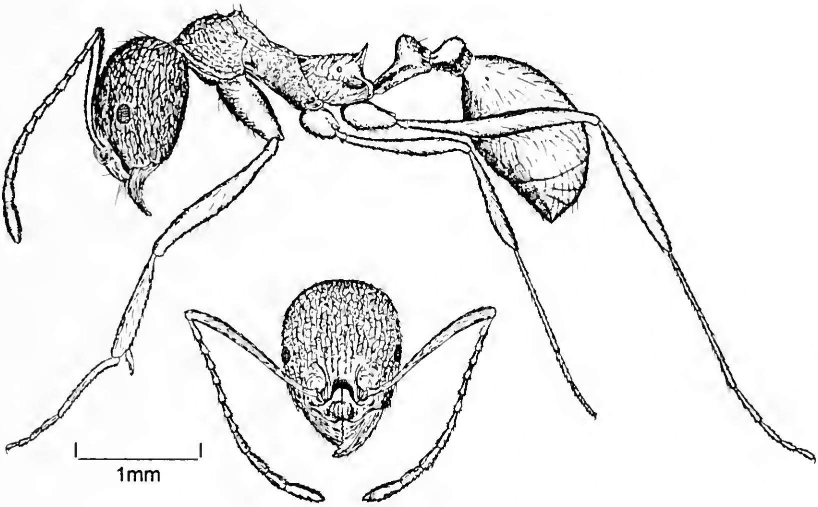

Figure 1. *Aphaenogaster umphreyi*, new species, worker.

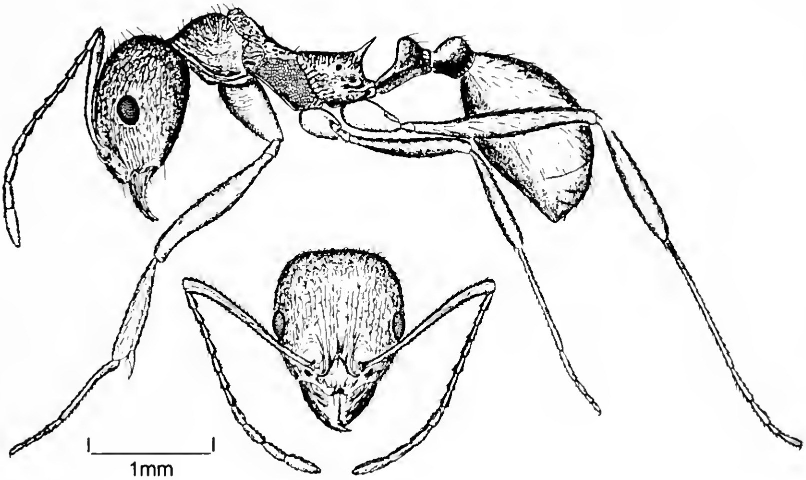

Figure 2. *Aphaenogaster fulva*, worker, Florida specimen.

Petiole and gaster similar to *fulva* (cf. Figs. 1 and 2), except petiole with more conspicuous rugae.

Color reddish brown, legs and gaster yellowish brown.

Diagnosis. Similar to *A. fulva*, but differs in having much smaller eyes, shorter propodeal spines, coarser and more extensive sculpture on the head and mesosoma, more convex vertex in frontal view, and reduced hind tibial spurs (compare Figs. 1 and 2).

Type material. Holotype worker: FLORIDA, Putnam Co., 3 miles east of Melrose, 20 Aug. 1995 (Lloyd R. Davis), Ordway Preserve, sandhill habitat, nest in ground, at base of small oak; deposited in Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts.

Paratypes: FLORIDA: 22 workers from nest series of holotype; same site and collector as holotype: 1 worker: 1 Oct. 1995; 1 worker: 24 Feb. 1995; 1 worker: 27 Aug. 1995; 1 worker: 6 Sept. 1996; 2 workers: 14 Sept. 1996; 2 workers: 3 Mar. 1995. One worker: Highlands Co., Archbold Biological Station, 16 May 1988 (M. Deyrup), sifted from sand, Florida scrub habitat; 1 worker: Highlands Co. Sebring, 11 Mar. 1987 (M. Deyrup), Red Water Lake, Florida scrub habitat; 2 workers: Highlands Co., Sebring 17 Sep. 1990 (M. Deyrup), Flamingo Villas development, Florida scrub habitat; 10 workers (callows, nest series): Marion Co., 16 Oct. 1990 (M. Deyrup), Ocala Waterway development, Florida scrub habitat; 3 workers: Alachua Co., 5.5 miles west of Gainesville (L. Davis), in soil beside rotten pine log, open oak woodland, 22 Mar. 1992; 6 workers: Highlands Co., Placid Lakes Development (M. Deyrup), 1 Jan. 1997, Florida scrub habitat, collector's yard, root mat below *Quercus inopina.*

Deposition of paratypes: 4: Museum of Comparative Zoology, Harvard University; 5: National Museum of Natural History, Smithsonian Institution, Washington, D.C.; 5: Florida State Collection of Arthropods, Gainesville; 5: The Natural History Museum, London; 4: Los Angeles County Museum of Natural History; 3: collection of Gary Umphrey, London, Ontario; 2 paratypes: collection of Mark Dubois, Washington, Illinois; 2: collection of Kye Hedlin, Raleigh, North Carolina; 2: collection of William MacKay, El Paso, Texas; 5: collection of Lloyd Davis, Gainesville, Florida; 17: Arthropod Collection, Archbold Biological Station.

Etymology. This species is named in honor of Dr. Gary Umphrey, in recognition of his long labors working to elucidate the taxonomy and phylogeny of the intractable *A. rudis* group.

DISCUSSION

Although we have known of specimens of an aberrant *Aphaenogaster* for almost nine years, we were wary about assigning them to a new species because of the notorious intraspecific variation within the genus, and the resulting history of synonymy. Our hypothesis was that there might be a southern isolate of *fulva* that differed in various ways from northern forms, and it was not until we had a good series of the new species from within the range of *fulva* in north Florida (Fig. 3) that this hypothesis became untenable. We had also hoped to find many more colonies, and associated sexuals, though these aims still elude us. Meanwhile, we gathered specimens of *fulva* from much of its range, so that variation within that species is now clearer to us.

The evidence that we use to establish the species-level distinctness of *umphreyi* is as follows: 1. *A. umphreyi* is sympatric with *fulva*, at least in Putnam and Marion Counties, and probably farther north as well, so *umphreyi* is not likely to be a geographic subspecies of *fulva*. 2. There is no overlap in the following structural character states used to distinguish the new species: relatively small eyes (Fig. 4); relatively small propodeal spines; heavy zigzag cari-

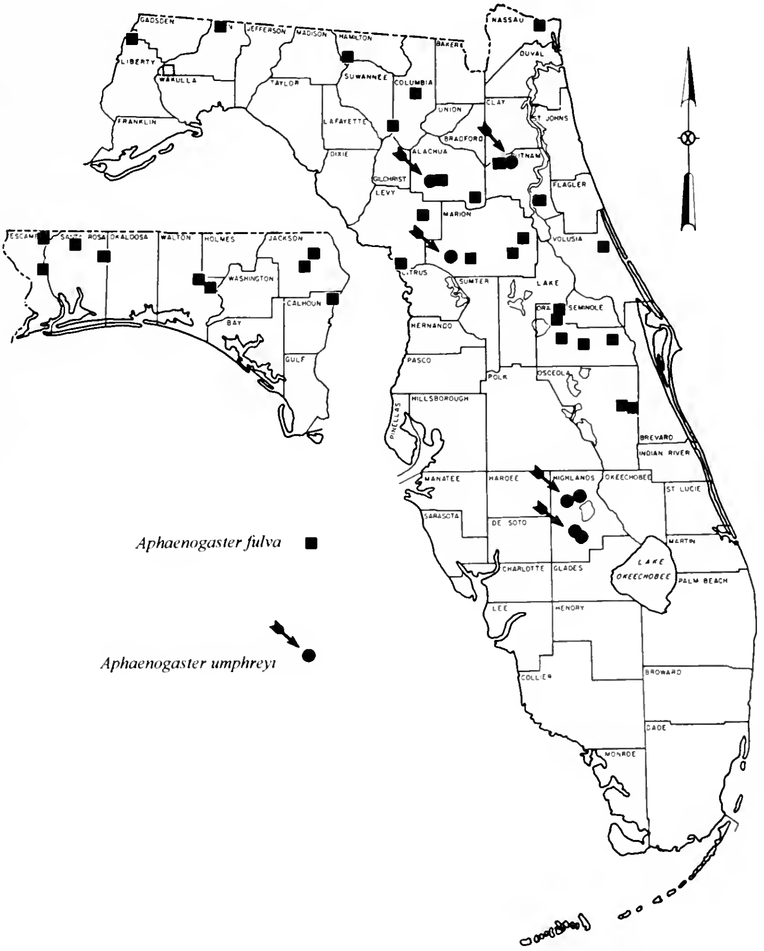

Figure 3. Collection sites for *Aphaenogaster umphreyi* and *A. fulva* in Florida.

nae on the sides of the pronotum and on the propodeum; reduced spurs on the middle and hind tibiae. 3. The occurrence of *umphreyi* in xeric habitats, while *fulva* (at least in the southeast) is in mesic, often wet sites. 4. The kinds of morphological differences between the two species go far beyond the kinds of intraspecific variation that seem to be directly influenced by environmental conditions in different habitats (e.g.: in xeric habitats *Pheidole dentata* Mayr seems paler, *Odontomachus brunneus* (Patton) paler and smaller).

The evidence available suggests that *umphreyi* and *fulva* are a closely related species pair. They share exclusively the following character states: coarse sculpture on the head and mesosoma; upward-pointing propodeal spines; strongly elevated, notched anterior edge of the mesonotum. This combination of features brings *umphreyi* out to couplet 18 in Creighton's key (1950) to *Aphaenogaster*, but the short propodeal spines produce an impasse.

Color is not a very reliable character in *fulva*; it is generally dark brown, but we have seen reddish specimens, particularly from its western range. It

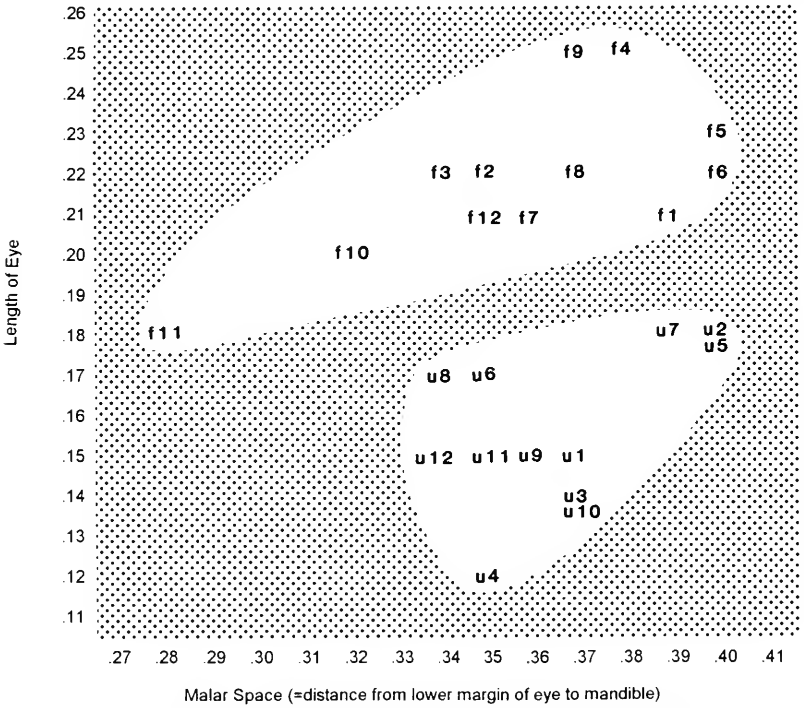

Figure 4. Malar space and eye length in *Aphaenogaster umphreyi* (u), representing 10 colonies, and *A. fulva* (f), representing 12 Florida colonies.

would still be useful to check reddish brown individuals assigned to *fulva* in collections to see whether they have smaller eyes and the other characteristics of *umphreyi.* We have provisionally identified as *umphreyi* a pair of pale specimens with small eyes collected in Decatur County, Georgia, but have not included them among the paratypes because they are small specimens with much less conspicuous rugae than normal in *umphreyi*; these specimens are in the Museum of Comparative Zoology, Harvard University.

The reduced hind and middle tibial spurs of *umphreyi* are quite variable. In some specimens they are absent, in others they are present, but short. The hind tibial spurs, when present, are shorter than the middle tibial spurs. The hind tibial spurs in *Aphaenogaster* as a whole are remarkably expressive, compared with most ant genera. In *A. floridana* Smith they are broad and abruptly acuminate. In *A. pallida* (Nylander), which also has very small eyes, they are extremely reduced. In *A. flemingi* Smith, the hind tibial spurs are somewhat reduced, shorter than the middle tibial spurs. In *A. tennesseensis* (Mayr), they are much reduced, thick, and sometimes curved. In *A. sardoa* Mayr, and *A. senilis* Mayr, the basal third is noticeably swollen. In *A. campana* Emery, they are bristle-like. In *A. cockerelli* Andre, they have apparently been lost, and replaced by enlarged lateral bristles. *Aphaenogaster fulva* and several other species have evenly tapering spurs. Nobody knows, of course, what ecological and evolutionary factors are affecting tibial spur morphology, but a study of the habits of *umphreyi* and other species that have unusual spurs might help us understand the function of tibial spurs in ants.

Aphaenogaster umphreyi may be almost entirely subterranean in habits, and if it does emerge, it may do so at night. All the specimens were collected underground, either in sand under a thick layer of dead leaves and roots, or under piles of litter and trash. The senior author has spent hundreds of hours over the last 14 years prowling scrub habitat at the Archbold Biological Station, without seeing a single specimen of *umphreyi* in the open. The small eyes and pale color of *umphreyi* are consistent with a subterranean life.

There are no sexuals associated with workers of *umphreyi*, but we believe that we may have collected an unassociated queen. Carroll (1975) states that queens of *fulva* are easily distinguished by the "heavily rugose mesothoracic episternite and sternite." The worker-associated queens we have seen from Florida, South Carolina, Maryland, and Arkansas seem to agree with this description, the rugosity consisting of long, gently undulating longitudinal rugae on a granulate background. We have one dealate queen from Archbold Biological Station (where *fulva* is unknown) that has zigzag rugae on the mesothoracic episternite and reduced spurs on the hind and middle tibiae. The eyes and propodeal spines are not reduced. The specimen was collected in a window trap in Florida scrub habitat in November, 1987.

Nothing is known about *umphreyi* other than it is a subterranean inhabitant of sandy uplands of the southeast, it is difficult to collect, and it appears to be closely related to *fulva*. We have no long series showing intraspecific variation, no associated sexuals, no details of its geographic range, and no information on diet or behavior. Until myrmecologists develop an effective method for finding colonies, this will remain one of our most obscure species of *Aphaenogaster*.

ACKNOWLEDGMENTS

We thank Gary Umphrey (University of Western Ontario) and Stefan Cover (Harvard University) for reviewing drafts of this paper. We thank Stefan Cover for arranging the loan of specimens from the Museum of Comparative Zoology, Harvard University, and Walter Suter, Zachary Prusak, and David Corey for contributing specimens of *Aphaenogaster fulva*, and Fabrizio Rigato for contributing specimens of several species of European *Aphaenogaster*. We thank our wives, Nancy and Marie, for waiting patiently whenever we left them by the roadside and went off into the woods for "a few minutes" of ant collecting.

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LABORATORY REARING OF *MESOVELIA CRYPTOPHILA* (HETEROPTERA: MESOVELIIDAE)[1]

Steven J. Taylor[2], J. E. McPherson[3]

ABSTRACT: *Mesovelia cryptophila* was reared from egg to adult at 26.7±0.6° C under a 14L:10D photoperiod. The incubation period averaged 14.93 days; and the four nymphal stadia, 3.24, 2.51, 3.15, and 4.85 days, respectively.

Mesovelia cryptophila Hungerford occurs from New Jersey south to Florida and west to Michigan, Iowa, Oklahoma, and Mississippi (Smith 1988); it also has been reported from Minnesota (Bennett and Cook 1981) and Texas (Polhemus 1997).

Little is known about the biology of this infrequently collected species. It has been collected from a shaded pool in Mississippi (Wilson 1958); a cypress swamp in South Carolina (Sanderson 1982); bog, lake, and impoundment habitats in New Jersey (Chapman 1959); a small pond and shaded, stagnant backwaters of a stream in Iowa (Harris 1943); and the margin of a bog lake in Michigan, similar to the habitat of *Mesovelia amoena* Uhler (reported as *Mesovelia douglasensis* Hungerford) (Hoffmann 1932, Hungerford 1924).

Hoffmann (1932) reported only apterous adults in Michigan, and Sanderson (1982) stated that macropterous adults were unknown. Chapman (1959) reported specimens (stages not given) collected in May and August through October in New Jersey; Sanderson (1982) collected specimens (stages not given) in July in South Carolina; and Hungerford (1924) and Hoffmann (1932) collected adults in June and July, and in July, respectively, in Michigan.

Hoffmann (1932) reared this species in the laboratory under unspecified conditions with limited success (i.e., five individuals reached adult) and briefly described the immature stages. He reported only four nymphal instars.

On 9 July 1991, one of us (SJT) discovered a small population of *M. cryptophila* in Gallatin County, Illinois. Because so little is known about this insect, and because Hoffmann's (1932) rearing data were limited and collected under unspecified conditions, we decided to rear the insect in our laboratory under controlled conditions.

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MATERIALS AND METHODS

The Gallatin County site was a small, shaded bay of Crab Lake (= Hulda Lake) located 6 mi NE of Shawneetown. The water was covered with a light (approximately 10 plants per m^2) covering of duckweed (Lemanaceae). Thirty apterous adults (15♂♂, 15♀♀) were collected with an aquatic D-net up to 2 m from shore, brought to the laboratory, and placed in glass creamers (1♂, 1♀/container). The creamers (4.5 cm deep x 3.0 cm diam.) were filled with 1 cm of deionized water and 3 floating plastic disks (0.6 cm in diam.) were added. The curved sides of the containers were sufficient to prevent the insects from escaping. Two paper strips of cardstock (approximately 1.25 x 2.5 cm) were angled against opposite sides of each container with the tops above the water. The disks and strips served as oviposition sites and allowed individuals to leave the water.

Containers were checked daily for eggs, all of which were laid beneath the water surface. Plastic disks and paper strips, with attached eggs, were transferred to new containers. If eggs were deposited on the walls of the container, adults were transferred to a new container. As eggs hatched, the newly emerged first instars were transferred to new containers prepared similarly to those for adults, but without paper strips. Nymphs of the same instar molting into the subsequent instar on the same day were transferred to new containers if other nymphs in the container had not molted. The water level was maintained just above (0.1 - 0.3 cm) the eggs. Maximum numbers of individuals reared per container were: 6 first instars, 4 second instars, 3 third instars, and 1 fourth instar. Adults reared from these eggs were preserved in 70% ethanol.

Each adult was fed 1, and each nymph 1/2, frozen adult fruit fly (*Drosophila melanogaster* Meigen) per day. Flies were crushed or torn slightly for nymphs to facilitate feeding and were replaced daily.

All individuals were maintained in incubators at 26.7 ± 0.6° C under a 14L:10D photoperiod. All containers were changed at least once per week but more frequently when water became cloudy.

Data were analyzed with the SAS (SAS Institute 1988) TTEST procedure. Level of significance was set at 0.05.

RESULTS AND DISCUSSION

Eggs (n = 96) were deposited singly on the paper strips, sides of the plastic disks, and walls of the containers. The incubation period averaged 14.93 days (Table 1). There were four nymphal instars, thus confirming Hoffmann's (1932) results. The first through fourth stadia averaged 3.24, 2.51, 3.15, and 4.85 days, respectively. Duration of total developmental time from egg to adult averaged 28.56 days. No sexual difference was detected for either the fourth stadium (T = -0.9685, df = 45, p = 0.3304) or for total length of development (T = -0.8387, df = 45, p = 0.4061). Of the 30 field-collected adults, five females and four males were still alive after one month.

Hoffmann (1932) collected adults in Michigan but reared their offspring in Kansas. Females laid up to 75 eggs (mean = 55, n = 4), which were inserted into plant tissue. He reported an egg laid on 27 July hatched on 14 March (229 days), and two eggs laid on 24 and 25 July hatched between 21 and 25 September (58-63 days). The large discrepency in incubation period between Hoffmann's study (58-229 days) and ours (12-19 days) (Table 1) suggests his eggs were in diapause. Hoffmann's (1932) five specimens reared from first instar to adult averaged 17.6 days (range = 16-21, no rearing temperature given), approximately four days longer than ours.

Although the occurrence of only four instars is rare in Gerromorpha (Štys and Davidová-Vilímová 1989), it is not unprecedented in the Mesoveliidae; *Mesovelia furcata* Mulsant and Rey, a European species, has only four nymphal instars (Zimmerman 1984).

Table 1. Durations (in days) of immature stages of laboratory-reared *Mesovelia cryptophila*.

Stage	Sex	Number completing stadium	Mean ± Std. Err.	Range
Egg[a]		94	14.93 ± 0.16	12-19
First instar		80	3.24 ± 0.07	2-5
Second instar		67	2.51 ± 0.07	2-4
Third instar		71	3.15 ± 0.07	2-4
Fourth instar	Males + Females[b]	48	4.85 ± 0.11	3-7
	Males	27	4.74 ± 0.15	3-7
	Females	20	4.95 ± 0.15	3-6
Egg through fourth instar	Males + Females[b]	48	28.56 ± 0.20	25-31
	Males	27	28.41 ± 0.26	25-31
	Females	20	28.75 ± 0.32	26-31

[a] 96 eggs were laid.

[b] One individual died during molting and could not be sexed.

ACKNOWLEDGMENTS

We thank the following individuals for their critical reviews of the manuscript: R. A. Brandon, J. A. Beatty, B. M. Burr, Department of Zoology; and D. Ugent, Department of Plant Biology, Southern Illinois University at Carbondale.

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TWO NEW SPECIES OF MICROCADDISFLIES (TRICHOPTERA: HYDROPTILIDAE) FROM KENTUCKY[1]

Ronald E. Houp[2], Katherine H. Houp[3], Steven C. Harris[4]

ABSTRACT: Two new species of microcaddisflies, *Hydroptila howelli* and *Hydroptila kuehnei* (Trichoptera: Hydroptilidae), from Kentucky are described and their affinities noted.

The caddisfly fauna of the southeastern United States has been fairly well studied, but new species continue to be found. This paper describes two new species in the genus *Hydroptila* from a single locality along Salt Lick Creek in Kentucky, an unaltered Reference Reach stream, draining a portion of the "Knobs", an area within the Interior Plateau ecoregion. Terminology used in the descriptions follows that of Marshall (1979). Specimen length was measured from the tip of the head to the end of the wings and is given as a range. Type material will be deposited at the National Museum of Natural History, Smithsonian Institution (NMNH), the Illinois Natural History Survey (INHS), the Branley A. Branson Museum of Zoology, Eastern Kentucky University (BABMZ) and the collections of the authors.

Hydroptila howelli NEW SPECIES

(Fig. 1)

Description. Male. Length 1.9 - 2.1 mm. 27 antennal segments. Brown in alcohol. Venter of abdominal segment VII with short apicomesal process. Segment VIII triangular in lateral view, acute posteroventrally; in ventral view, deep rounded incision posteromesally, laterally terminating in several sclerotized teeth; nearly rectangular in dorsal aspect. Segment IX retracted within segment VIII in ventral view; in dorsal view, anterior portion retracted within VIII and mesally incised, posterior portion divided into pair of truncate lateral lobes, widely separated mesally. Tenth tergum broadly triangular, laterally with elongate, sinuate sclerotized processes with acute apices turned inward; in lateral view these thin processes sharply turned ventrad. Subgenital plate a rounded shelf in ventral view, bearing pair of short setae posteromesally. Inferior appendages in lateral view thin and elongate, clublike at apex; in ventral view widely separated, nearly parallel along mesal margin, outer margins sinuate, apices acute and strongly turned outward. Phallus tubular, widening at base and narrowing at midlength, ejaculatory duct protruding apically about 1/4 phallus length, thin paramere at midlength encircling shaft.

Female and larva. Unknown.

Type material. Holotype, male. Kentucky, LaRue-Marion County line, Salt Lick Creek on Salt Lick Road, 17 May 1996, at blacklight, R. Houp and K. Houp (NMNH). Paratype, same locality as holotype, 1 male (BABMZ).

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ENT. NEWS 109(2) 99-102, March & April, 1998

Etymology. Named for the late Dr. Henry H. Howell, in honor of his contributions to aquatic ecology. A teacher, friend and mentor.

Diagnosis. This species is similar to several species in the *H. waubesiana* group, including *H. delineata* Morton, *H. tridentata* Holzenthal and Kelly, *H. englishi* Hamilton, and *H. grandiosa* Ross. From the latter two species, *H. howelli* is separated by the lack of elongate, heavy spines from the sternum of abdominal segment IX. The new species is separated from other species in the *waubesiana* group by the ventral elongation of segment VIII, the elongate, sinuate lateral straps of the tenth tergite, and the thin, widely separated inferior appendages which are strongly hooked apically.

Hydroptila kuehnei NEW SPECIES

(Fig. 2)

Description. Male. Length 2.8 - 3.1 mm. 28 antennal segments. Brown in alcohol. Venter of abdominal segment VII with short apicomesal process. Segment VIII annular; slightly incised along posterior margin in ventral view; dorsally with pair of crescent-shaped sclerites posteriorly. Segment IX elongate posterodorsally in ventral view; in dorsal view, emarginate posteriorly, elongate processes laterally, deeply incised anteriorly. Segment X fused with IX, dorsum divided at base into pair of thin arms, nearly parallel sided, distally with acute points apically and subapically; in lateral view, arms separated distally with apical points dorsad and ventrad. Subgenital plate in ventral view thin, lateral margins curved inward, rounded apically bearing pair of mesal setae. Inferior appendages elongate and thin in lateral view, sharply curved downward at base, apically with sclerotized ventral point; in ventral view short and slightly elbowed outward, heavy peglike setae subapically, elongate seta on lateral margin subapically and basally. Phallus tubular, widening at base, ejaculatory duct protruding distally, elongate paramere encircling shaft near midlength.

Type material. Holotype, male. Kentucky, LaRue-Marion County line, Salt Lick Creek on Salt Creek Road, 7 August 1996, at blacklight, R. Houp and K. Houp (NMNH). Paratypes, same data as holotype, 5 males (NMNH, INHS, BABMZ, REH, SCH).

Etymology. Named for the late Dr. Robert A. Kuehne, and his contributions to aquatic ecology. A friend, teacher and mentor.

Diagnosis. This species, another member of the *H. waubesiana* group, is most similar to *H. patriciae* Harris and *H. eramosa* Harper. With these two species, *H. kuehnei* shares the lateral elongation of abdominal segment IX and the division of the tenth tergite into two lateral arms. These lateral arms are elongate in the new species, but short in both *H. patriciae* and *H. eramosa* and terminate in long apical extensions in *H. patriciae*, but short acute extensions in *H. kuehnei* and *H. eramosa*. The inferior appendages are strongly elbowed in *H. patriciae* and to the lesser degree in *H. kuehnei*, but they are nearly straight in *H. eramosa*. As well, these appendages in both *H. eramosa* and the new species have a strong peglike seta apically which is absent in *H. patriciae*. The subgenital plate, in ventral view, in both *H. patriciae* and *H. kuehnei* is thin apically, but broadly rounded in *H. eramosa*. This combination of characters serves to distinguish the new species from other members of the *H. waubesiana* group.

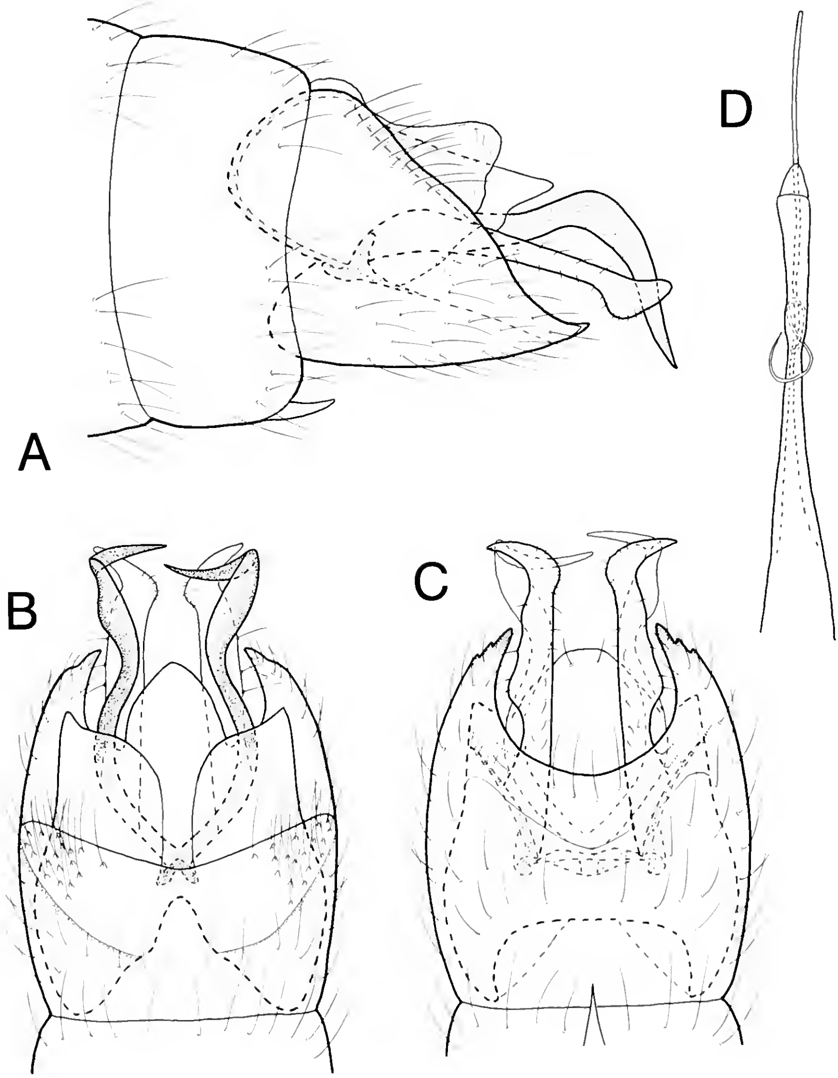

Figure 1. *Hydroptila howelli*, n. sp. male genitalia. A. Lateral view; B. Dorsal view; C. Ventral view; D. Phallus, ventral view.

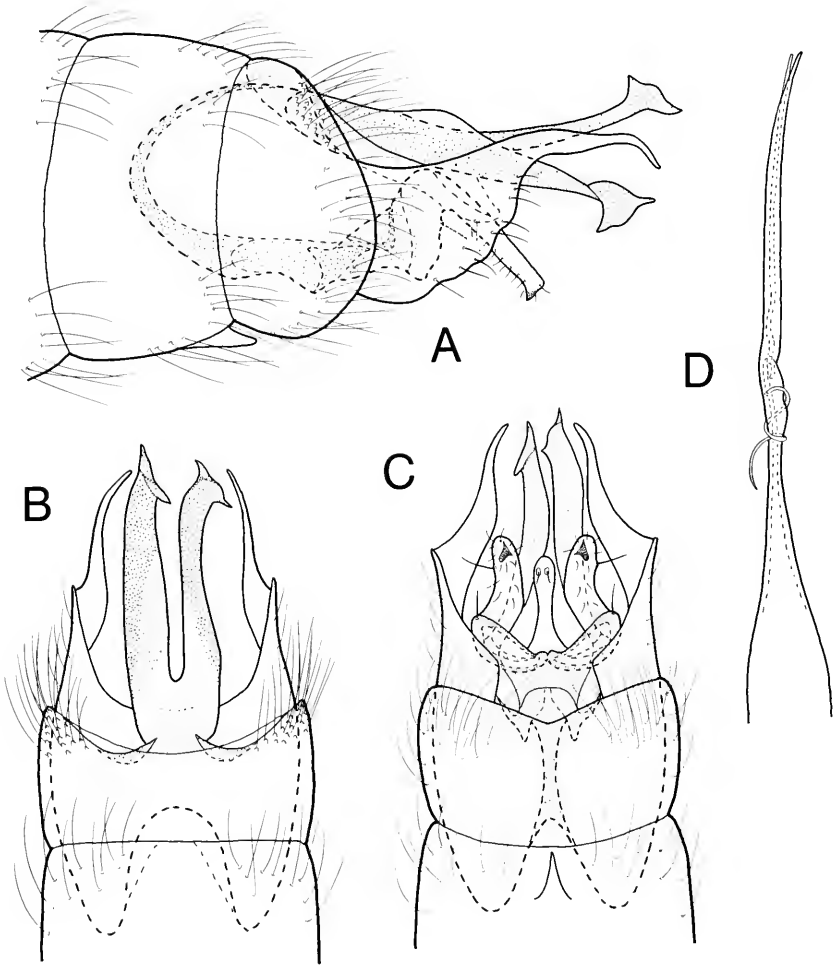

Figure 2. *Hydroptila kuehnei*, n. sp. male genitalia. A. Lateral view; B. Dorsal view; C. Ventral view; D. Phallus, ventral view.

ACKNOWLEDGMENTS

The authors appreciate the interest and assistance of G. A. Schuster, Eastern Kentucky University.

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SEASONAL FLIGHT PERIODICITIES OF SIX MICROCADDISFLIES (TRICHOPTERA: HYDROPTILIDAE, GLOSSOSOMATIDAE) IN THE BRAZOS RIVER, TEXAS, WITH NOTES ON LARVAL BIOLOGY AND SITE RECORDS[1]

David C. Houghton[2,3], Kenneth W. Stewart[2]

ABSTRACT: The seasonal flight periodicities of six small caddisflies were studied from April, 1995, to November, 1996, at a large riffle of the Brazos River in north-central Texas. Light trap samples for adults suggested a synchronized univoltine cycle for *Protoptila alexanderi*, asynchronous univoltine cycles for *Hydroptila icona* and *Orthotrichia cristata*, bivoltine cycles for *Ithytrichia clavata* and *Ochrotrichia tarsalis*, and a multivoltine cycle for *Hydroptila angusta*; the last species accounted for 82% of the total hydroptilid adult abundance. Larval collections of *P. alexanderi, H. angusta* and *I. clavata* confirmed their presence in the benthic community. Seven site records and one drainage record of *Neotrichia vibrans* were documented, increasing the total number of caddisfly species found at this site by Moulton et al. (1993) to 30.

The caddisfly family Hydroptilidae, often referred to as the "microcaddisflies", contains the smallest members of the Trichoptera, with adults of many of the 220 Nearctic species reaching only 2-3 mm in length (Wiggins 1996). Hydroptilidae is the most species rich trichopteran family, and often ten or more congeners can occur together at a single site (Moulton and Stewart 1996). Despite this, very little is known concerning hydroptilid life histories and behavior. Nielson (1948) studied the biology of five Danish species; elucidating univoltine cycles for *Orthotrichia tetensii* Kolbe and *Ithytrichia lamellaris* Eaton, and bivoltine cycles for *Agraylea multipunctata* Curtis, *Hydroptila femoralis* Eaton and *Oxeythira costalis* Curtis. This work remains the source for much of the knowledge of larval morphology, feeding, case-building behavior and general biology of the family (Marshall 1979, Wiggins 1996).

Other ecological studies of hydroptilids have dealt with the drift patterns of larvae, including those of *Hydroptila rono* Ross and *H. icona* Mosely, respectively, in an Oregon and Texas stream (Anderson 1967, Cloud and Stewart 1974a) from which an interpretation of univoltine life cycles was made by Wiggins (1996). Resh and Houp (1986) studied the biology of *Dibusa angata* Ross and found it to be bivoltine in a Kentucky stream and dependent on the red alga *Lemanea australis* Atkinson for food and case-building material. Marshall (1979) reviewed the world genera of Hydroptilidae.

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[1] Received May 15, 1997. Accepted July 25, 1997.

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Moulton et al. (1993) documented 23 species of Trichoptera from a riffle of the Brazos River in Palo Pinto County, Texas as part of their investigation of the Brazos River caddisfly fauna. This documentation included 10 hydroptilid species and one member of the glossosomatid caddisfly subfamily Protoptilinae, *Culoptila cantha* (Ross). Protoptiline glossosomatids are often field-sorted in with hydroptilids due to their small size; no life history information has been reported for any of the 18 North American species (Wiggins 1996). The purpose of our study was to document the seasonal flight periodicities of microcaddisflies at this Brazos River site as suggestive of their respective voltinisms.

MATERIALS AND METHODS

Study site. The Brazos River arises on the Caprock Escarpment in eastern New Mexico and flows southeasterly through Texas to the Gulf of Mexico. Our study was conducted at a 200 m riffle located approximately 35 km downstream of the Morris Shepard Dam in Palo Pinto County; research on the biology of many aquatic insects has been ongoing at this site for 25 years (Stewart et al. 1973; Cloud and Stewart 1974a,b; Vaught and Stewart 1974; McClure and Stewart 1976; Rhame and Stewart 1976; Houghton 1997). Recent descriptions of this site can be found in Moulton et al. (1993) and Houghton (1997).

Adults. Adults were collected from April, 1995, to November, 1996, using two 8-watt portable ultra-violet lights placed over two 22.5 X 35 cm white porcelain pans filled with 70% ETOH. These samples were generally taken monthly from October to March and twice monthly from April to September. The pans were set about 1.0 m from the water's edge; one at the head of the riffle, and the other 16.5 m downstream. Preliminary observations had indicated predominately nocturnal flight periods for Brazos microcaddisflies; therefore lights were run for 20 minute intervals beginning at dusk, separated by 40 minutes between samples, until three sets of samples were taken or until a sample yielded no adults of any species. A small number of *Hydroptila angusta* Ross adults were aspirated from riparian rocks and vegetation prior to dusk during February and March, 1996. Each sample taken was sub-sampled by the following procedure: the specimens were placed in a 9.5 cm diameter round petrie dish and mixed thoroughly; a 3 cm diameter ring was randomly placed into the sample and all individuals within the ring area were counted; the number of males and females of each species found was extrapolated to estimate the total number present in each sample; the samples were combined to estimate the number present on each sampling date.

Larvae and Pupae. Larvae and pupae were collected off rocks with soft-touch forceps on the same sampling dates as adults and either preserved in 70% ETOH or transported alive back to the laboratory in Styrofoam "six-pack" coolers (Szczytko and Stewart 1979). Larvae and pupae were reared in wire mesh baskets within a Frigid Units Living Stream™ with Brazos River simulated flow, temperature, photoperiod, and natural algal food to estimate pupation period and associate the life stages using the metamorphotype method (Milne 1938). Behavior of fifth instar larvae was observed by placing individuals in a 5 cm diameter petrie dish under a Wild M2E dissecting microscope equipped with a Dyonics fiberoptic light source. Voucher specimens of all species studied are deposited in the University of North Texas Entomological Collection.

RESULTS AND DISCUSSION

Seasonal flight periodicities were determined for the hydroptilid species *Hydroptila icona*, *H. angusta*, *Ithytrichia clavata* Eaton, *Ochrotrichia tarsalis* (Hagen) and *Orthotrichia cristata* Morton, and for *Protoptila alexanderi* Ross (Glossosomatidae: Protoptilinae) (Fig. 1); the life history of the protoptiline glossosomatid *Culoptila cantha*, which was very common at this site, was studied by Houghton (1997) and will be published in a separate paper. *Protoptila alexanderi* and *Ochrotrichia tarsalis* represented site records not reported by Moulton et al. (1993), as did the following species which did not occur in enough abundance to discern a flight periodicity pattern: *Hydroptila waubesiana* Betten ($n = 63$), *Neotrichia minutisimella* (Chambers) ($n = 1$), *N. vibrans* Ross ($n = 2$), *Oxeythira aculea* Ross ($n = 3$), and *O. azteca* (Mosely) ($n = 2$). *Neotrichia vibrans* also represented a new drainage record.

Protoptila alexanderi Ross. Adults of this species were caught from early July to late September, 1995, and early August to October, 1996 (Fig. 1). Peak abundances occurred in late August, 1995, and early September, 1996, suggesting a synchronized univoltine cycle. Males were slightly more abundant than females; both sexes exhbited similar seasonal periodicity. We collected a series of twelve fifth instar larvae in early July, 1995, on clean 10-20 cm diameter stones in the upstream half of the riffle. Moulton et al. (1993) collected adults from the Paluxy River and Ham Creek, Brazos River tributaries, in June and October. Previously, the species had been reported in Texas only from the San Antonio and San Marcos Rivers (Edwards 1973).

Hydroptila angusta Ross. Adults of this species were collected in all months of the year (Fig. 1) and accounted for 82% of the total hydroptilid sample. As many as four generations may have occurred during both years as suggested by the peaks in abundance, although an exact determination is not possible without extensive larval data. Males and females exhibited similar seasonal periodicity. Larvae were reared to adults during April, July, and September, 1995, and March, April, and June, 1996. Moulton et al. (1993) collected adults throughout their Brazos Drainage study area during the months of March-April, May-June, and October. Cloud and Stewart (1974a) did not report this species in the drift of the Brazos River. We found substantial numbers of fifth instar larvae in the filamentous algal growth (mostly *Cladophora* sp.) that was common on most of the rocks in the riffle during summer months. When placed on small stones in a petrie dish, larvae were sedentary and held their cases at acute angles to the faces of the stones.

Hydroptila icona Mosely. Adults of this species were collected from early May to November during both years (Fig. 1). Peak abundances of both sexes occurred in late June, 1995, and early July, 1996, suggesting a univoltine cycle; this would corroborate the one-year cycle proposed by Cloud and Stewart (1974a) and Wiggins (1996). However, voltinism is confounded by a second peak in male abundance that occurred in late August, 1995, and early August, 1996. Moulton et al. (1993) collected adults throughout their study area during the months of June and October-November. Cloud and Stewart (1974a) reported *H. icona* as one of the two common hydroptilids at this site and noted a nocturnal drift of both cased and caseless larvae. We did not find larvae of this species in our benthic samples.

Ithytrichia clavata Eaton. Adults of this species were collected from early April to November, 1995, and early April to October, 1996 (Fig. 1). Adult abundance peaked during early May and early September, 1995, and late April and late September, 1996, suggesting a synchronized bivoltine cycle. Males were slightly more abundant during the early generation and females were slightly more abundant in the later generation during both years. A series of 12 pupae collected in early April, 1995, emerged in the laboratory in early May, 1995; a series of 6 pupae collected in early April, 1996, emerged in late April, 1996. We also collected approximately 50 empty cases in early April, 1996, and only one cased larva in early May, 1995. These pupae and empty cases were found on rocks in quiet areas of the riffle. Moulton et al. (1993) collected adults throughout most of their study area, including this site, during the months of March-April, June and October. Despite the low numbers of larvae and pupae that we found, Cloud and Stewart (1974a) reported that *I. clavata* was a common hydroptilid at this site and that it drifted nocturnally. The one fifth instar larva was found on a rock near the head of the riffle. When placed on a small stone in a petrie dish under microscopic light and videotaped, this individual exhibited strong negative phototaxicity and actively sought the underside of the stone. A torsion angle of 90° between the first two abdominal segments, causing the flat sides of the case to be held parallel to the ground, was evident. This phenomenon was also noted for *I. lamellaris* (Nielson 1948).

Ochrotrichia tarsalis (Hagen). Adults of this species were collected from early June to November, 1995, and early April to October, 1996. Adult abun-

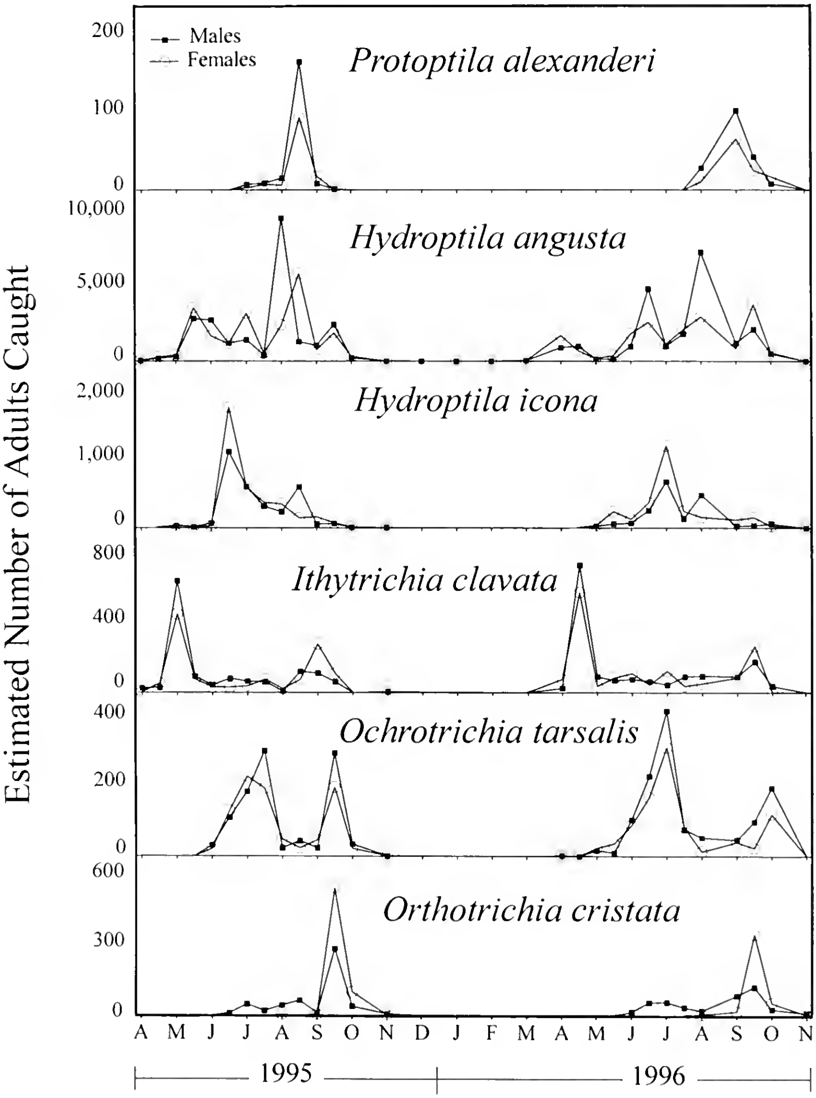

Figure 1. Estimated number of adults caught from a riffle on the Brazos River, Texas from April, 1995, to November, 1996, based on subsamples.

dance peaked in late July and late September, 1995, and early July and October, 1996 (Fig. 1), suggesting a synchronized bivoltine cycle. Males and females had similar seasonal periodicity. Moulton et al. (1993) did not collect this species at our site but found adults in much of their Brazos Drainage study area during June and October. Cloud and Stewart (1974a) reported *Ochrotrichia* larvae in low abundance in their drift samples but did not identify a species. We did not find larvae of this species in our study riffle.

Orthotrichia cristata Morton. Adults of this species were collected from late June to November, 1995, and early June to November, 1996 (Fig. 1). Both sexes peaked in abundance in late September during both years, suggesting a univoltine cycle. However, females were not collected until early August both years, while males were present for 3-4 months before their peak abundance. Moulton et al. (1993) collected adults at our site during June and July. Cloud and Stewart (1974a) report *Orthotrichia* larvae in low abundance in their drift samples but did not identify a species. We did not find larvae of this species in our sampling area.

ACKNOWLEDGMENTS

The authors thank S.R. Moulton, II for confirming the identity of several species and the following people for assisting us in the field and laboratory: J.C. Abbott, I.W. Agado, G.L. Akin, R.G. Jones, C.J. Larson, J.C. Norwood, S.A. Peterson, J.P. Snow and N.L. Witt. We also thank K.D. Alexander, S.W. Szczytko and two anonymous reviewers for commenting on earlier versions of our manuscript.

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A NEW SPECIES OF *PSEUDOCENTROPTILOIDES* (EPHEMEROPTERA: BAETIDAE), WITH REVISIONS TO OTHER PREVIOUSLY UNNAMED BAETID SPECIES FROM TEXAS[1,2]

N. A. Wiersema[3], W. P. McCafferty[4]

ABSTRACT: *Pseudocentroptiloides morihari*, new species, is described from larvae and male and female adults from Texas, USA. The species represents the second of the genus to be discovered in North America, where it is distinguished from *P. usa* primarily by size, labral and maxillary morphology, and ventral abdominal pattern in the larvae. *Pseudocentroptiloides morihari* was previously reported as *Centroptilum* sp. 2. Some other unnamed but numbered species of Baetidae reported from Texas are resolved to known nominal species of *Acerpenna*, *Baetis*, and *Centroptilum*, and the status of others is reviewed. Difficulty in separating adult males of *Pseudocentroptiloides* and some *Procloeon* is noted.

The small minnow mayfly genus *Pseudocentroptiloides* Jacob (Ephemeroptera: Baetidae) was revised by Waltz and McCafferty (1989) and has included *P. ceylonica* Glazaczow (Oriental), *P. christineae* Waltz and McCafferty (Oriental), *P. shadini* (Kazlauskas) (Palearctic; type species), and *P. usa* Waltz and McCafferty (Nearctic). Larvae are characterized by a V-shaped emargination on the labrum, broad maxillae, labial palp segments 3 that are greatly expanded and truncated, and glossae that are relatively short and truncate.

In 1977, one of us (WPM) collected very small and then unidentifiable larvae in Texas that were simply referred to as *Centroptilum* sp. 2, and subsequently reported as such by McCafferty and Davis (1992) and Lugo-Ortiz and McCafferty (1995). Recently, the other of us (NAW) collected additional larvae of this species in Texas and was able to rear adults. Close examination of the material in light of recent revisions of North American Baetidae (see e.g., McCafferty and Waltz 1990, Edmunds and Waltz 1996) shows that it is clearly *Pseudocentroptiloides* and that it represents a previously undescribed species. Prior to this discovery, *P. usa*, from the Midwest, was the only species of *Pseudocentroptiloides* known from the Western Hemisphere, and it and *P. shadini* were the only species known as adults. McCafferty and Waltz (1990) had predicted that additional species of *Pseudocentroptiloides* eventually would be found in North America. We are most honored to name this new species after Dennis Morihara (Pukalani, Hawaii), who helped collect the original material, and who contributed significant systematic work that catalyzed our modern understanding of the diverse and challenging family Baetidae in North America.

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[1] Received August 18, 1997. Accepted September 10, 1997.

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Because of the state of knowledge at the time, a number of baetids collected from Texas could not be assuredly assigned to nominal species and thus were reported as numbered species by McCafferty and Davis (1992) and Lugo-Ortiz and McCafferty (1995). New analyses of much of that material, often in light of subsequent collections, have allowed us to update the identification status of those species. We provide this new information under the heading *Additional Species Revisions* following the new species description below.

Pseudocentroptiloides morihari, NEW SPECIES

(Figs. 1-8)

Centroptilum sp. 2 McCafferty and Davis, 1992:207.

Larva. Lengths: body 4.0-5.5 mm; caudal filaments 1.6-2.0 mm. Head: Coloration pale, darkest around coronal and frontal sutures. Antennae broken but extending at least as far as fore coxae; scapes, pedicels, and flagella with sparse, fine, simple setae. Labrum (Fig. 1) sclerotized posterolaterally, slightly wider than long, and with broad triangular emargination apically; dorsal subapical setae present across entire width of labrum, relatively short and not extending beyond, or much beyond, distal margin of labrum. Mandibles (Figs. 2 and 3) with relatively broad bases. Maxillae (Fig. 4) with crest of fine setae extending basally well below galealacinia crown, setae longer or subequal to galealacinia denticles; digitate setae of galealacinia comb poorly developed (1-2 setae); palpi three segmented. Labium as in Fig. 5, with glossae nearly as wide as long and two-thirds to three-fourths length of paraglossae. Thorax: Nota cream, without distinct patterns. Hindwingpads present. Legs similar to Figs. 6 and 7 of Waltz and McCafferty (1989); claws subequal in length to respective tarsi. Abdomen: Coloration pale; terga light brown, darkest at anterior margins of each tergum. Sterna unicolorous cream, except for wide transverse brown band anteriorly on sternum 8 [mature individuals also with purplish transverse markings of adults (see below) on sterna 7 and 8]. Paraprocts with five to six marginal spines. Median caudal filament subequal in length to cerci.

Male adult. Lengths: body 4.6-5.8 mm; forewings 3.8-5.0 mm; hindwings 0.8-1.0 mm; cerci 8.0-10.0 mm. Head: Turbinate portion of compound eyes yellow, slightly divergent anteriorly, oval, ca. 1.6 times longer than wide in dorsal view, and on low stalks. Thorax: Coloration generally cream to light brown, sterna slightly paler than nota. Forewings (Fig. 6) with marginal intercalaries relatively long, especially posterior to MA_2 (longer than respective distal crossveins connecting longitudinal veins between MA_2 and $lCuA_1$). Hindwings (Fig. 7) slightly broadened, with short marginal veins following 2nd main longitudinal vein. Abdomen: Segments 2-6 translucent white; segments 7-10 slightly darker; small longitudinal dashes laterally on segments 1-9; prominent black, complex, internal maculation visible in dorsal view on segments 7 and 8. Sterna 7 and 8 often with transverse, pale reddish purple line anteriorly. Genitalia as in Fig. 8.

Female adult. Lengths: body 5.6-5.8 mm; forewings 5.0 mm; hindwings 1.0 mm; cerci 6.5-7.0 mm. Body more robust than male, generally pale throughout except for prominent black spiracular markings dorsolaterally on abdomen, black line in cervical area, and faint dark markings laterally on thorax.

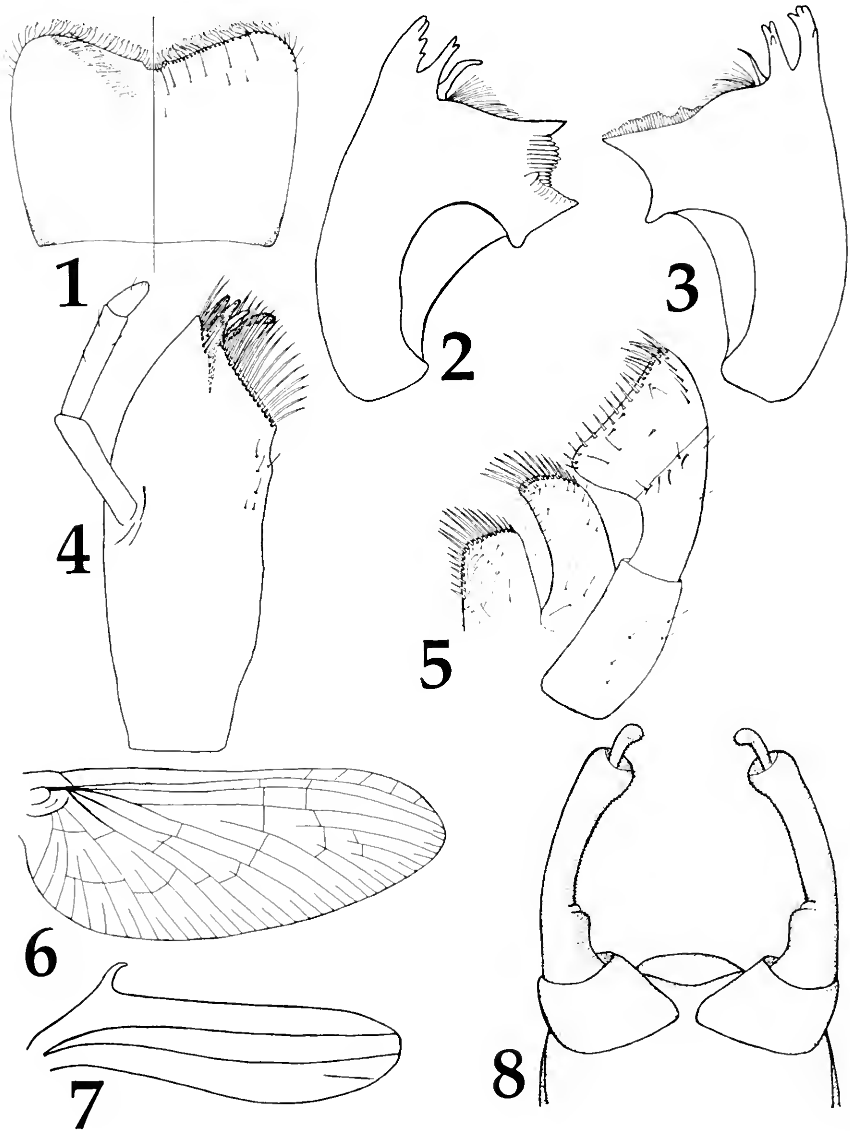
Material examined. HOLOTYPE: male larva, TEXAS, Austin Co., San Bernard River at I-10, west of Sealy, V-9-1977, W. P. McCafferty, A. V. Provonsha, D. Morihara, in the Purdue Entomological Research Collection. PARATYPES: one male and one female larva, same data and deposition as holotype. Additional material: One female larva and one reared male adult (some parts mounted on slides), TEXAS, Austin Co., San Bernard River at I-10 west of Sealy, V-19-1997, N. A. Wiersema, same deposition as holotype. Three male and two female adults, TEXAS, Williamson Co., Georgetown, San Gabriel River at San Gabriel Park, X-7-1996, N. A. Wiersema, same deposition of holotype, except one male in private collection of NAW. One male adult, TEXAS, Comal Co., Guadalupe River about 11 miles below Canyon Dam, XII-7-1996, N. A. Wiersema, in private collection of NAW.

Diagnosis. Larvae of *P. usa* are much larger and more robust than those of *P. morihari*, with mature individuals nearly twice as large. Structurally, *P. morihari* can be further easily distinguished from *P. usa* by the shape of the distal emargination of the labrum (Fig. 1), dorsal labral subapical setae that extend in a row along the entire width of the labrum (Fig. 1), the much more extensive crest of setae on the gaIealaciniae (Fig. 4), and relatively broader glossae and labial palps segment 3 (Fig. 5) [see comparative figures of *P. usa* in Waltz and McCafferty (1989): Figs. 1,4, and 5)]. In addition, whereas the paraprocts of *P. morihari* have five or six marginal spines, re-examination of the type material of *P. usa* indicated that they have six or seven. This latter difference is of inconsistent value for diagnosis; however, significant color pattern differences were also revealed from the type material of *P. usa*. Whereas *P. morihari* larvae have a somewhat broad band of pigment anteriorly on abdominal sternum 8, in *P. usa* such a band is prominent on both sterna 8 and 9 and weakly present on sternum 7. In addition, sublateral paired spots that are present on all the abdominal sterna of *P. usa*, but particularly well developed on sterna 7-9, are entirely absent in *P. morihari*.

In the larval key to world species of *Pseudocentroptiloides* provided by Waltz and McCafferty (1989), *P. morihari* can most easily be incorporated into it simply by adding another couplet at the end. First, however, the couplet part 3' should be modified to read: "Maxillae [Figs. 31 (Keffermüller and Sowa 1984) and 4 herein] with crest of setae extending basally below crown of galealacinia, subequal to or longer than denticles of galealacinia . . . 4." Couplet 4 should then be added as follows:

4. Labrum (Fig. 1 herein) with relatively short dorsal subapical setae not extending beyond, or much beyond, distal margin of labrum .... *P. morihari*.
4'. Labrum [Fig. 1a of Jacob and Glazaczow (1986)] with long dorsal subapical setae extending well beyond distal margin of labrum .... *P. shadini*.

The adults of *P. morihari* and *P. usa* are remarkably similar. Structurally, the only apparently significant differences found involve the wings. In *P. morihari*, the marginal intercalaries of the forewing are relatively long, especially in the posterior half of the wing. Whereas the intercalaries are longer than the respective crossveins connecting longitudinal veins between MA_2 and $lCuA_1$ in *P. morihari* (Fig. 6), they are shorter by the same comparison in *P. usa* [Fig. 8 of Waltz and McCafferty (1989)]. Also, the hindwings of *P. morihari* (Fig. 7) are slightly broader and have an additional short vein posteriorly. The hindwings of *P. usa* are very narrow and have only two long longitudinal veins [Fig. 9 of Waltz and McCafferty (1989)]. The abdominal segments 1-6 of the male adults are light in color in both species, as is common in many baetid



Figs. 1-8. *Pseudocentroptiloides morihari*, n. sp., 1-5. Larva. 1. Labrum (right: dorsal, left: ventral). 2. Left mandible. 3. Right mandible. 4. Left maxilla. 5. Labium (half, dorsal view). 6-8. Male adult. 6. Forewing. 7. Hindwing (enlarged relative to forewing). 8. Genitalia (ventral).

males, but the thorax and abdominal segments 7-10 are slightly more darkly contrasting in *P. usa* than in *P. morihari*. One other possible difference between the males of these species is that in all the material known thus far, the anterior line on abdominal sterna 7 and 8 is broken in the middle in *P. usa*, thus appearing as a pair of lines rather than a single line as in *P. morihari*. Unfortunately, we cannot be sure if any of the adult differences we have reviewed above will be consistent between the species when larger populations are known. All such characteristics have been known to be variable in other adults of certain baetids.

Although the female adult of *P. usa* was not described by Waltz and McCafferty (1989), our examination of the female adult paratype of *P. usa* indicated that the females of *P. morihari* and *P. usa* are very similar, except for the venational differences noted above. In addition, based on the few comparative specimens available, the branching spiracular maculations appear more developed in *P. usa*, and there is a long, horizontal, unbroken, thin, dark line connecting abdominal segments 8 and 9 laterally in *P. usa* that is not present as such in *P. morihari*.

Remarks. The San Bernard River where larvae of *P. morihari* have been collected has a shifting sand substrate. Larvae were kicked into a screen or dredged with a D-net from sand and vegetation in relatively shallow water. Adults have been collected at lights at night (as subimagos) from the Guadalupe and San Gabriel Rivers. All of the localities are in the Hill Country of central Texas. Lugo-Ortiz and McCafferty (1995) showed that this area had the highest mayfly diversity in Texas. They also indicated that this area was strongly influenced by eastern North American faunal elements.

Caution should be taken when sorting Texas adults with single marginal intercalaries in the forewings, including *P. morihari*. We have recently reared *Procloeon viridoculare* (Berner) from Texas that as adults have genitalia with a medial protrusion on the forceps that will make them key out to *Pseudocentroptiloides* when using the generic key by Edmunds and Waltz (1996). Because there is no doubt that they are *P. viridoculare*, and because we have seen the slight development of such a protrusion on other *Procloeon* in the South and Midwest, there is a potential problem in separating *Procloeon* from *Pseudocentroptiloides* when only adults are in hand.

ADDITIONAL SPECIES REVISIONS

Acentrella* sp. 1** Lugo-Ortiz and McCafferty [= ***Baetis virilis (McDunnough)]. The original report of *Acentrella* sp. 1 by Lugo-Ortiz and McCafferty (1995) was based on the male larval stage of *Baetis virilis*. This species lacks hindwings, and because of leg setation was provisionally placed in *Acentrella* at the time. This also represents the first report of *B. virilis* from Texas.

Acentrella* sp. 2** Lugo-Ortiz and McCafferty [= ***Baetis virilis (McDunnough)]. The fact that the female larvae originally referred to as *Acentrella* sp. 2 by Lugo-Ortiz and McCafferty (1995) also is referable to *B. virilis* reflects the fact that the larvae of *B. virilis* are sexually dimorphic (Ide 1937). Differences in the male and female adults of *B. virilis* were first noted by McDunnough (1924).

Acerpenna* sp. 1** McCafferty and Davis **[=** ***Acerpenna pygmaea (Hagen)**].** McCafferty and Davis (1992) stated that this species was similar to *A. harti* (McDunnough). We now interpret *A.* sp. 1 as an adult variant of the relatively widespread species *A. pygmaea*.

Baetis* sp. 1** McCafferty and Davis **[=** ***Baetis punctiventris (McDunnough)**].** These larvae represent a pale color variant of *B. punctiventris* that lacks the ventral spotting usually typical of the species. It is the most common two-tailed *Baetis* in the Hill country of Texas, where we have additionally seen it from Medina River, Bandera County; Guadalupe River, Comal County; Blanco River, Hays County; Block Creek, Kendall County; and Gorman Creek, San Saba County.

***Camelobaetidius* sp. 1** McCafferty and Davis. This species was originally reported from larvae from the Rio Grande River along the Texas/Mexico border by McCafferty and Davis (1992), and more recently larvae were reported from Colorado by McCafferty et al. (1993). Formal description of a new species has been postponed until more mature specimens are available.

Centroptilum* sp. 1** McCafferty and Davis **[=** ***Centroptilum triangulifer (McDunnough)**].** McCafferty and Davis (1992) initially noted the similarity of *C.* sp. 1 to *C. triangulifer*. Observations of variation in this species since that time indicate that the Texas material falls within the range of variation, and *C. triangulifer* should be added to the list of Texas mayflies.

***Centroptilum* sp. 3** Lugo-Ortiz and McCafferty. The single larva that the report of Lugo-Ortiz and McCafferty (1995) was based on was sent to another co-worker for an opinion as to its identification and has since been lost. Thus, we presume that it will never be resolved. *Procloeon viridoculare* (Berner), which was recently reported from Texas by Wiersema (1998), has been taken from the same locality as *C.* sp. 3, on the South Llano River in Kimble County, but we cannot be sure of any association.

***Procloeon* sp. 1** McCafferty and Davis. Due primarily to the fact that this report was based on female adults, the material still cannot be placed to any nominal species.

Procloeon* sp. 2** McCafferty and Davis **[=** ***Centroptilum album McDunnough**].** *Centroptilum album* was first reported by Moore (1950) from Texas (San Marcos River); however, that report generally has not been referenced in subsequent inventories of mayflies in Texas. We still cannot verify the accuracy of Moore's report, but must assume it was correct, based on the now confirmed presence of *C. album* in Texas. *Procloeon* sp. 2 was based on larvae that fall within the expected range variation of *C. album*, as had been suggested by McCafferty and Davis (1992). This species has been placed both in *Centroptilum* and *Procloeon* recently; however, it is more consistent with the concept of *Centroptilum* reflected in the key to North American mayfly genera by Edmunds and Waltz (1996).

***Procloeon* sp. 3** McCafferty and Davis. This new but unnamed species was based on highly distinctive larvae from the J. R. Davis private collection taken from Pinto Creek, Kinney County Texas (see McCafferty and Davis 1992). While we were in the process of writing up the formal new description and new name for the McCafferty and Davis species for publication, we learned that other workers had also decided to describe this species independently. Rather than cause an unnecessary synonym in the literature, we are deferring to those others, although to our knowledge a formal description is not in press at this time, nor can we be sure when or if it will be published in the near future.

ACKNOWLEDGMENTS

We thank C. R. Lugo-Ortiz and R. P. Randolph (West Lafayette, Indiana) for discussing and reviewing this paper.

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THE ADULT OF *MORIBAETIS MACAFERTI* (EPHEMEROPTERA: BAETIDAE)[1]

W. P. McCafferty, C. R. Lugo-Ortiz[2]

ABSTRACT: Alate stages of the common and distinctive Central American and southern Mexican species *Moribaetis macaferti* are described for the first time based on males of both the adult and subimago stages. The species is distinct as an adult in having forewings with extensive staining, an abdomen with distinctive patterning, and genital forceps with a smooth medial margin. The species' abdominal color pattern is also apparent in the subimago. A key to the male adults of *Moribaetis* species is provided. *Moribaetis macaferti* is reported from Panama for the first time.

The distinctive mayfly genus *Moribaetis* was described by Waltz and McCafferty (1985). It was later restricted by Lugo-Ortiz and McCafferty (1996a) and shown to be a monophyletic, relatively ancestral lineage within the New World *Baetodes* complex of genera, which also includes the genera *Baetodes* Needham and Murphy, *Mayobaetis* Waltz and McCafferty, and *Prebaetodes* Lugo-Ortiz and McCafferty. *Moribaetis* is Neotropical in origin (McCafferty et al. 1992), and the entire *Baetodes* complex is evidently South American in origin (McCafferty 1998), although several species of *Baetodes* are found in the southwestern Nearctic region.

Moribaetis essentially is a Central American genus. It currently consists of *M. macaferti* Waltz, *M. maculipennis* (Flowers), and *M. salvini* (Eaton). Mention of the genus as occurring in South America (Lugo-Ortiz and McCafferty 1996a) was inadvertent, although an unspecified report of the genus by Rojas de Hernández et al. (1995) could actually be applicable to either *Moribaetis* or *Mayobaetis* because they were considered subgenera of *Moribaetis* at the time. The latter may be more likely because *Mayobaetis* is known from Ecuador and Peru as well as Central America.

Moribaetis macaferti has recently been reported from southern Mexico in addition to Costa Rica, Honduras, and Guatemala (Lugo-Ortiz and McCafferty 1994, 1996b). This is a relatively large, striking species of Baetidae that has been collected by WPM from streams and waterfalls, including splash zones, in Costa Rica. A key to the larvae of all three species of *Moribaetis* was provided by Waltz and McCafferty (1985). Although *M. maculipennis* and *M. salvini* are known as adults (Eaton 1885, Flowers 1979), the adult of *M. macaferti* has remained unknown up to this time.

Boris Kondratieff (Fort Collins, Colorado) has kindly given us larvae and an adult of *M. macaferti* that he recently collected from Puebla, Mexico in

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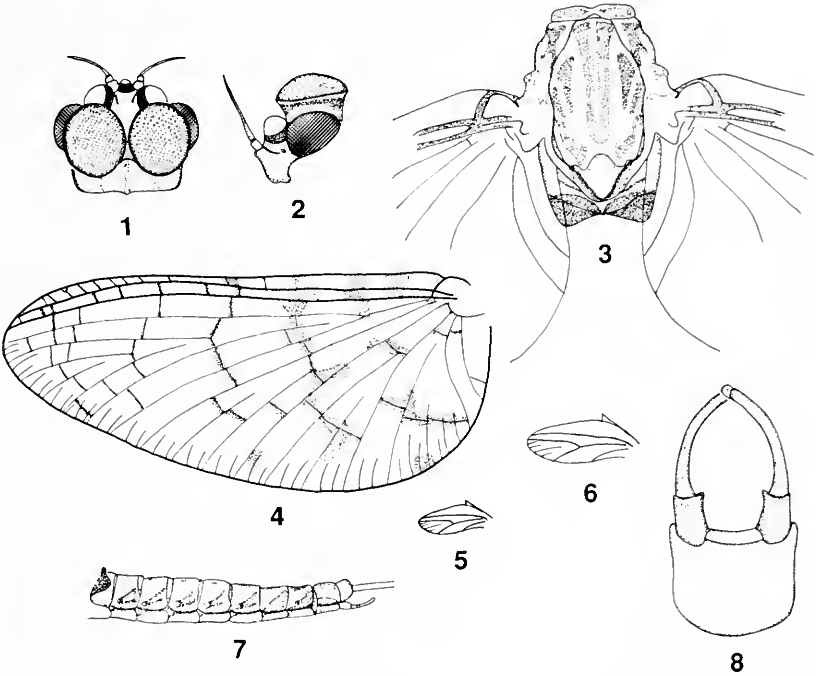
1994. In addition, Wills Flowers (Tallahassee, Florida) has kindly loaned us larvae and a reared subimago of *M. macaferti* that represent a new country record (see material examined, below). We are thereby able to provide a first description of the adult *M. macaferti* and the first species key to male adults of *Moribaetis*.

Moribaetis macaferti Waltz

Male adult. Dimensions in mm: body length, 9.7; forewing length, 7.6; forewing width, 3.5; hindwing length, 1.2; caudal filaments length, 20.0. Head (Figs. 1 and 2): Coloration generally light yellowish brown. Turbinate portion of compound eyes smoke yellow, nearly round with anterior-posterior length only slightly longer than width, nearly contiguous, and mounted on short stalks with encircling band of suffused black. Scape and pedicel of antennae distally marked with brown. Thorax (Figs. 1 and 3): Pronotum (Fig. 1) cream medially and light brown laterally. Antecosta of mesotergum (Fig. 3) suffused dark brown. Meso- and metanota cream with medium and light brown elongated markings as illustrated in Figure 3, including conspicuous narrow-elongate U-shaped submedian medium brown mark on scutum. Forefemora light to medium brown; foretibiae medium brown, with length 1.32x that of femora; foretarsal segment 1 medium brown; foretarsal segments 2-5 cream basally and light brown distally. Mid- and hindlegs cream with femora and tarsi light brown distally; tibiae subequal in length to femora. Claws dissimilar, each consisting of one hooked-acute and one straight-ovoid member. Forewings with distinct markings as illustrated in Figure 4; yellowish brown stains generally associated with crossvenation but more extensive in basal area of membrane with large free spots in basal costal and subcostal area and extensions from crossveins near MA_2 and MP_2. Hindwings as in Figures 5 and 6; membrane devoid of staining; costal process acute and asymmetrical (straight edged posteriorly); first elongate vein unforked; second elongate vein forked in distal half, with forks encompassing free marginal intercalaries; third elongate vein short, terminating in anal margin. Abdomen (Fig. 7): Terga light basally, becoming more suffused with yellowish light brown shading posteriorly (terga 6-10 markedly becoming progressively more shaded); tergum 1 with narrow lateral medium brown markings; terga 2-8 with additional triangular medium brown markings extending length of terga and filling posterolateral corners of terga; tergum 9 with lateral markings more extensive anteriorly and not well developed posteriorly, with additional pair of small oblique dashes sublaterally at posterior margin; tergum 10 pale and unmarked. Sterna 1-6 whitish, almost translucent; sterna 7-9 pale yellow, almost translucent; sternum 9 pale yellow. Genitalia (Fig. 8) with short, medially smooth basal segment, elongate second segment, and small, rounded terminal segment weakly demarcated from second segment. Caudal filaments, for most of length, distinctly banded in alternating pattern of one white and three darkened segments.

Male subimago. Generally similar to adult. Turbinate portion of compound eyes appearing slightly more oval-elongate. Color pattern not well developed on body and not yet evident in forewings as described above. Submedian elongate marking on thoracic scutum not formed into U-shape, but unconnected posteriorly. Subcostal process of hindwings similar to adults but appearing minutely hooked, probably as an artifact of the subimaginal pellicle; only one major intercalary evident between forks of second elongate vein. Triangular posterolateral abdominal tergal markings evident but not highly contrasting as in adult. Genitalia and caudal filaments missing.

Material examined. MEXICO, Puebla Sta, Pahuatlán, Hwy 106, VIII-17-1994, B. C. Kondratieff, male adult and associated larvae (left fore- and hindwings slide mounted). PANAMA, Bocas del Toro Prov., trib. of Rio Guabo at pipeline rd., V-28-1985, R. W. Flowers (male subimago and associated larvae).



Figs. 1-8. *Moribaetis macaferti*, male adult. 1. Head and pronotum. 2. Head (lateral view). 3. Meso- and metanota. 4. Left forewing. 5. Left hindwing (to scale with forewing). 6. Left hindwing (enlarged). 7. Abdomen (lateral view). 8. Male genitalia (ventral view).

DISCUSSION

The adult male described above was not reared; however, we have no doubt that it is *M. macaferti*. It was taken where only *M. macaferti* larvae were taken (B. C. Kondratieff, pers. comm.), is specifically distinct from other adults in the genus, and essentially agrees with the subimago from Panama that was indeed reared from larvae of *M. macaferti* (R. W. Flowers, pers. comm.).

The forewings of *M. macaferti* have more extensive staining than those of *M. maculipennis* [see Flowers (1979): Fig. 1] and *M. salvini* [see Eaton (1885): Fig. 29a]. The hindwings are most similar to those of *M. maculipennis* in venation but differ in not having any staining [see Flowers (1979): Figs. 2 and 3]. It is possible that the number of marginal intercalaries between the forks of the second elongate vein in the hindwings is variable within *M. macaferti*, based on a comparison of the hindwings of the subimago from Panama and the adult from Mexico, and thus we do not recommend attempting to identify adults of species of *Moribaetis* on that basis. The abdominal terga of *M. macaferti* (Fig.

7) possess distinct posterolateral markings on segments 2-8, and additionally lack the distinctive large brown submedian markings of *M. maculipennis* [see Flowers (1979): Fig. 5] and the pitch-black posterior marginal markings of the terga described by Eaton (1885). There are, however, very slight and difficult to detect indications of a pair of pale spots on most abdominal terga in *M. macaferti*. The terminal segment of the genital forceps of *M. macaferti* (Fig. 8) is most similar to that of *M. maculipennis* [see Flowers (1979): Fig. 4] in that it is weakly demarcated from segment 2. However, *M. macaferti* lacks the roughened medial margin of the basal segment of the forceps that is present in both *M. maculipennis* and *M. salvini* [see also Kimmins (1934): Fig. 13], in addition to the well-defined rounded and setose medioapical protrusion of the basal forceps segment seen in *M. maculipennis* [Flowers (1979): Fig. 4].

Key To Male Adults of *Moribaetis* Species

[key to larvae in Waltz and McCafferty (1985)]

1. Forewings with extensive staining throughout membrane (Fig. 4); abdominal terga 2-8 with triangular posterolateral markings (Fig. 7); forceps with medial margin of basal segment smooth medially (Fig. 8) .... *M. macaferti*
1'. Forewings [Flowers (1979): Fig. 1; Waltz and McCafferty (1985): Fig. 43] and abdominal terga not as above; forceps [Kimmins (1934): Fig. 13; Flowers (1979): Fig. 4] with medial margin of basal segment roughened.. 2

2. Cerci banded with two to three dark segments alternating with two light segments [Waltz and McCafferty (1985): Fig. 33]... *M. maculipennis*
2'. Cerci banded with one slightly darkened segment alternating with three light segments [Waltz and McCafferty (1985): Fig. 42]. .... *M. salvini*

ACKNOWLEDGMENTS

We thank R. W. Flowers (Florida A & M Univ.) and B. C. Kondratieff (Colorado State Univ.) for collecting and providing the specimens that have made this paper possible. The paper has been assigned Purdue Agricultural Research Program Journal No. 15467.

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METHODS IN ECOLOGICAL & AGRICULTURAL ENTOMOLOGY. D.R. Dent & M.P. Walton, eds. 1997. CAB International. 387 pp.

Citing the need for an up-to-date and comprehensive textbook on experimental and analytical methods in both ecological and agricultural entomology, this book seeks to integrate new technologies and approaches to research with traditional methods, to provide a balanced view of the subject for final year undergraduates and postgraduates, and to be a useful source of reference for research workers. Twenty three authors contributed chapters on thirteen subjects ranging from sampling, handling and rearing insects to studying insect behavior, quantifying insect populations and insect migration, host plant selection, insect pollination, insecticide efficacy and efficacy of natural enemies, and modelling.

THE EVOLUTION OF MATING SYSTEMS IN INSECTS AND ARACHNIDS. J.C. Choe & B.J. Crespi, eds. 1997. Cambridge University Press. 387 pp. $44.95 pbk, $100 hdbk.

The complex mixtures of conflict and cooperation that typify sex and sociality make these among the most endlessly fascinating and difficult topics in ecology and evolution. The twenty one chapters in this volume, contributed by thirty six authors, explore the intricacies of sexual and social competition and the variety of ways in which males and females pursue, persuade, manipulate and control, and help one another. This volume is intended to update the synthesis of insect mating systems by Thornhill and Alcock (1983) and complement the recent synthesis of the study of sexual selection by Andersson (1994).

PROGRESS AND PROSPECTS IN EVOLUTIONARY BIOLOGY: THE *DROSOPHILA* MODEL. J.R. Powell. 1997. Oxford University Press. 562 pp. Cloth $70.00.

The author states the primary impetus for this book is the conviction that if a major advance in understanding evolution is to be achieved, it is most likely to come from integration of levels of knowledge centered on a single closely related set of organisms. *Drosophila* has the greatest chance of being this organism. Thus, this book is about empirical studies of *Drosophila*, and is directed primarily toward graduate students but also to evolutionary biologists and colleagues studying development, molecular biology, and neurobiology of *Drosophila*.

FIRST REPORT AND NEW SPECIES OF THE GENUS *CLOEODES* (EPHEMEROPTERA: BAETIDAE) FROM AUSTRALIA[1,2]

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

ABSTRACT: *Cloeodes fustipalpus*, new species, and *C. illiesi*, new species, are described from larvae from eastern Australia. The two species represent the first report of *Cloeodes* from the continent. *Cloeodes fustipalpus* is distinguished by the irregular labral setation, clublike labial palps segment 3, and abdominal color pattern. *Cloeodes illiesi* is distinguished by the bifid right prostheca with a medially setose branch, reduced maxillary palps, medially bulbous labial palps segment 3, abdominal color pattern, and narrow-elongate gills. Numerous morphological characteristics indicate that *C. fustipalpus* and *C. illiesi* are most closely related to the Afrotropical *C. inzingae* and the Oriental *C. longisetosus* and *C. soldani*. Three biogeographic scenarios are discussed that would explain the world distribution of *Cloeodes*.

Traver (1938) erected the genus *Cloeodes* (Ephemeroptera: Baetidae) for the Caribbean species *C. maculipes* Traver and *C. consignatus* Traver. The genus is distinct among small minnow mayflies because its larvae have edentate tarsal claws (Fig. 6; Waltz and McCafferty 1987b: Fig. 8), a conspicuous subproximal arc of long, fine, simple setae on the tibiae (Fig. 6; Waltz and McCafferty 1987b: Fig. 7), and setal tufts on sterna 2-6 (Waltz and McCafferty 1987a: Fig. 5; Waltz and McCafferty 1987b: Figs. 9, 44). Adults of *Cloeodes* are distinguished by having segment 2 of the male genital forceps basally bulbous and with abundant minute, fine, simple setae (Waltz and McCafferty 1987b: Fig. 34).

Cloeodes has been reported from the Afrotropics, Neotropics, Orient, and southwestern Nearctic (Traver 1938, Waltz and McCafferty 1987ab, 1994, Kluge 1991, Flowers 1991, Lugo-Ortiz and McCafferty 1993, 1994, 1995, McCafferty and Lugo-Ortiz 1995, McCafferty et al. 1997). Herein we report *Cloeodes* for the first time from Australia. The report is based on two new species described from larvae collected from Queensland and New South Wales. The specimens studied are housed in the Purdue Entomological Research Collection, West Lafayette, Indiana.

The discovery of *Cloeodes* in Australia is of considerable biogeographic interest because it is the first genus of Baetidae known to occur throughout the Southern Hemisphere. *Cloeodes* may have been widespread in Gondwanaland during the Jurassic approximately 180 million years ago (mya). Southern Hemisphere landmasses drifting to their present positions would have carried an-

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[1] Received July 28, 1997. Accepted August 27, 1997.

[2] Purdue Agricultural Research Program Journal No. 15460.

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cestral species of *Cloeodes* with them. The South East Asian distribution could be explained by the northward drifting and abutment of the Indian subcontinent approximately 45 mya. The southern Nearctic distribution of the genus has been explained by northward dispersal during and after the formation of the Isthmus of Panama approximately 6-5 mya, as reviewed by McCafferty (1998). Alternatively, *Cloeodes* may have originated somewhat later on the African-Indian-South American landmass (essentially West Gondwanaland) during the Early Cretaceous approximately 140 mya. This explanation is similar to the first, except that dispersal of the genus from Asia into Australia during the Middle Miocene approximately 15 mya is assumed. A third historical explanation would have *Cloeodes* originating in Africa-South America during the Middle Cretaceous approximately 110-100 mya. At that time, however, the genus might not have been present on the Indian subcontinent, and the presence of *Cloeodes* in the Orient, Australia, and North America would all be attributed to dispersal events beginning in the Eastern Hemisphere when Africa and Eurasia reunited during the middle Miocene approximately 17 mya. Interchange between Africa and Asia in this period is consistent with some other animal groups (e.g., see Cox and Moore 1985).

We cannot at this time be sure which of these three biogeographic explanations is the most likely because only a small number of species of *Cloeodes* are known and cladistic analysis is not possible. Considerable insular evolution of the genus has occurred in South America since the isolation of that continent, as evidenced by the fact that Western Hemisphere *Cloeodes* are a closely related, distinctive grouping (Waltz and McCafferty 1987b). The fact that all species in the Eastern Hemisphere are closely related to each other (see species discussions below) would further suggest that African, Asian, and Australian lineages have dispersed relatively recently, not having been isolated from each other to the extent in which Western and Eastern Hemisphere lineages of the genus have.

Cloeodes fustipalpus Lugo-Ortiz and McCafferty, NEW SPECIES

Larva. Body length: 5.1-6.0 mm. Caudal filaments length: 2.3-2.5 mm. Head: Coloration light yellow-brown, with faint vermiform markings on vertex. Antennae approximately 1.5x length of head capsule. Labrum (Fig. 1) with submedial pair of long, fine, simple setae and submarginal row of six to eight fine, simple setae of various lengths. Hypopharynx similar to Figure 11. [Left and right mandibles (Figs. 2, 3) with outer incisors worn in material examined.] Left mandible (Fig. 2) with inner incisor with three denticles; prostheca robust, apically denticulate; minute denticles present between prostheca and mola. Right mandible (Fig. 3) with inner incisor with four denticles; prostheca somewhat slender, apically acute; minute denticles present between prostheca and mola. Maxillae (Fig. 4) with three long, fine, simple setae near medial hump; maxillary palps reaching galealaciniae; palp segment 1 approximately 0.50x length of segment 2. Labium (Fig. 5) with glossae and paraglossae equal in length; palp segment 1 approximately 0.80x length of segments 2 and 3 combined; segment 2 approximately 1.20x length of segment 3;

segment 3 bulbous, clublike (medially broader than apical width of segment 2). Thorax: Coloration pale yellow-brown, with complex markings. Hindwingpads absent. Legs (Fig. 6) cream; femora with dorsal row of five to eight long, robust, simple setae, last two almost contiguous and longer than others; tibiae with dorsal row of long, fine, simple setae; tarsi with dorsal row of long, fine, simple setae. Abdomen (Fig. 7): Coloration pale brown and cream; segment 1 cream; segment 2 pale brown, with submedial and sublateral pairs of large, oblong, cream markings; segment 3, 5, and 6 pale brown, with submedial pair of circular cream markings; segment 4 anteriorly and posteriorly pale brown, medially cream; segment 7 anteriorly pale brown, posteriorly cream; segment 8 cream; segment 9 pale brown, with semicircular anteromedial cream marking; segment 10 pale brown. Sterna cream. Gills (Fig. 8) subtriangular, well tracheated, with smooth margin. Paraprocts (Fig. 9) with 18-20 sharp marginal spines, increasing in size apically; abundant scale bases scattered over surface. Caudal filaments whitish; medial caudal filament approximately 0.80x length of cerci.

Adult. Unknown.

Material examined. Holotype: Larva, AUSTRALIA, New South Wales, Chandler R., 26 mi E of Armidale, no date, G. F. Edmunds. Paratypes: Larva, same data as holotype [mouthparts, left foreleg, gill 4, and paraproct mounted on slide (medium: Euparal)]; two larvae, AUSTRALIA, New South Wales, Bellinger R., at Bellinger, II-23-1966, G. F. Edmunds. Additional material: Three exuviae, AUSTRALIA, New South Wales, Serpentine R., New England National Park, II-19-1966, G. F. Edmunds; three larvae, AUSTRALIA, New South Wales, Bellinger R., at Bellinger, II-23-1966, G. F. Edmunds.

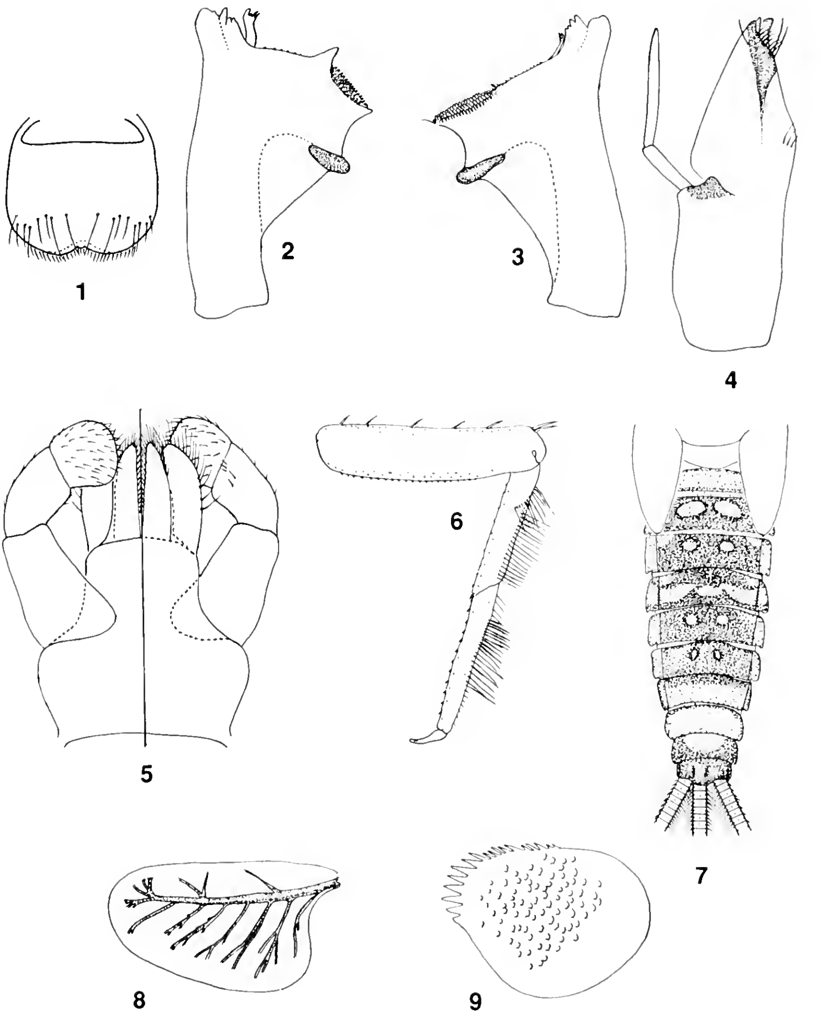
Etymology. The specific epithet is a combination of the Latin words *fustis* (club) and *palpus* (palps). It is in reference to the clublike labial palps.

Discussion. *Cloeodes fustipalpus* is distinguished from other members of the genus by the irregular setation of the labrum (Fig. 1), clublike segment 3 of the labial palps (Fig. 5), and abdominal color pattern (Fig. 7). The abdominal color pattern varies somewhat among specimens, but the most consistent is the one shown in Figure 7.

Cloeodes fustipalpus appears to be related to the Oriental species *C. longisetosus* (Braasch and Soldán) and *C. soldani* (Müller-Liebenau), the Afrotropical species *C. inzingae* (Crass), and *C. illiesi*, new species, from Australia (see below). The larvae of all these species have a bulbous labial palp segment 3 (Figs. 5, 15; Crass 1947: Fig. 9a; Braasch and Soldán 1980: Fig. 12; Müller-Liebenau 1983: Fig. 3b), well-developed rows of long, fine, simple setae on the tibiae and tarsi (Fig. 6; Braasch and Soldán 1980: Figs. 2, 3; Waltz and McCafferty 1994: Fig. 2), and lack hindwingpads.

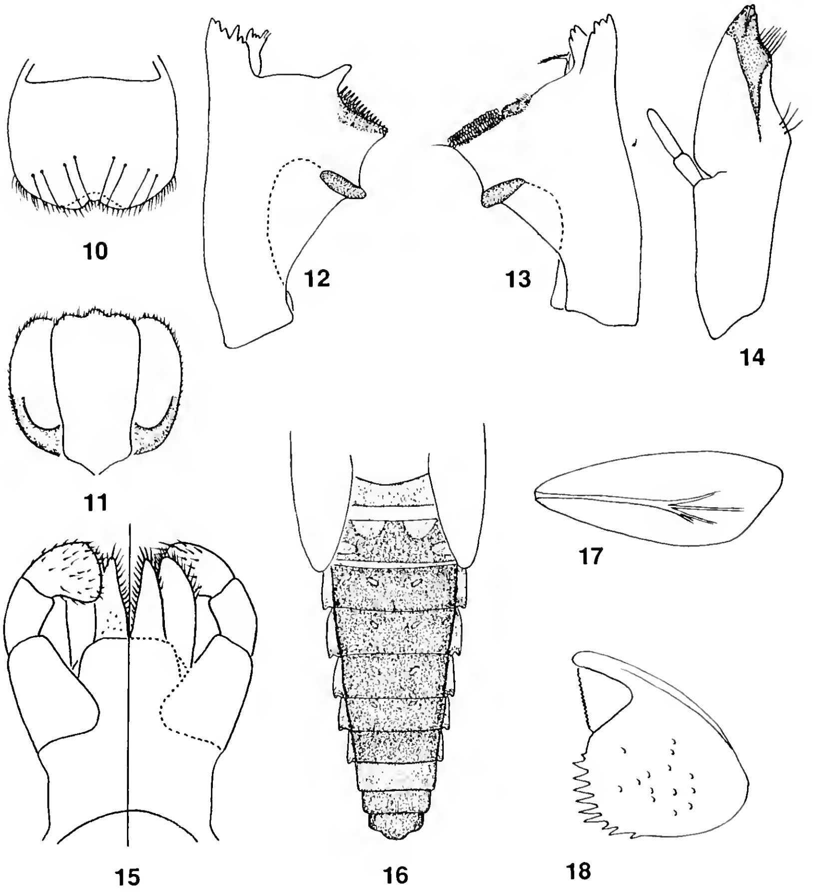
Cloeodes illiesi Lugo-Ortiz and McCafferty, NEW SPECIES

Larva. Body length: 3.9 mm. Caudal filaments length: unknown. Head: Coloration yellow-brown to medium brown, with faint vermiform markings on vertex. Antennae approximately 1.5x length of head capsule. Labrum (Fig. 10) with submedial pair of long, simple setae and submarginal row of three to four long, fine, simple setae. Hypopharynx as in Figure 11. Left mandible (Fig. 12) with six denticles; prostheca robust, apically denticulate; minute denticles between prostheca and mola absent. Right mandible (Fig. 13) with outer incisor with four denticles; inner incisor with three denticles; prostheca slender, bifid, one branch medially with minute, fine, simple setae; minute denticles between prostheca and mola absent. Maxillae (Fig. 14) with



Figs. 1-9. *Cloeodes fustipalpus*, new species, larva. 1. Labrum. 2. Left mandible. 3. Right mandible. 4. Right maxilla. 5. Labium (left-ventral; right-dorsal). 6. Left foreleg. 7. Abdomen (dorsal). 8. Gill 4. 9. Paraproct.

three long, fine, simple setae near medial hump; maxillary palps not reaching galealaciniae; palp segment 1 approximately 0.60x length of segment 2. Labium (Fig. 15) with glossae and paraglossae equal in length; palp segment 1 as long as segments 2 and 3 combined; segment 2 approximately 0.74x length of segment 3; segment 3 bulbous, apically flattened. Thorax: Coloration pale to medium yellow-brown, with complex markings. Hindwingpads absent. Legs (similar to Fig. 6) cream; femora with dorsal row of five to seven long, robust, simple setae, last two almost contiguous; tibiae with dorsal row of long, fine, simple setae; tarsi with dorsal row of long, fine, simple setae. Abdomen (Fig. 16): Coloration pale brown and yellow-brown; segment 1 yellow-



Figs. 10-18. *Cloeodes illiesi,* new species, larva. 10. Labrum. 11. Hypopharynx. 12. Left mandible. 13. Right mandible. 14. Right maxilla. 15. Labium (left-ventral; right-dorsal). 16. Abdomen (dorsal). 17. Gill 6. 18. Paraproct.

brown; segment 2 pale brown, with submedial anterior pair of large yellow-brown oblong markings and sublateral oblong yellow-brown markings; segments 3-6 pale brown, with submedial anterior pair of small subtriangular yellow-brown markings; segment 7 pale brown; segment 8 yellow-brown; segment 9 pale brown, with faint medial streak; segment 10 pale brown. Sterna cream to yellow-brown. Gills (Fig. 17) narrow-elongate, poorly tracheated, with smooth margin. Paraprocts (Fig. 18) with 9-10 sharp marginal spines; scale bases scattered over surface. Caudal filaments whitish.

Adult. Unknown.

Material examined. Holotype: Larva, AUSTRALIA, Queensland Province, nr. Cairns, Cascade Falls, sea level, 20°C, X-13-1966, J. Illies [mouthparts, left foreleg, and paraproct mounted on slide (medium: Euparal)].

Etymology. This species is named after the late renowned entomologist-limnologist Joachim Illies, who collected it.

Discussion. *Cloeodes illiesi* is distinguished from other members of the genus by the bifid right prostheca with a setose branch (Fig. 13), reduced maxillary palps (Fig. 14), medially bulbous labial palps segment 3 (Fig. 15), abdominal color pattern (Fig. 16), and narrow-elongate gills (Fig. 17). Its possible relationships to other species of *Cloeodes* are discussed above under *C. fustipalpus.*

ACKNOWLEDGMENTS

We thank G. F. Edmunds, Jr. (Salt Lake City, Utah) for the donation of the material used in this study.

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THE BIONOMICS OF GRASSHOPPERS, KATYDIDS AND THEIR KIN. S.K. Gangwere & M.C. & M. Muralirangan, eds. 1997. CAB International. 529 pp.

This volume consists of twenty chapters authored by an international group of twenty eight scientists and is written from a broad, comparative biological, behavioral, and evolutionary approach best expressed by the term bionomics. It focuses on history and recent developments in grasshopper and plague locust biology as well as the biology of katydids, crickets, and other Orthoptera, an insect group of exceptional economic and biological interest.

INSECT ECOLOGY, 3rd ed. P.W. Price. 1997. J. Wiley & Sons. 874 pp.

Moving from the dynamics of plant-insect interactions, predation, parasites and hosts, as well as mutualistic relationships, including pollination ecology, this book examines the themes central to understanding the role of insects in our environment. It describes the various levels of insect interaction, from trophic relationships, populations, and communities, while unfolding the infinite variety of insect species and their visible legacy in the fossil record. This new edition includes discussion on the nature of ecological theory and how it is advanced, the evolutionary perspectives on population dynamics, the existence and study of vacant ecological niches, latitudinal gradients in species richness, and conservation of biodiversity.

DIEL EMERGENCE PATTERNS OF *TRICORYTHODES STYGIATUS* (EPHEMEROPTERA: LEPTOHYPHIDAE) ON THE LITTLE LEHIGH CREEK NEAR ALLENTOWN, PENNSYLVANIA[1]

Fran Gough, Bruce L. Haase[2]

ABSTRACT: *Tricorythodes stygiatus* subimagos and adults show a diel periodicity in drift rates. Most of their activity is centered around the hours of sunrise and sunset. There is a differential emergence of male and female subimagos, males emerge after sunset and females emerge after sunrise. Light periodicity is the primary influence in the timing of *T. stygiatus* emergence, molting, and oviposition. This species is univoltine at this study site.

Tricorythodes stygiatus McDunnough (Ephemeroptera: Leptohyphidae) is a common species in the limestone streams of southeastern Pennsylvania . The species emerges throughout the summer. *Tricorythodes* species have been described as univoltine (Newell and Minshall 1978), bivoltine (Hall 1975), or multivoltine (Newell and Minshall 1978) depending on geographic location and water temperatures.

Tricorythodes species are atypical of most mayflies in that the subimago emerges from the larval shuck underwater and swims/floats/crawls to the surface, with males emerging after dark and females emerging early the next morning (Hall 1975; Edmunds and McCafferty 1988).

In Hall's (1975) study of *T. allectus* Needham, the surface drifting of male subimagos took place from sunset until the early hours of the morning, while female subimagos showed a peak in surface drift rate around sunrise. The emergence of male subimagos of *T. allectus* was correlated with low light intensity in the evening, while female subimago emergence is correlated with increasing light intensity in the morning (Hall 1975). However, in a study by Newell and Minshall (1978) *T. minutus* always emerged at the water surface, usually in the afternoon. *T. minutus* seems to be little influenced by photoperiod.

T. allectus male subimagos molt to adults before dawn, so the length of the male subimago stage is 5-7 hours. The female's subimago stage is very short. Some female subimagos molt immediately after emergence, others may wait up to 2 hours (Hall 1975). The male alate life of *T. allectus* lasts about 9-10 hours, beginning after dusk until the sun is well above the horizon. The female's alate stage spans a few short hours after dawn (Hall, Berner and Cook 1975).

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[1] Received June 9, 1997. Accepted September 20, 1997.

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ENT. NEWS 109(2) 129-135 , March & April, 1998

In *T. minutus,* the subimago stage usually lasts less than 30 minutes and the alate forms live less than 6 hours (Newell and Minshall 1978).

The purpose of this study is to determine if there is a differential emergence of male and female subimagos of *T. stygiatus* in the Little Lehigh Creek in Allentown, PA., and to determine if this differential emergence can be correlated with water temperature or time of day.

METHODS

This study took place on the Little Lehigh Creek, a 4th order stream in Salisbury Township, Lehigh County, Pennsylvania. The study site was at the end of a riffle in the main channel of the stream. It is a limestone spring creek with a typical riffle-pool complex, with a substrate composed mainly of marl and silt.

Sampling was done using a Munro style drift net with a 250 micron mesh size and a net opening measuring 39cm x 39cm and a length of approximately one meter. A removable (250 cm) catch basket, composed of 3 inch PVC pipe and mesh screen was attached to the end of the drift net. The frame, made of 0.5 inch PVC pipe, was slid over steel reinforcing rods that were hammered into the stream bottom. When in place, the Munro drift net extended from the stream bottom through the water's surface (anywhere from 5 cm to 15 cm above the surface depending on water levels).

The net was placed in the selected riffle of the study area for 24 hours at a time. Samples were removed and the net replaced every hour during the study period. At this time, the stream temperature was also taken and recorded. These 24 hour study periods were conducted three times, about one month apart, on July 13, August 11, and September 8 of 1995.

The samples were rinsed from the net into a pan, concentrated with an aquarium net and preserved in 70% ethanol. Using a 20x Swift dissecting microscope, these insects were counted, aged (as subimagos or adults) and the subimagos sexed. To determine the life stage of the alate *T. stygiatus,* the methods described by Edmunds and McCafferty (1988) were used. Subimagos had translucent wings with cilia along the hind edge. Adults had transparent wings without cilia on the hind edge of the wing. Subimagos and adults were sexed as males if claspers were present at the end of the abdomen, and as females if claspers were absent. Voucher specimens are deposited at the Department of Biological Sciences, East Stroudsburg University, East Stroudsburg, Pa.

RESULTS

The largest numbers of alate *T. stygiatus* were caught in the July 1995 sample with 891 organisms collected, including 73 subimagos and 818 adults. During the July 13th sample period, the water temperatures ranged from 16° C. in the early morning hours to 21° C. in the late afternoon. Sunrise was at

0542 and sunset was 2033 so the day length was 14 hours 51 minutes. The peak drift time for male subimagos occurred between 2200 and 2400; for female subimagos this peak occurred between the hours of 0600 and 0900 (Table 1, Figure 1). Adults showed a peak drift rate between the hours of 0800 and 1100 (Table 1, Figure 2).

Fifty- four alate *T. stygiatus* were collected in the August drift samples, including 8 subimagos and 46 adults. During the August 11th sample period, the water temperatures ranged from 15° C. in the early morning hours to 19° C. in the late afternoon. Sunrise was at 0608 and sunset was 2006, so the day length was 13 hours and 58 minutes. The peak drift time for male subimagos occurred between 2100 and 2300, for female subimagos this peak occurred between 0900 and 1000 (Table 1, Figure 1). Adults showed a peak drift rate between the hours of 0900 and 1000 (Table 1, Figure 2).

Table 1. Hourly drift rates of *Tricorythodes stygiatus* subimagos and adults taken over a 24 hour period in the Little Lehigh Creek.

Time	**Subimago Male**			**Subimago Female**			**Adults**		
	7/13/95	**8/11/95**	**9/08/95**	**7/13/95**	**8/11/95**	**9/08/95**	**7/13/95**	**8/11/95**	**9/08/95**
0100	1	0	0	1	0	0	0	0	0
0200	1	0	0	0	0	0	0	2	0
0300	0	0	0	0	0	0	0	0	0
0400	0	0	0	0	0	0	0	0	0
0500	1	0	0	0	0	0	0	0	0
0600	0	0	0	20	0	0	1	1	0
0700	1	0	0	4	0	1	1	1	6
0800	0	0	0	4	0	0	59	1	16
0900	1	0	0	15	1	1	349	11	7
1000	0	0	0	1	1	0	335	22	16
1100	0	0	0	0	0	0	63	3	4
1200	0	0	0	0	0	0	2	1	1
1300	0	0	0	0	0	0	1	0	0
1400	0	0	0	0	0	0	0	1	0
1500	0	0	0	0	0	0	2	0	1
1600	0	0	0	0	0	0	0	1	0
1700	0	0	0	0	0	0	0	1	0
1800	0	0	1	0	0	0	0	0	0
1900	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0
2100	0	5	1	0	0	0	0	0	0
2200	8	0	0	0	0	0	1	0	0
2300	4	1	0	0	0	0	1	1	0
2400	11	0	0	0	0	0	3	0	0
Total	28	6	2	45	2	2	818	46	52

Fifty-five alate *T. stygiatus* were collected in the September drift samples, including 4 subimagos and 51 adults. During the September 8th sample period, the water temperatures ranged between 15° C. and 16° C. Sunrise was at 0636 and sunset was 1921, so the day length was 12 hours 45 minutes. The peaks in drift time for male subimagos were at 1800 and 2100, for female subimagos these peaks were at 0700 to 0900 (Table 1, Figure 1). Adults showed a peak in drift rate from 0700 to 1100 (Table 1, Figure 2).

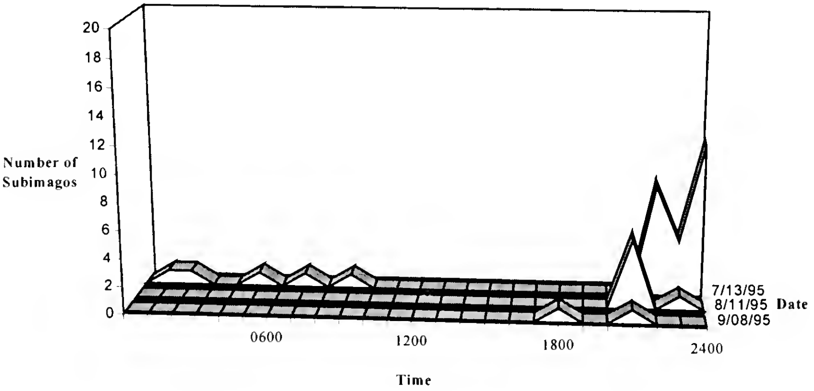

Figure 1A. Hourly drift rate of *Tricorythodes stygiatus* male subimagos in the Little Lehigh Creek.

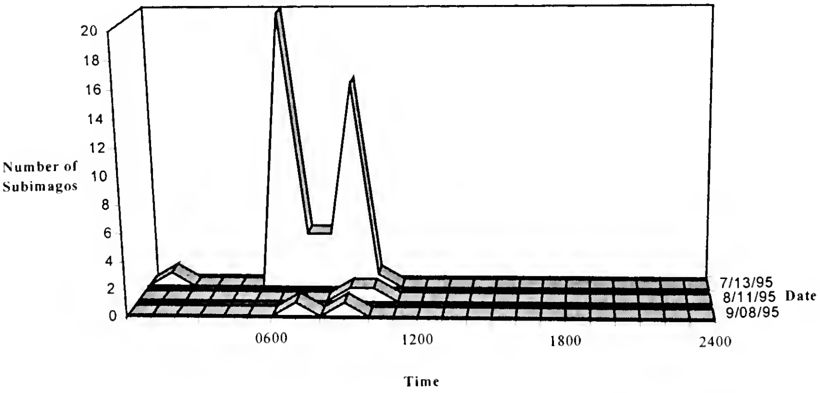

Figure 1B. Hourly drift rate of *Tricorythodes stygiatus* female subimagos in the Little Lehigh Creek.

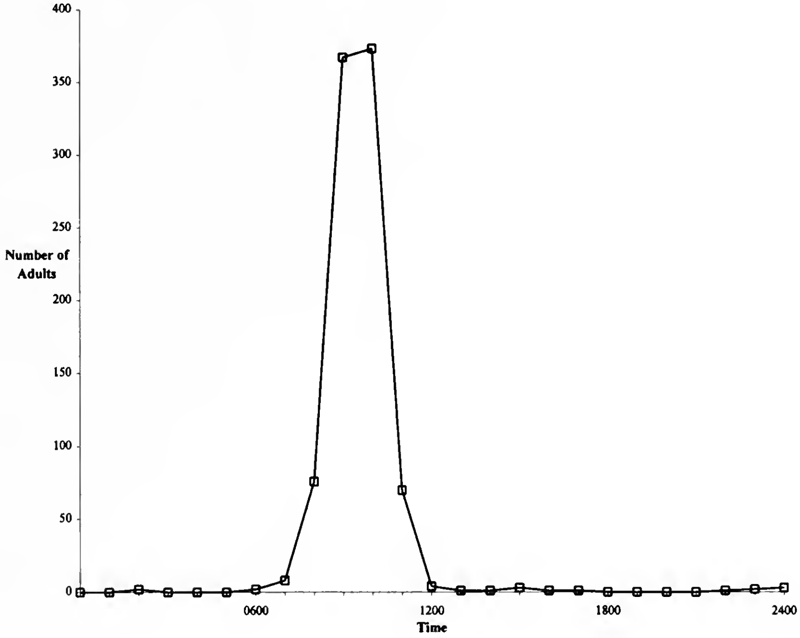

Figure 2. Hourly drift rate of *Tricorythodes stygiatus* adults in the Little Lehigh Creek.

DISCUSSION

Alate forms of *T. stygiatus* adults on the Little Lehigh show a diel periodicity in their drift rates. Water temperature did not appear to trigger the differential emergence of *T. stygiatus* in this study. The temperature of the stream did not fluctuate much (+ 2° C.) on a 24 hour basis, or on a seasonal basis (15°-21° C.) throughout the study period. Instead, the peak for subimago and adult drift revolves around the hours of sunrise and sunset. This can be seen in the data as the season progresses and the day length shortens. It is apparent that light periodicity is the primary influence in the timing of the *T. stygiatus* alate life activities of emergence, molting, mating and oviposition. This agrees with the findings of Hall (1975) and Friesen, Flannagan and Lautersweiler (1980) (*T. allectus).*

There was differential emergence of male and female subimagos of *T. stygiatus* in the Little Lehigh. This is similar to what Hall (1975), Friesen, Flannagan and Lautersweiler (1980) and Edmunds and McCafferty (1988) have found in other parts of North America for other species of *Tricorythodes*. In found in other parts of North America for other species of *Tricorythodes*. In this study 83% (30 of 36) of the male subimagos emerged in the first 3 hours after sunset, and 93% (43 of 49) of the female subimagos emerged in the first 3 hours after sunrise. About 98% (894 of 915) of the spent adults were collected from 1 to 5 hours after sunrise, so mating and ovipostion had occurred prior to this event. Mating and oviposition occur for about 3-4 hours after sunrise based on the first/last appearance of spent wing adults in the drift samples. This is a somewhat longer period than was observed by Hall, Berner and Cook (1975) in *T. allectus*. These findings were similar to R. J. Hall's (1975) study of *T. allectus* except that male subimago emergence did not occur steadily through the night, while the peak emergence of female subimagos occurred after sunrise.

The short life span of *Tricorythodes* species has been well documented (Hall 1975; Hall, Berner and Cook 1975; Edmunds and McCafferty 1988). On the Little Lehigh, alate males live 8-14 hours and alate females live 2-5 hours on average, based on the time from first/last appearance of subimagos and the first/last appearance of adults.

It appears that the *T. stygiatus* on the Little Lehigh Creek are univoltine based on this study. This would agree with Newell and Minshall's (1978) study on *T. minutus*. The drift rate of alate *T. stygiatus* was many times greater in July than in August or September. In this study, 89% (891 of 996) of the total drift is accounted for in the July sample alone.

In a number of the *T. stygiatus* larvae, subimagos and adults, a distinct red coloration on the thorax was noted. In the 0600 hour sample on July 13, 1995, 70% of the female subimagos had a red thorax. The cause of this red coloration is another area for further investigation. A number of causes have been hypothesized from 1) an element of water chemistry (Gary Borger personal communication 1995), 2) parasitic mites (Greg Hoover personal communication 1996, Brittain 1982), to 3) a type of polymorphism (Peters & Peters 1977).

ACKNOWLEDGMENTS

We would like to acknowledge the following people who helped make this project a success: for much needed assistance from Rod Rohrbach, Rich Heiserman, Steve Hoovler, Joe Kohler, Gary Pyle and other members of the Little Lehigh Fly Fishers and Little Lehigh Trout Unlimited; to Andy Shiels of the PA Fish and Boat Commission and Don Marushak of the Allentown Parks Dept., to Jim Munro for his drift nets; to Mark Gerber for his word processing skills; and the primary author gives special thanks to his wife, Maura, for her endless patience and understanding. The identification of this species as *T. stygiatus* was verified by Don Baylor of Aquatic Resource Consulting of Saylorsburg, PA and by Greg Hoover, Penn State University Department of Entomology. The authors would like to thank R.D. Waltz and W.P. McCafferty for their suggestions in reviewing this article.

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THE FIRST FOSSIL DORYLINAE WITH NOTES ON FOSSIL ECITONINAE (HYMENOPTERA: FORMICIDAE)[1]

Mark B. DuBois [2, 3, 4]

ABSTRACT: Two army ant species, *Dorylus molestus* and *Neivamyrmex iridescens*, are reported from copal of undetermined age (possibly Upper Pliocene and Pleistocene respectively). The presence of such fossils is remarkable given the disposition of many such species to foraging underground. Until more precise dates for this material are available, historical and biogeographic implications of these fossils remain uncertain.

Ants are represented in the fossil record from Cretaceous through Pleistocene (Carpenter 1992; Bolton 1994). The currently recognized classification includes 16 extant subfamilies and four extinct subfamilies (Bolton 1994). A number of species are known from impressions in Tertiary shale (Carpenter 1930) and are mostly represented by reproductives. Many ants have been preserved in amber (Wheeler 1914; Mayr 1868; Wilson 1985) and are mostly represented by workers. Foraging workers were trapped in resins which became amber, while reproductives flying over bodies of water were drowned and buried in silt (which later became shale). Some species, such as *Stenamma berendti* (Mayr), are known only from reproductives preserved in amber (Mayr 1868). Most publications have concentrated on pre-Pleistocene fossils; a few have dealt with sub-fossils (Francoeur and Elias 1985; DuBois 1993). Limited work has been done on specimens preserved in copal, which is usually Pleistocene or Pliocene in age (Poinar 1992, Larsson 1978).

Most fossil worker ants belong to the extant subfamilies Formicinae, Dolichoderinae, Myrmicinae, and Ponerinae. Though some wing fragments have been tentatively identified as belonging to army ants, until recently, no fossil worker army ants were known. Wilson (1985) described *Neivamyrmex ectopus* from workers preserved in amber in the Dominican Republic. These fossils are thought to be late Oligocene or early Miocene in age. The rarity of fossil worker army ants is probably due to their behavior because many species principally forage underground.

Recently, I had the opportunity to study fossil ants of both Ecitoninae and Dorylinae preserved in copal. Although copal is considered much younger in

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age (Recent, Pleistocene or Pliocene), these specimens provide a link (geologically and biogeographically) with older material. Both species are briefly discussed below.

There appears to be a vast number of ant specimens preserved in copal from various deposits. The species discussed above represent a minuscule portion of available material. I hope this paper will stimulate further study of such fossils and subfossils. The precise age of the material discussed below is unknown (this is true for much copal). Although ages ranging from Recent through Pliocene have been proposed for various copal deposits, the stratigraphy of sites containing this material (and associations with micro-fossils) must be established to determine proper age.

Dorylus molestus (Gerstäcker)

This species can be distinguished from related *Dorylus* species through the following combination of characters: head with convex sides; posterior angles of head pointed; ventral lobe of petiole well developed (Raignier and Van Boven 1955). Specimens appear identical to modern forms (as described in Raignier and Van Boven 1955). Bill Gotwald examined selected specimens and concluded they were this species ("... the common driver ant of East Africa, especially Kenya and Tanzania.") (Gotwald, pers. comm.). Wheeler (1922: 740) gave the distribution of this species in Eastern Africa (including Mombassa, Mt. Kenia (2400 - 2800 m), Bura Mountains, Freretown, and Naivasha, Rift Valley).

Two hundred and seventy one specimens contained in 12 pieces of copal were examined. This material was collected along the Tanzania - Kenya border (Tanzania side, approximately 100 km south-west of Mombassa, Kenya). Individual pieces of copal were covered in caliche and found in a layer 11 m below the soil surface (Alan Graffham, pers. comm.). Specimen disposition is as follows. Lloyd Davis, Jr. provided two pieces of copal containing *Dorylus*. These have been returned to him. All remaining pieces discussed are from my personal collection and were obtained from Allen Graffham and other sources. Of these, one piece containing *Dorylus* has been donated to the British Museum of Natural History and another piece containing *Dorylus* has been donated to the Museum of Comparative Zoology.

Schluter and von Gnielinski (1987) indicated this copal was derived almost entirely from resin of *Hymenaea verrucosa* (Leguminosae: Caesalpinaceae). Deposition sites were listed as in the forest soil (primary), in the mangrove fringed estuary (secondary), and along the beach (tertiary).

These deposits are part of the Mikindani beds (Stockley 1928). Stockley (1928) assigned an age of Upper Pliocene. Poinar (1992) indicated this Tanzanian copal may be Pliocene in age (1.6 - 5 Ma). Schluter and von Gnielinski

(1987: 11) presented an age of Pleistocene, but cautioned that ". . . stratigraphically well defined associations of copal with index- or guide-fossils do not exist." von Gnielinski (pers. comm.) reiterated the uncertainty with the dating of copal from that region (Pleistocene or Pliocene could be argued). Additionally, Ken Anderson who is currently studying amber and copal deposits from around the world (pers. comm.) indicated these were "resins of undetermined geological age, but probably not of great antiquity."

Schluter and von Gnielinski (1987: 18) further stated: "Generally, it can be assumed that the fauna of the East African copal does not show significant differences from the fauna living today, i.e., all the trapped specimens represent recent species..." Although a number of insects have been reported from these deposits (including nine species of Hymenoptera), no ants have previously been reported (Schluter and von Gnielinski 1987).

Figures 4 through 8 illustrate typical features of these specimens. Figures 11 and 12 show the general appearance of these specimens within the copal. Other arthropods were preserved with the ants. Their state of preservation, coupled with problems in identification of many East African insects, did not permit precise identifications. Specimens include other ants (several male Ponerinae, two male Myrmicinae, three worker Dolichoderinae, one minor worker *Pheidole* sp., one worker *Crematogaster* sp.), four Chalcidoidea, one alate termite, and a number of flies, beetles, leafhoppers, and spiders. After examining the fossils in cross section, it appears a foraging column of driver ants became trapped on the sticky resin and were then covered with another resin flow.

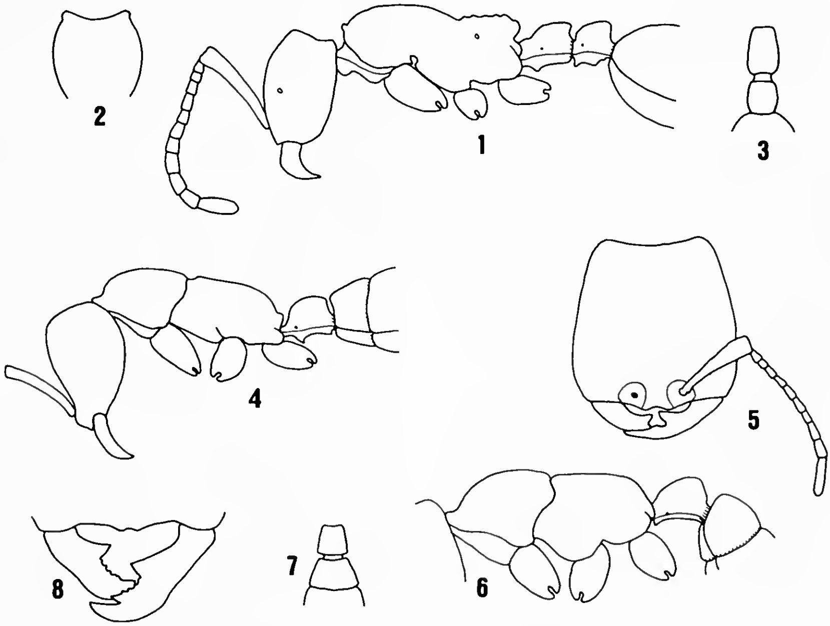
Neivamyrmex iridescens Borgmeier

This species can be distinguished from related *Neivamyrmex* species (Borgmeier 1955 - Group VII) through the following combination of characters: postpetiole about five-sixths as long as high; head with violet reflections (difficult to see in fossil material); postpetiole about as long as wide, higher than long with posterior surface of node more steeply sloping than anterior surface; head smooth and distinctly shining; apex of scape closer to upper margin of head than eye level (Watkins 1976). Julian Watkins II identified the *Neivamyrmex* in one of these samples. He indicated the fossil is most similar to specimens of *Neivamyrmex iridescens* from Cundinamarca, Colombia in his collection. The only significant difference is a slightly longer than usual petiole. (Julian Watkins II, pers. comm.). Specimens key to *N. iridescens* using Watkins (1976) and fit the description provided by Borgmeier (1955: 540 - 542). This species is presently known from scattered localities: Panama, Guianas, Surinam, Bolivia, Colombia (Borgmeier 1955; Watkins 1976).

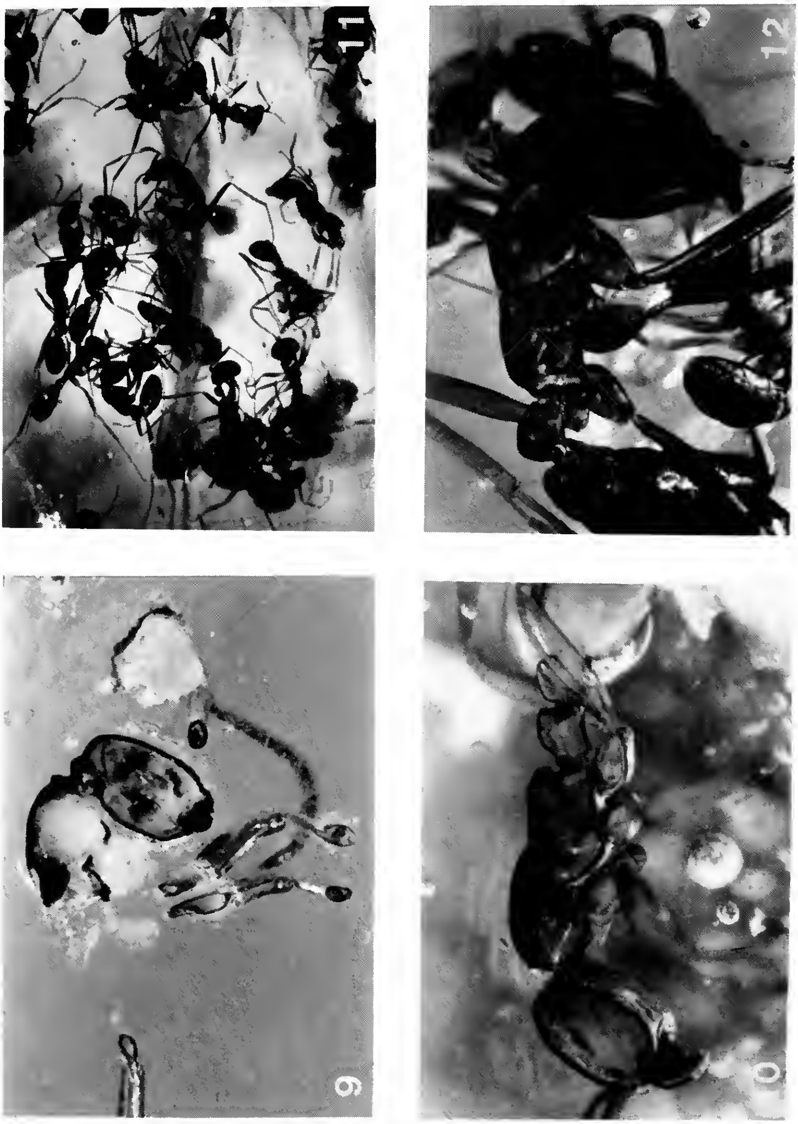
Four specimens contained in two pieces of copal were examined from Colombia. Disposition of specimens: these *Neivamyrmex* remain in my collection. They originally came from Colombia via Mr. Allen Graffham.

The specific locality for this material is unknown, but Schlee (1984) indicated this may be from "Peña Blanca." This material bears locality information of Santander Department, Colombia. Allen Graffham (pers. comm.) indicated it came from a roadcut and provided several photographs. He indicated that he doubts any deposition has occurred in this area for a very long time as it is quite mountainous with very steep slopes. I have examined fossil ants in copal from both Santandar and Boyaca departments. Most material was collected at a depth of 2 - 3 meters in Santandar and up to 10 meters in Boyaca. Poinar (1992) indicated all known Colombian material is of Pleistocene age. Ken Anderson (pers. comm.) also considered these were "resins of undetermined geological age, but probably not of great antiquity."

This copal is presumed to be derived from a species of *Hymenaea*, but details regarding this locality, deposition, and origin of this material are sketchy at best. It is not known to this author whether any species of *Hymenaea* live in



Figures 1 - 8. Scale varying. Legs, pilosity, and sculpture omitted. Figures 1 - 3. *Neivamyrmex iridescens*. Figure 1. Worker, lateral view. Figure 2. Head, profile of occipital vertex. Remainder of head obscured by position within copal. Figure 3. Petiole and postpetiole, dorsal view. Figures 4 - 8. *Dorylus molestus*. Figure 4. Minor worker, lateral view. Figure 5. Major worker, head, full face view. Figure 6. Major worker, lateral view. Figure 7. Worker, petiole and postpetiole, dorsal view. Figure 8. Major worker, mandibles and anterior clypeal margin.



Figures 9 - 12. Photographs of fossilized army ants and driver ants. Scale varying. Figures 9 - 10. *Neivamyrmex iridescens*. Figure 9. Damaged specimen (damaged previously by polishing). Figure 10. Worker, lateral view. Figures 11 - 12. *Dorylus molestus*. Figure 11. Numerous workers in copal. Figure 12. Major worker, lateral view.

the area today.

Figures 1 - 3 show typical features of these specimens. Figures 9 and 10 depict the general appearance of these specimens within the copal. Other arthropods were preserved with the ants. Their state of preservation coupled with problems in identification of South American insects did not permit precise identifications. Specimens include two other ants (one minor worker *Pheidole* sp., one worker *Anochetus* sp.), one Chalcidoidea, one fly, one worker termite, one set of termite wings, and one spider. Since only four ants were trapped, it is possible that they were on the periphery of a foraging column which encountered the resin.

ACKNOWLEDGMENTS

This paper is dedicated to the memory of the late Frank M. Carpenter (Museum of Comparative Zoology, Harvard Univ. advisor and friend for the past 2 decades). His encouragement was appreciated.

My continuing thanks is extended to Jeri and Benjamin DuBois for their support and understanding. They make it all possible. Lloyd Davis (Gainesville, Florida) provided some specimens of *Dorylus*. Julian Watkins II (Baylor University, Waco, Texas) identified some specimens of *Neivamyrmex iridescens*. Bill Gotwald (Utica College of Syracuse University, Utica, New York) identified some specimens of *Dorylus molestus*. Merrill Foster (Bradley University, Peoria, Illinois) put me in contact with Allen Graffham (Ardmore, Oklahoma) who provided numerous comments regarding localities and possible ages for the ant fossils discussed herein. The majority of fossil ants discussed herein also came from Allen Graffham. F. von Gnielinski (Geological Survey of Queensland, Brisbane, Queensland) provided insights into the age and conditions of deposition of the African copal. Thanks also to Ken Anderson (Argonne National Laboratory, Argonne, Illinois) who reviewed his current analyses of assigning ages to copal and amber worldwide and discussed his view of the age of these resins with me.

This paper has been reviewed by Wallace LaBerge and Don Webb (Illinois Natural History Survey, Champaign, Illinois), Julian Watkins II, Stefan Cover (Museum of Comparative Zoology, Harvard University), and three anonymous reviewers. Where possible, I have tried to incorporate their comments. I accept responsibility for any remaining errors or omissions.

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COCCINELLIDAE (COLEOPTERA) IN APPLE ORCHARDS OF EASTERN WEST VIRGINIA AND THE IMPACT OF INVASION BY *HARMONIA AXYRIDIS*[1]

M. W. Brown, S. S. Miller[2]

ABSTRACT: Twenty-five species of Coccinellidae were found on apple in eastern West Virginia from 1983 to 1996. From 1989 through 1994, the exotic coccinellid, *Coccinella septempunctata* (first collected in 1983), has dominated the fauna of the tribe Coccinellini. Another adventive species, *Harmonia axyridis* (first collected in 1994), became the dominant species in the tribe Coccinellini in 1995, and continues to dominate the coccinelline guild on apple. *Harmonia axyridis* has displaced *C. septempunctata* and is providing better biological control of *Aphis spiraecola* on apple in eastern West Virginia.

Coccinellids (Coleoptera: Coccinellidae) are an important group of aphid predators in many ecosystems. Because of their ability to contribute to the control of pests, many coccinellids have been selected for introduction in biological control programs. As of 1985, there had been 179 introductions of coccinellids into the U. S., with 26 species having become established; however, 8 were a result of accidental introductions (Gordon 1985). Two recent coccinellid immigrants have made an obvious impact in the mid-Atlantic states. In 1973, *Coccinella septempunctata* L. was first found in New Jersey (Angalet et al. 1979), and it gradually spread throughout the Northeast (Schaefer et al. 1987). In 1988, *H. axyridis* was first found in Louisiana (Chapin and Brou 1991), and has since spread into the mid-Atlantic region (Day et al. 1994). Although both species had been released intentionally, their establishment appears to be a result of accidental introductions (Day et al. 1994). Both species are now abundant throughout much of the northeastern United States and eastern Canada (Hoebeke and Wheeler 1996) and have even become subjects of public concern because of occasional massive migrations of *C. septempunctata* (Schaefer et al. 1987) and by large numbers of *H. axyridis* overwintering in houses (Knodel and Hoebeke 1996).

There have been numerous studies cataloguing the coccinellids in apple orchards in Europe and North America. In Europe, more than 23 species of coccinellids have been collected on apple, but usually 3 to 14 species in any one study (Hodek and Honěk 1996). In a study spanning 4 years in 3 regions of Hungary, 23 coccinellid species were found on apple (Markó et al. 1995). In Europe, *Adalia bipunctata* (L.) and *C. septempunctata* dominate in apple

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[1] Received July 7, 1997. Accepted September 6, 1997.

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orchards. The number of coccinellid species recorded from North American orchards has been similar to that reported in Europe: 7 species in Ontario (Smith 1957), 17 in another study in Ontario (Hagley 1974), 15 in Quebec (LeRoux 1960), 8 in Washington state (Carroll and Hoyt 1984), and 6 in Pennsylvania (Horsburgh and Asquith 1968). Putman (1964) found 10 species of coccinellids in peach orchards in Ontario. In Washington, *Coccinella transversoguttata* Faldermann was the most abundant (Carroll and Hoyt 1984) but in the east, the dominant species varied temporally and spatially. In this paper, we characterize the coccinellid fauna of apple orchards in eastern West Virginia. Data are taken from several studies covering a 14-year period, 1983 to 1996. These years span the time of the invasion of *H. axyridis* into the region and are used to evaluate the effect of *H. axyridis* on other species in the tribe Coccinellini, and on *Aphis spiraecola* Patch (Homoptera: Aphididae) populations.

MATERIALS AND METHODS

Data from several studies were used to characterize the Coccinellidae in apple orchards in eastern West Virginia. Except for the years 1993 to 1995, both conventionally managed and unsprayed orchards were sampled in each study. Data from 1983 to 1984 were taken from Brown and Adler (1989), and Brown et al. (1988). These studies covered the region from Virginia to New York, but only data from West Virginia are used in the present paper. Sampling consisted of visual examination of 7 branches from 6 trees in each of 4 orchards, repeated 6 times per year. The purpose of the study was to examine the phytophagous community structure on apple, but occurrence, not abundance, of natural enemies was also recorded. Data from 1984 to 1988 were from Brown and Welker (1992) using whole-tree visual sampling from 5 to 10 trees from each of 3 orchards, 4 to 6 times per year. Data from 1989 to 1990 were from Brown (1993), sampling in 2 orchards, 2 branches from each of 10 trees in 1989 and 5 trees in 1990, 6 samples per year. Data from 1991 were taken from limb-jarring samples from 3 branches of 6 apple trees each hour over a 24-hour period 4 times during the summer. Limb-jarring samples from 2 peach trees per hour and one sour cherry tree every other hour provide data for Coccinellidae on those tree species. A second study in 1991 added data for Coccinellidae on peach trees (Brown and Puterka 1997) and used observations on 6 branches from each of 6 trees in 3 orchards at 5 times during the summer.

Coccinellid data from 1992 to 1996 were based largely on two experimental orchards planted in 1992: one managed with conventional methods, and the second managed with reduced insecticides and diverse ground cover plantings underneath the trees. In 1992, sampling involved two, 15-tree transects per orchard 6 times per year (Brown and Lightner 1997). Every terminal on each sample tree was examined for aphids and predators. Monthly samples from 10 randomly selected trees per orchard, 10 shoots per tree, were collected from

1993 to 1995 (Brown et al. 1997). In 1996 the same two orchards were sampled more intensively to estimate populations of *A. spiraecola* and aphid predators. Ten terminals on 20 randomly selected trees were sampled weekly in May and June, then biweekly into September whenever aphids were present. In 1992 and 1996, three other orchards were also sampled with the same methodology as described above for those years.

Identification of adult Scymninae, Sticholotidinae, and Psylloborini were made by R. D. Gordon, USDA, ARS, Systematic Entomology Laboratory, Washington, DC. Adult Coccinellinae (except Psylloborini) and Chilocorinae were identified using Dillon and Dillon (1961).

Data on populations of *A. spiraecola*, the predominant aphid on apple trees in West Virginia (Pfeiffer et al. 1989), resulted from pest monitoring in three conventionally managed apple orchards. Ten terminals on two trees from each orchard were sampled and the number of leaves per terminal infested with aphids was recorded. Sampling was conducted every week from early May to September from 1992 to 1996.

Assessment of the impact of *H. axyridis* on coccinellids was limited to the tribe Coccinellini. Any effect on the endemic fauna would be expected to be greatest on members of the same tribe because of their generally similar biologies and niche requirements.

RESULTS AND DISCUSSION

Twenty-five species of coccinellids in 4 subfamilies and 9 tribes were found on apple in eastern West Virginia from 1983 to 1996 (Table 1). Fourteen species of coccinellids were found on peach, including *Scymnus caudalis* LeConte, which was not found on apple, and 7 on sour cherry in limited sampling on these host trees (Table 1). In addition to those species listed, 4 others, all belonging to the Coccinellini, were caught in sticky or blacklight traps located in apple orchards but were not seen foraging on fruit trees: *C. transversoguttata*, *Hippodamia convergens* Guerin, *H. tredecimpunctata tibialis* (Say), and *Mulsantina picta* (Randall). The 25 species listed in Table 1 represent a larger and more comprehensive list of the coccinellid fauna on apple than other studies because it covers a 14-year period, whereas all previous studies, except for Markó et al. (1995), covered only 1 to 3 years.

For the 8 years in which numerical data are available (1989 to 1996), the two exotic species, *C. septempunctata* and *H. axyridis*, dominated the coccinelline fauna (Table 2). Although 7 species of Coccinellini were recorded on apple during these years, over 70% of the individuals collected belonged to the two exotic species. *Coccinella septempunctata* was first collected from apple in West Virginia in 1983. By 1985, *C. septempunctata* was the most frequently encountered coccinelline in orchards, and it was the only coccinelline

Table 1. Coccinellidae, by subfamily and tribe (after Kovář 1996), found in apple orchards of eastern West Virginia, 1983-1996.

Scymninae
- Stethorini
  - *Stethorus punctum* (LeConte) 1
- Scymnillini (Zilini)
  - *Zilus horni* Gordon
- Scymnini
  - *Diomus terminatus* (Say) 1,2
  - *Scymnus fraternus* LeConte
  - *S. circumspectus* Horn 2
  - *S. iowensis* Casey 1,2
  - *S. rubricaudus* Casey
  - *Scymnus* sp. 1
- Brachiacanthini
  - *Brachiacantha ursina* (F.)
- Hyperaspidini
  - *Hyperaspis proba* (Say) 1,2

Chilocorinae
- Chilocorini
  - *Chilocorus stigma* (Say) 1,2

Coccinellinae
- Coccinellini
  - *Adalia bipunctata* (L.) [1]
  - *Anatis labiculata* (Say)
  - *Anatis mali* (Say) 1
  - *Coccinella novemnotata* Herbst
  - *C. septempunctata* L. 1,2
  - *C. transversoguttata* Faldermann
  - *Coleomegilla maculata lengi* Timberlake 1
  - *Cycloneda munda* (Say) 1
  - *C. sanguinea* (L.)
  - *Harmonia axyridis* (Pallas)
  - *Hippodamia parenthesis* (Say)
  - *Olla v-nigrum* (Mulsant) 1
- Psylloborini
  - *Psyllobora vigintimaculata* (Say) 2

Sticholotidinae
- Microweiseini
  - *Microweisea misella* (LeConte) 1

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[1] Also found on peach trees; *Scymnus caudalis* LeConte (Scymninae: Scymnini) was found only on peach trees.

[2] Also found on sour cherry trees.

Table 2. Percentage composition of the coccinelline fauna on apple in eastern West Virginia, 1989-1996.

Species	1989-90	1991	1992	1993	1994	1995	1996
C. septempunctata	72.7	86.4	99.5	93.2	79.4	9.1	10.2
A. bipunctata	9.1	2.3		1.7			
C. munda	9.1	4.5	0.5				
A. labiculata	9.1						
C. maculata lengi		2.3		5.1	2.9	27.3	1.1
O. v-nigrum		4.5					
H. axyridis					17.7	63.6	88.7
Number observed	11	44	192	59	34	11	265

seen in 1987 and 1988 during sampling of the same orchards (Kozár et al. 1994). *Coccinella novemnotata* Herbst, which Wheeler and Hoebeke (1995) suggest may be negatively correlated with *C. septempunctata*, has not been seen in West Virginia apple orchards since 1985. In a survey prior to the arrival of *C. septempunctata* in nearby south-central Pennsylvania (Horsburgh and Asquith 1968), the only Coccinellini found were *A. bipunctata*, *C. munda*, and *H. convergens*.

Harmonia axyridis, first collected in 1994, has replaced *C. septempunctata* as the dominant coccinelline in apple orchards (Fig. 1). In 1995, *C. septempunctata* was reduced to the third most abundant species of Coccinellini behind *H. axyridis* and *Coleomegilla maculata lengi* Timberlake (Table 2). Of

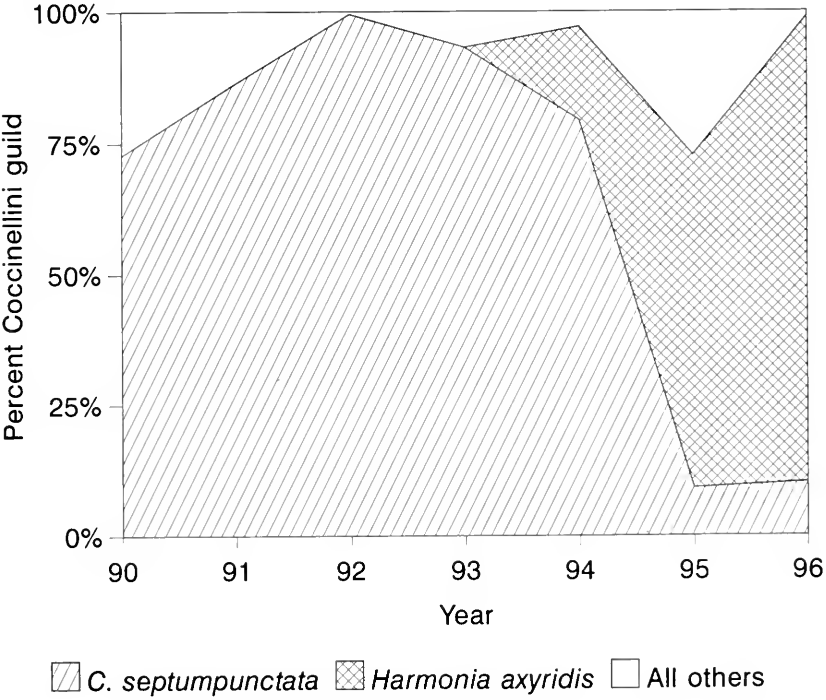

Fig. 1. Percentage composition of the coccinelline fauna in apple orchards of eastern West Virginia from 1990 to 1996, showing the displacement of *C. septempunctata* by *H. axyridis*.

the less abundant coccinellids, *A. bipunctata*, *Cycloneda munda* (Say), *Anatis labiculata* (Say), and *Olla v-nigrum* (Mulsant) have not been seen in apple orchards in the three years since *H. axyridis* appeared. Only *C. maculata lengi* has seemed to become more abundant on apple since the arrival of *H. axyridis*. *Harmonia axyridis* has shown its ability to rapidly dominate in other ecosystems in other regions where it has invaded (Tedders and Schaefer 1994, Day et al. 1994).

Comparing the two years in which intensive sampling of aphid predators was conducted, 1992 and 1996, gives insight into the interaction between *C. septempunctata* and *H. axyridis* (Table 3). In 1992, all but one coccinelline was *C. septempunctata*, with about equal numbers of adults and immatures. By 1996, two years after *H. axyridis* was first detected, no *C. septempunctata* immatures were seen on apple trees. The 12 unidentified immatures were either egg masses or first instar larvae that we could not identify to species. The reduction in total numbers of *C. septempunctata* from 1992 to 1996 suggests that *H. axyridis* not only replaced *C. septempunctata* as the dominant species but also largely displaced it from apple, especially in its use of apple as a larval habitat. It has been shown in Japan that *H. axyridis* larvae prey on *C. septempunctata brucki* Mulsant, but predation in the reverse direction does not occur (Hironori and Katsuhiro 1997).

Table 3. Number of Coccinellini collected in two intensive surveys of aphid predators in eastern West Virginia apple orchards.

	1992		1996	
Species	Adults	Immatures	Adults	Immatures
C. septempunctata	92	99	27	0
C. munda	1	0	0	0
H. axyridis	0	0	48	187
C. maculata lengi	0	0	3	0
Unidentified	0	0	0	12

The displacement of *C. septempunctata* by *H. axyridis* has had a positive impact on biological control of *A. spiraecola* in West Virginia apple orchards (Fig. 2.). Aphid populations were much lower from 1994 to 1996 than in previous years; peak aphid populations were lower and the duration of aphid infestations was shorter, particularly in 1996 (Fig. 2). The aphid data were from orchards sprayed with insecticides, explaining the sharp declines in population abundance in most years. *Harmonia axyridis* was first found in apple orchards in 1994, but it did not dominate until 1995, when aphid populations appeared to be suppressed. Only in 1995 and 1996, the two years in which *H.*

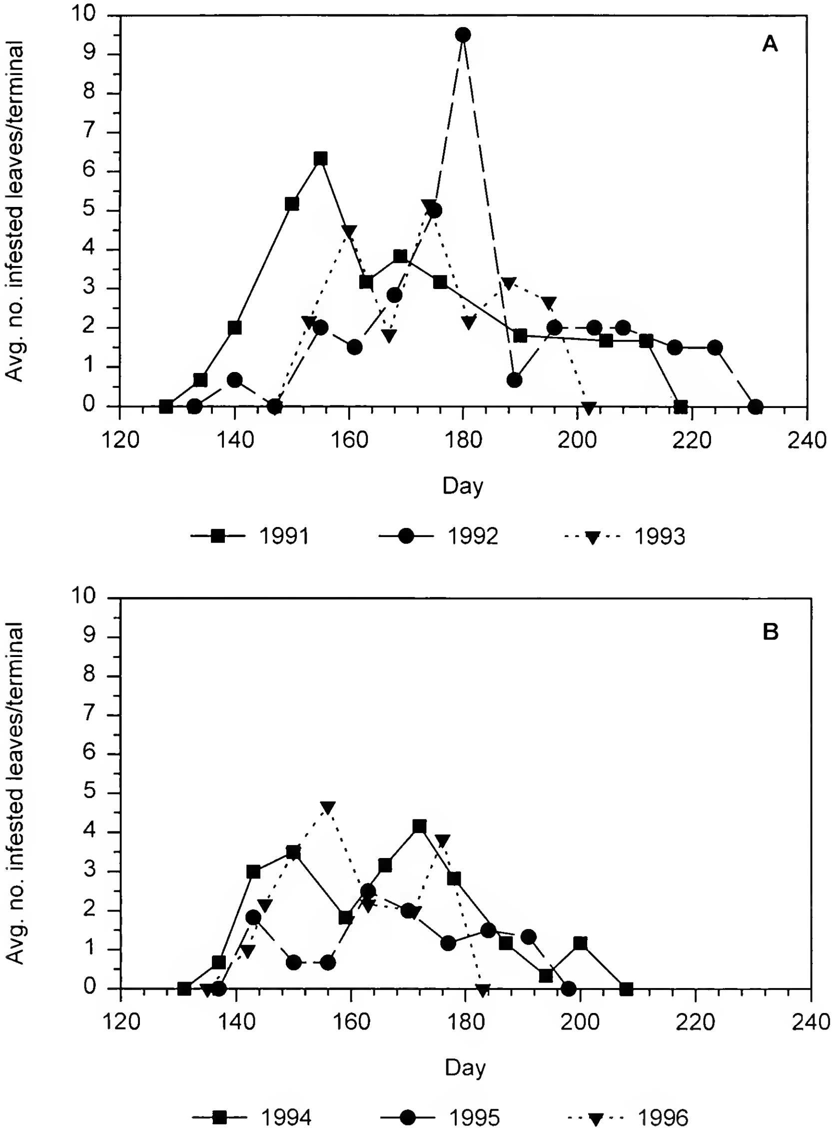

Fig. 2. Population estimates of *A. spiraecola* by day of the year in three conventionally managed orchards in eastern West Virginia; A, 1991 to 1993, prior to arrival of *H. axyridis*; B, 1994-1996, after arrival of *H. axyridis*.

axyridis dominated the coccinelline fauna, were insecticide sprays not applied to control aphids. Data on aphids were obtained only from a few trees in three orchards in only one location and, therefore, cannot be considered conclusive. The indication, however, is that the arrival of *H. axyridis* has improved the biological control of aphids on apple.

Conclusions: Exotic species of Coccinellini have greatly affected the coccinelline fauna of West Virginia apple orchards. First, *C. septempunctata* dominated the fauna, but it was in turn displaced by the newly arrived *H. axyridis* in 1995. The overall effect of *H. axyridis* on native Coccinellini has not been evaluated, but since the arrival of *C. septempunctata*, native coccinellines have represented only a very minor component of the fauna on apple. Aphid biological control has been enhanced since the arrival of *H. axyridis*, so this latest addition to the coccinelline fauna has been beneficial in the apple agroecosystem.

ACKNOWLEDGMENTS

We thank R. D. Gordon (USDA—ARS, Systematic Entomology Laboratory, Beltsville, MD) for identifications of the Scymninae, Sticholotidinae, and Psylloborini; L. Claire Stuart, Cynthia R. L. Adler, Donald C. Weber, Jeffrey J. Schmitt, and V. Larry Crim for their data collection; and William H. Day, Henry W. Hogmire, Jeffrey J. Schmitt, and Natalia J. Vandenberg for their comments on an earlier draft of this paper.

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SOCIETY MEETING OF OCTOBER 22, 1997

Dr. Susan P. Whitney
University of Delaware, Cooperative Extension

SUBTERRANEAN TERMITE COMMUNITY ECOLOGY

Dr. Whitney began by explaining that her research is an effort to answer basic questions about termite ecology, sparked by the need to find new controls. Chlordane, the old standby, has been unavailable since 1988. Subterranean termites are the number two household insect in terms of damage caused.

After providing a brief account of the natural history of termites, Dr. Whitney reported on studies of three species of subterranean termites in two sites in Delaware. *Reticulitermes flavipes*, the eastern subterranean termite, is found in wooded areas in northern Delaware. *R. virginicus* and *R. hageni* are found in dry habitats in southern Delaware. During the summers (May-September) of 95 and 96, field sites were monitored for termite activity with pine stakes buried approximately 20 cm in the ground. Stakes that showed feeding were replaced with "bucket traps" — plastic buckets with the bottom cut off. Into each bucket was placed a wood "sandwich" — six pieces of pine arranged to allow gaps for workers to build mud tubes. Termites were removed from an initial bucket at the start of the field season. Individual workers were marked by allowing them to feed on filter paper saturated with Nile blue A dye. After three days of feeding, marked workers were returned to their bucket. After one week all wood "sandwiches" in the field site were examined for termite presence. The data from repeated marking and recapture were analyzed and average number of workers in colonies of each species calculated. Foraging distances were determined to be as much as thirty feet. Comparisons of the two sites, the experimental farm at University of Delaware in Newark and the field station at Lewes, suggested that colony size and relations among the three species are different in the dry pinewoods at Lewes.

Dr. Whitney described her plans to confirm these findings at other sites and to try reducing colonies with toxic baits to test population recovery.

In entomological notes, Susan Whitney reported finding mole crickets in Delaware; Jon Gelhaus noted AES treasurer Howard Boyd's new book on the New Jersey Pine Barrens; and Roger Fuester reported on the low levels of gypsy moth in Delaware this year – no acreage over 30% defoliated.

W. J. Cromartie
Corresponding Secretary

NOTE RE PRIORITY OF NEW SPECIES DESCRIBED IN JANUARY-FEBRUARY 1998 ISSUE OF ENTOMOLOGICAL NEWS

The January-February 1998 issue, Vol. 109, No. 1, of *Entomological News* was mailed on December 1, 1997. Due to this early mailing date, and for purposes of priority, any new species described in that issue must be cited with a 1997 date, even though it appeared in a 1998 issue.

H.P.B., ed.

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

Titles should be carefully composed to reflect the true contents of the article, and be kept as brief as possible. Classification as to order and family should be included in the title, except where not pertinent. Following the title there should be a short informative abstract (not a descriptive abstract) of not over 150 words. The abstract is the key to how an article is cited in abstracting journals and should be carefully written. It should be an informative digest of the significant contents and of the main conclusions of the research. The author's complete mailing address, including zip code number, should be given as a footnote to the article. All papers describing new taxa should include enough information to make them useful to the nonspecialist. Generally this requires a key and a short review or discussion of the group, plus references to existing revisions or monographs. Authors must include the name(s) of recognized institution(s) where their voucher specimens have been deposited. Illustrations nearly always are needed. All measurements shall be given using the metric system or, if in the standard system, comparable equivalent metric values shall be included. Authors can be very helpful by indicating, in pencil in the margin of the manuscript, approximate desired locations within the text of accompanying figures, tables and other illustrations.

Illustrations: For maximum size and definition, full page figures, including legends, should be submitted as nearly as possible in a proportion of 4/6. Maximum size of printed illustration, including all legends, is $4^{1}/_{2}$ x $6^{1}/_{2}$ inches. Authors will be charged for all text figures and half-tones at the rate of $20.00 each, regardless of size.

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US ISSN 0013-872X
VOL. 109 MAY & JUNE, 1998 NO. 3

ENTOMOLOGICAL NEWS

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NEOPERLA COOSA (PLECOPTERA: PERLIDAE), A NEW STONEFLY SPECIES FROM ALABAMA[1]

Angela D. Smith, Bill P. Stark[2]

ABSTRACT: *Neoperla coosa*, a new stonefly species, is described from male, female and egg stages. The species resembles *Neoperla osage* from the Ozark Mountains, but the male aedeagus is more similar to that of *Neoperla clymene*. The new species is known only from the Coosa and Cahaba drainage systems of Alabama.

During a scanning electron microscopy study of chorionic variability among Alabama and Mississippi *Neoperla*, several populations from the Coosa and Cahaba systems with distinctive eggs were found. These eggs were quite unlike those of known *Neoperla* from the southeastern United States (Stark and Baumann 1978; Stark and Lentz 1988; Stark 1995) and subsequently the females were found to be associated at several localities with males misidentified as *N. clymene* (Newman). Because the eggs closely resemble those of *N. osage* Stark and Lentz, comparisons were made of the male and female genitalia of these species. Results of this study suggest the Coosa-Cahaba specimens represent a previously unrecognized species of the *N. clymene* complex. Terminology for the description follows Stark and Lentz (1988) and Stark (1995). The holotype is deposited in the United States National Museum of Natural History (USNM) and paratypes are deposited in the University of Alabama (UA) or in the collection of the junior author (BPS).

Neoperla coosa, NEW SPECIES

Male.- Forewing length 9-11 mm. General color pale brown, head pale except for dark ocellar and mesal clypeal areas. Wing membrane and veins brown. Legs brown, cerci pale. Process of tergum 7 apically truncate, upturned in lateral aspect, armed ventrally with prominent sensilla basiconica. Mesal sclerite of tergum 8 triangular. Hemiterga rounded apically; finger-like process of hemiterga slender and relatively straight (Fig. 1). Tube of aedeagus slightly sinuate, ca. four times as long as bulb width (Fig. 2); spicule patch relatively prominent along dorsobasal to dorsomesal sides and margins of tube (Figs. 2, 10). Sac unarmed in basal third, apical sac armature of scattered, large and small spines (Fig. 2). Apex of tube curved slightly ventrad (Fig. 2).

Female.- Forewing length 11-13 mm. Color pattern similar to male. Posterior margin of sternum 8 sinuate, mesal portion slightly produced to approximate level of adjacent lateral areas (Fig. 3). Spermathecal stalk robust and irregularly armed with fine brown setae; apex of armature truncate with subapical basally directed extensions (Fig. 4).

Egg.– Length ca. 331.0 ± 7.0 μm; equatorial width ca. 181.1 ± 3.9 μm. Collar sessile,

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[1] Received August 22, 1997. Accepted September 29, 1997.

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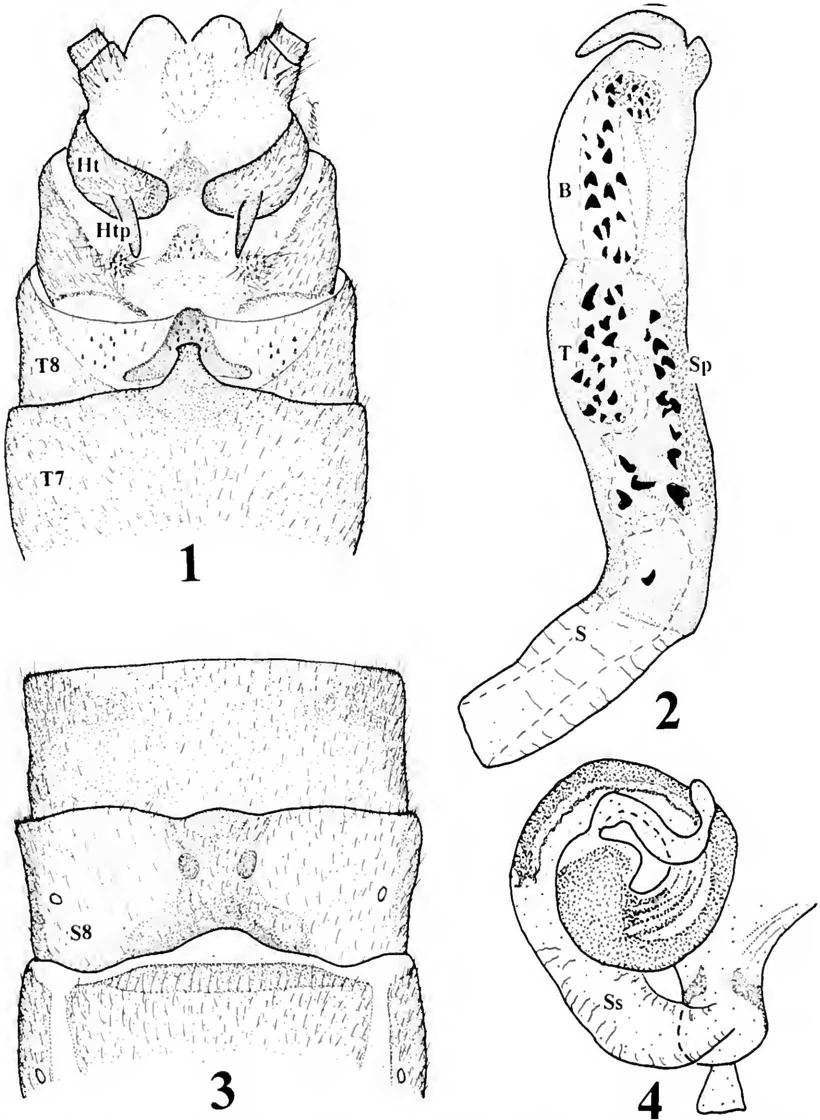
surrounded by two irregular rows of reticulation; collar diameter ca. 66.7 ± 1.4 µm (Fig. 7). Striae slender near poles, widening at equator to ca. 12.9 ± 0.6 µm (Fig. 5). Number of visible striae from anterior aspect ca. 38. Most striae connect directly to posterior follicle cell impression walls (FCIs), some arise from stalks of FCIs (Fig. 8). Sulci punctate with 2-3 rows of aeropyles (Fig. 6); equatorial width of sulci ca. 1.3 ± 0.2 µm. Micropyles form an irregular row displaced slightly from equator toward posterior pole; micropylar orifices simple, without raised lip. Posterior pole covered with FCIs containing ca. 21.8 ± 2.5 aeropyles. FCI walls smooth and slightly thinner than adjacent striae (Figs. 5, 8).

Types.- Holotype ♂ and 41 ♀ paratypes from Yellowleaf Creek, Jumbo, Chilton County, Alabama, 5 July 1989, P. O'Neil, S. McGregor (Holotype and 1 ♀ paratype deposited at the National Museum of Natural History). Additional paratypes, all from Alabama: Cherokee Co. Spring Creek, Hwy 87, 27 June 1989, S. Harris, S. McGregor, 2 ♀ (UA). Chilton Co. Yellowleaf Creek, 2.5 mi SE Mineral Springs, 6 June 1989, 4 ♀ (UA). Walnut Creek, N Refuge Church, 5 July 1989, P. O'Neil, S. McGregor, 1 ♂, 17 ♀ (BPS). Clay Co. Cheaha Creek, abv. Lake Chinnabbee, 3 June 1978, B. Stark, K. W. Stewart, 1 ♂ (BPS). DeKalb Co. Little River at Bear Creek, 22 June 1987, 5 ♂, 98 ♀ (BPS). Elmore Co. Fischer Creek, 3.5 mi SW Weako, 24 June 1987, S. Harris, P. O'Neil, 2 ♂, 3 ♀ (UA). Jefferson Co. Cahaba River, Trussville, 24 May 1981, S. Harris, P. O'Neil 3 ♀ (UA). Cahaba River, I-59, 14 August 1984, S. Harris, P. O'Neil, 1 ♂, 1 ♀ (UA). Shelly Co. Camp Branch Creek, Hwy 42, 17 June 1984, S. Harris 2 ♂, 5 ♀ BPS).

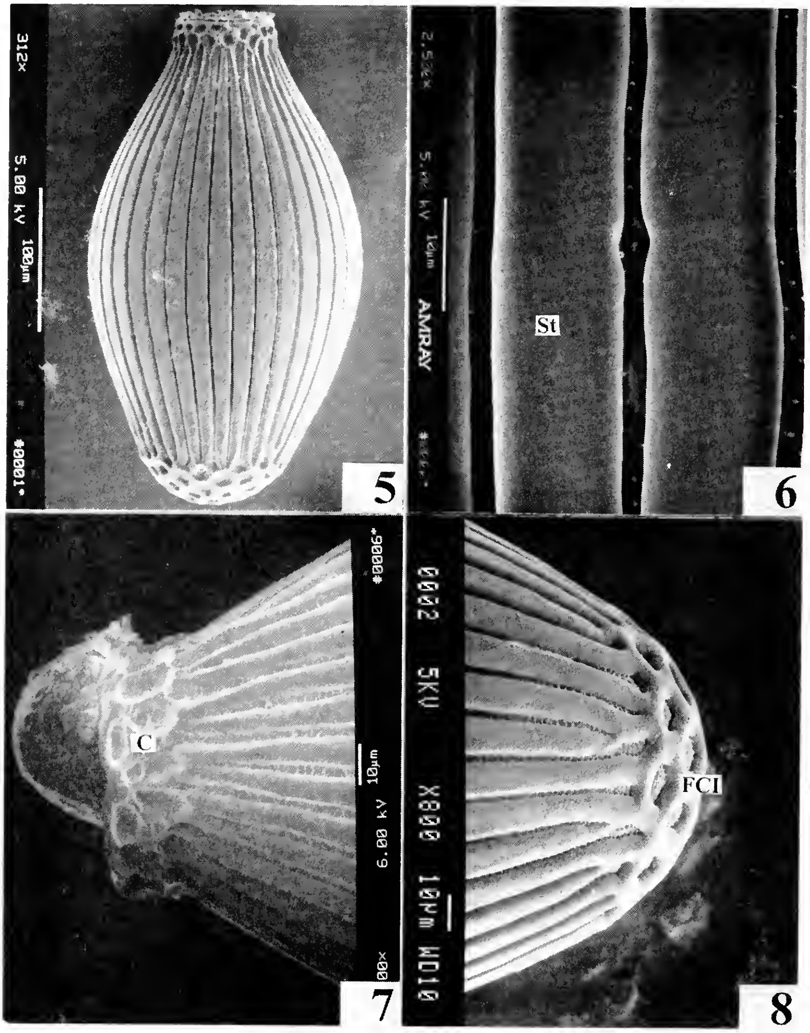
Etymology.- The species name is based on the Coosa River.

Diagnosis.- The aedeagal tube of male *N. coosa* is generally similar to that of the group of species in which an abrupt bend at tube midlength is lacking. In the southeastern United States, *N. clymene* (Newman), *N. coxi* Stark, *N. harrisi* Stark and Lentz, *N. occipitalis* (Pictet), and *N. stewarti* Stark and Baumann are included, but only *N. clymene* and *N. stewarti*, of this group, are known to occur with *N. coosa*. In the most recently available species key (Stark and Lentz 1988), male *N. coosa* are identified as *N. clymene* but differences in the tube dimensions and armature permit separation of these species. The following modification of "couplet 8" from the Stark and Lentz (1988) key is offered:

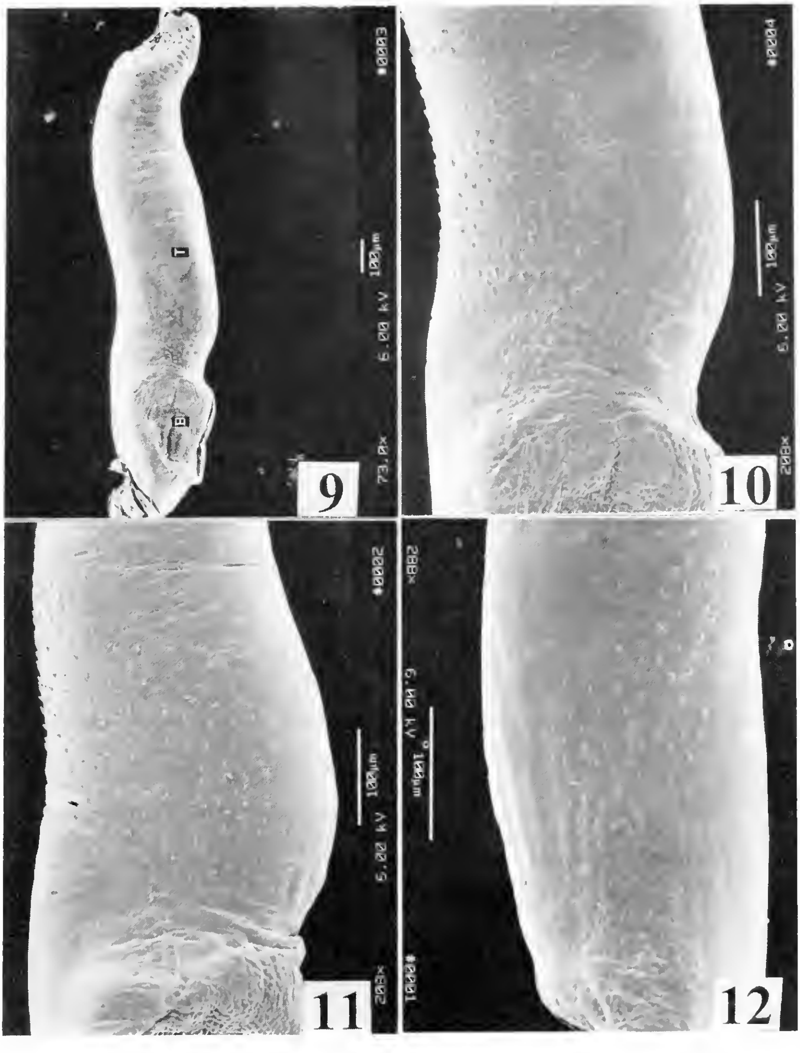
8. Tube apex essentially straight along ventral margin .... *N. occipitalis*
   Tube apex curved ventrad (Fig. 2) 9
9. Dorsobasal margin of tube weakly armed with spicules (Fig. 12); tube length ca. 6 times width at bulb .... *N. clymene*
   Dorsobasal margin of tube with prominent spicules (Fig. 10); tube length ca. 4 times width at bulb (Fig. 9) .... *N. coosa*



Figs. 1-4. *Neoperla coosa*, male and female genitalia. 1. Male terminalia, dorsal. 2. Aedeagal tube, sac partially everted, lateral, ventral side directed to the left. 3. Female sterna 7-9. 4. Vagina and spermathecal stalk, dorsal. B – bulb; T – tube; S – sac; T7 – tergum 7; T8 – tergum 8; S8 – sternum 8; Ss – spermathecal stalk; Sp – spicule patch; Ht – hemitergum; Htp – hemitergal process.



Figs. 5-8. SEM micrographs of *Neoperla coosa* eggs. 5. Egg, lateral. 6. Detail of striae. 7. Detail of collar and anchor. 8. Detail of posterior pole with FCIs. C = collar; FCI = follicle cell impression; St = stria.



Figs. 9-12. SEM micrographs of *Neoperla* aedeagal tubes. 9. *N. coosa*, lateral (B = bulb; T = tube). 10. N. coosa, detail of dorsolateral spicule patch. 11. *N. osage*, detail of dorsolateral spicule patch. 12. *N. clymene*, detail of dorsolateral spicule patch.

The egg (Figs. 5-8) and female subgenital plate morphology (Fig. 3) suggest *N. coosa* is most closely related to an Ozark Mountain species, *N. osage* Stark and Lentz. However, females of these species can usually be distinguished by examination of the spermathecal stalk lining. In *N. coosa* the lining resembles that of *N. robisoni* Poulton and Stewart (Ernst et al. 1986) in displaying 2-3 irregular dark longitudinal folds (Fig. 4) but in *N. osage*, the lining is more uniformly distributed over the apical third of the stalk (Stark and Lentz 1988). The aedeagal tube spicule armature is also similar for *N. coosa* and *N. osage* (Figs. 10, 11) however, the tube dimensions differ for these species. *Neoperla osage* has the aedeagal tube length about three times the bulb width (Stark and Lentz 1988) whereas in *N. coosa* the tube is about four times the bulb width.

Neoperla coosa is presently known from eight sites in the Coosa-Little River basin and two sites in the upper Cahaba River basin. All sites are above the Fall Line in the Piedmont Upland or Alabama Valley and Ridge Physiographic Section (Harris et al. 1991).

ACKNOWLEDGMENTS

We thank S. C. Harris for providing specimens used in this study and R. W. Baumann and B. C. Kondratieff for prepublication reviews. This study was supported in part by the Howard Hughes Medical Institute, Undergraduate Biological Sciences Education Program Grant # 71195-538901.

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THE BIOLOGY AND HOSTS OF *PROCECIDOCHARES ATRA* (DIPTERA: TEPHRITIDAE): EVIDENCE FOR CRYPTIC SPECIES?[1]

T. Keith Philips[2], D. Courtney Smith[3]

ABSTRACT: Galls of *Procecidochares atra* on *Solidago* in late spring contained an average of 15.3 ± 5.1 gregarious larvae (n = 3). Previous records note only monothalamous galls for this species. Twenty-one larvae were found in one gall whereas the previous maximum number of larvae per gall in the genus was 13. Our spring record indicates that *P. atra* is bivoltine, uncommon for a temperate species of fruit fly. We also note new records of *Solidago canadensis* and *Erigeron canadensis* as hosts and a *Eurytoma* species (Hymenoptera: Eurytomidae) as a parasitoid of *P. atra*. The possibility that our collections represent undescribed cryptic species of *Procecidochares* closely related to *P. atra* is discussed.

Most species of *Procecidochares* Hendel cause galls on composite plants. Galls form either in the stems or in the flowers of hosts (Benjamin 1934). One known exception is the non-galling *P. flavipes* Aldrich, which reproduces in flower heads (Goeden et al. 1994). Eleven species have been described in this genus in North America north of Mexico (Foote et al. 1993). *Procecidochares atra* (Loew) is one of the largest and most commonly collected species in the eastern United States and ranges from Florida to Nova Scotia and West to Utah and Idaho. Only monothalamous galls (i.e., galls which contain single larvae) in late summer are known in this species (Felt 1918, Phillips 1946, Philips and Smith, unpublished). Published hosts include several species of *Solidago* Linneaus and an undetermined species of *Aster* Linneaus (Wasbauer 1972) with the latter record questionable (Foote et al. 1993). Here, we report the occurrence of galls where the larvae develop gregariously within a single gall; our observations represent the largest number of larvae per gall reported in the genus. We also discuss the probability of a bivoltine life cycle and note two new hosts for, and a parasitoid of, *P. atra*.

METHODS

Galls were collected in Franklin County, Ohio. Two galls on an undetermined *Solidago* species were collected on 8 May, 1991. One of these galls was dissected. A third gall on *Solidago canadensis* Linneaus was collected two years later on the 14 May, 1993. A single gall growing on *Erigeron canadensis* Linneaus was found in August 1992. All larvae or pupae were allowed to com-

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plete development to adult stage in the laboratory. Twelve galls on *Solidago canadensis* were collected in early September, 1996. These galls were dissected and number of puparia per gall counted. Pupae were also examined for evidence of parasitism. The single parasitoid discovered was allowed to emerge and then killed for identification. Voucher specimens from both plant hosts, the parasitoid, and *Solidago* galls from one of the May collections and the September collection are deposited in the Ohio State University Insect Collection and the United States National Museum. Adults which emerged from *Solidago* are also in the authors' collections.

RESULTS

The three late spring *Solidago* galls were found two to four inches above the surface of the ground at the apical meristem. The first two galls collected in 1991 contained 14 and 21 pupae. Adults emerged from five to 11 days after collection (13-19 May) with the majority (25 of 33 flies) emerging from the 14-16 May. Two flies failed to eclose. The third gall collected in 1993 contained 11 pupae. All adults successfully eclosed (but dates of emergence were not recorded). This third gall (in a dry state) measured 25-30 mm in length by 9 mm in width. The average number of larvae per spring *Solidago* gall was 15.3 ± 5.1 ($n = 3$). Larvae develop gregariously in each gall, without separate compartments for each individual.

Galls on *Solidago canadensis* collected in September were all monothalamous. Each contained a single, empty puparium except for two of them. One produced a parasitoid in the genus *Eurytoma* Illiger (Hymenoptera: Eurytomidae) and the other held a partially eclosed, dead *P. atra*. All late summer *Solidago* galls were situated approximately midway or higher on the plant stalk on apical meristems. Both the late spring and late summer *Solidago* galls were composed of swollen tissue surrounded by leaves in a typical rosette growth form.

A single gall collected on *Erigeron canadensis* in August contained only one larva which eclosed in late August or early September. The *Erigeron* gall was a swollen stem approximately two inches above the ground.

DISCUSSION

Several species of *Procecidochares* produce galls containing single larvae. Examples include *P. atra* (Felt 1918, Phillips 1946), *P. minuta* (Snow) (Novak et al. 1967), *P. stonei* Blanc and Foote (Tauber and Tauber 1968) and various species in the literature without precise identities (Silverman and Goeden 1980, Wangberg 1980). In other species, one to several larvae develop within a single gall. Wangberg (1980) usually found one to three larvae but recorded up to six in his *Procecidochares* sp. "B" and from one to seven (recorded in table 1) for *Procecidochares* sp. "C." Stegmaier (1968) found *P. australis* Aldrich galls contained two to eight larvae per gall. Similarly, Phillips (1946) found this species to have up to eight, but most often had only a single larva per gall. Bess and Haramoto (1958) record an average of three larvae in each gall of *P. utilis* Stone. The highest reported number of larvae in a single gall is 13 in *P. stonei* (Green et al. 1993). But the average for this species was only 2.5 ± 0.1 larvae per gall. By comparison, in spring galls we found up to 21 larvae of *P. atra* in a single gall and an average of 15.3 ± 5.1 (n = 3) larvae or pupae per gall. Published biologies of *P. atra* are not explicit on the number of larvae per gall or the life cycle. For example, Felt (1918) lists a small rosette gall containing a single larval cell on *Solidago altissima* and refers to two species, *P. polita* (Loew) and *P. atra* (as *Oedaspis polita* and *O. atra*). He cites Stebbins (1910), but she only mentions *P. polita* and not *P. atra*. Felt (1918) either had his own records or may have listed both species because they are sympatric in Massachusetts, where Stebbins (1910) based her study. Phillips (1946) studied two larvae of *P. atra* taken from goldenrod galls, implying a single larva per gall. Galls we collected on *Solidago canadensis* in late summer contained only single puparia but, as previously mentioned, galls collected in late spring produced an average of 15.3 ± 5.1 (n = 3) larvae or pupae.

The number of larvae per gall can vary within a species depending upon the host. *Procecidochares stonei*, when living in *Virguiera laciniata* Gray, produces up to 13 larvae per gall (Green et al. 1993). When this same species uses *Virguiera deltoidea* Gray var. *parishii* (Greene) the maximum number of larvae per gall drops to three. For unknown reasons, the number of larvae varies seasonally even within the same host in *P. atra*. The spring generation on *Solidago* develops with large numbers of larvae per gall, whereas the fall generation, whether on *Solidago* or on *Erigeron canadensis*, occurs as a single larva per gall.

Galls with more than one larva can have two different types of internal gall structure. Polythalamous galls contain separate compartments for each larva while others are without internal divisions. Species of *Procecidochares* are known to form both types. Wangberg's (1980) *Procecidochares* sp. "C" forms polythalamous galls. In contrast, *P. stonei* larvae develop gregariously within a gall (Green et al. 1993). Our dissections showed that *P. atra* develops in galls gregariously in the spring, without separate compartments for each larva.

Most species of *Procecidochares* appear to have a limited number of hosts (Foote et al. 1993). For those species with large numbers of reported hosts, such as *P. minuta* (Snow), it appears as though sibling or cryptic species are involved (Wangberg 1980, Foote et al. 1993). Previously recorded hosts for *P. atra* are *Solidago altissima* Linneaus, *S. nemoralis* Ait., *S. odora* Ait. and one questionable record from *Aster* (Wasbauer 1972, Foote et al. 1993). Our collections add two additional hosts, *Solidago canadensis* and *Erigeron canadensis*. *Procecidochares anthracina* (Doane) is the only species of this genus previously recorded from a species of *Erigeron*. Like *P. atra*, this species has been recorded from both *Solidago* and *Erigeron*. This is evidence that galling by one tephritid species on both of these hosts may be common. The other notable aspect of our *Erigeron* record is that the gall was located on the stem near the ground and not on an apical meristem as in *Solidago*. In light of the differences in both host plant and gall location, we initially thought the *Erigeron* galler represented a different species. But we are unable to differentiate this specimen morphologically from other specimens of *P. atra*.

Procecidochares atra adult emergence from galls in late spring and late summer indicate a bivoltine life cycle, whereas most temperate species of tephritids have only one generation per year (Bateman 1972, Christenson and Foote 1960). There are other species of *Procecidochares* that are bivoltine or even multivoltine. *Procecidochares utilis*, a species native to Mexico, has two generations per year (Hoy 1960). The *Procecidochares* sp. of Silverman and Goeden (1980) is bivoltine in Southern California, although it is sometimes univoltine and conceivably even biennial if adequate rainfall, which triggers necessary vegetative regrowth, does not occur. Huettel and Bush (1972) mention both *P. australis* and an undescribed *Procecidochares* species as multivoltine. These two species emerge in the fall from galls in flower heads. The adults then oviposit in small, overwintering rosette plants. Larvae and their galls develop slowly over the winter and the spring generation emerges from these plants. Our records of *Procecidochares atra* suggest a similar life cycle, except that adults may overwinter and oviposit on the perenial *Solidago* as new shoots emerge in the spring. Most temperate species of fruit flies overwinter as diapausing pupae (Bateman 1972).

Biological records for some *Procecidochares* species are questionable because of the need for systematic revision of the genus. Incomplete taxonomy has resulted in species listed by letter designations (Wangberg 1980) or species listed as near a described taxon (Dodson 1986, 1987). Even with *P. atra*, which could be considered a well-known species, there is potential for cryptic species. As evidence, Foote et al. (1993) mention that specimens of *P. atra* from the western part of the range have only one pair of dorsocentral bristles. The more typical pattern is two pairs, with one pair anterior to and the other posterior to the transverse suture. Although two pairs is the more common pattern, we found this character to be extremely variable in our specimens reared from the late spring galls. Almost half of our specimens have three or four setae anterior to the suture (in addition to the posterior pair) and more rarely a single pair anterior and two pairs of setae posterior to the suture.

Regardless of the morphological variability in *P. atra*, it is clear that our May records from *Solidago* are not for another described species. The only *Procecidochares* that use *Solidago* as a host are *P. anthracina*, *P. minuta*, and *P. polita*. Of these, only *P. polita* (Loew) is an eastern species, and although about the same size as *P. atra*, both are relatively easy to differentiate (see Foote et al. 1993). One possibility is that our May records are for a new cryptic species temporally separated from *P. atra*. Our record on *Erigeron* may even represent a second new species. Similar to the situation described by Huettel and Bush (1972), the species may have differentiated in their host plant use, but have not diverged morphologically, even though they exist sympatrically. Genetic studies may be useful in determining if our records represent a single bivoltine species with two hosts, two separate species with possibly different hosts, or even three species.

ACKNOWLEDGMENTS

We foremost thank George Keeney for his collection of the spring galls and his information on the host species and gall location. We also thank John Furlow for his assistance with plant identification and his discussions on *Solidago* and Andrey Sharkov for the Hymenoptera identification. Our appreciation to two anonymous reviewers whose comments greatly improved the manuscript.

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BOOK REVIEW

WORLD CATALOG OF ODONATA. VOLUME I, ZYGOPTERA; VOLUME II, ANISOPTERA. Henrik Steinmann. 1997. Walter de Gruyter, Berlin & New York. 1025 plus pp. $870.00 US.

These two volumes comprise a straightforward, well-produced, and comprehensive catalog of the worldwide odonate fauna. It attempts to list all known species, arranged according to the taxonomic categories recognized in Davies and Tobin's earlier (1984, 1985) lists, except that the arrangement of Gomphidae follows Carle (1986). Taxa are listed alphabetically within each higher category (i.e., genera are alphabetical within tribes, etc). Each entry includes a fairly extensive synonomy, although not a complete bibliography of each taxon. This is especially helpful for categories above genus, for which such information often does not come easily to hand. Unfortunately, in a number of cases Steinmann cites references in Davies and Tobin as the first entry in a species synonymy rather than citing the actual original description (e.g., - "1985 *Gomphurus ozarkensis* Westfall, 1975 - loc. cit. Davies & Tobin, ..."). Taxa down to and including tribes are diagnosed briefly, although these descriptions merely repeat those of Davies and Tobin, which sometimes are not, in fact, adequately diagnostic. The type species is listed for each genus as well as the location of the type (if known) and type locality for each species. Species entries also give an indication of the geographic range, although this often is quite general or incomplete. At the end of each volume is a complete index of all names within the corresponding suborder and at the end of Vol. II a selected bibliography totaling about 600 entries (not all synonymic listings appear in the collected bibliography). A certain number of errors have crept in. The type species of *Aeshna*, e.g., is given as *Libellula vulgatissima* L. (it is actually *L. grandis; L. vulgatissima* is later, correctly, cited as the type of *Gomphus)*, and *Pseudohagenius* is placed as a subgenus of *Hagenius* rather than of *Sieboldius*. Warts and all, this work is much as one would expect from a catalog for a medium-sized order of insects and, because it contains substantially more information than those it is intended to supersede (Davies and Tobin, 1984, 1985; Tsuda, 1991), it represents a major improvement on them. Unfortunately, it has appeared about six years too late.

I say this because the present work seems to have been done without any reference to (or awareness of ?) the excellent catalog of Bridges, first published in 1991, with the third and final edition appearing in 1994, shortly before the author's untimely death. Bridges' work was privately published, but it has been discovered by most serious students of Odonata and has been widely used and cited. It thus seems astonishing that Steinmann's books should take no account of Bridges'. Be that as it may, a comparison is certainly in order, since each work has the same general objectives and each has its strengths and weaknesses.

Bridges' catalog organizes and lists family group, genus group, and species group names, each alphabetically within separate sections. A fourth section lists species within genera; genera are again listed alphabetically, but higher classification to the level of subfamily or, when possible, tribe, is indicated in compact form after each genus. Thus Steinmann's work provides a more quickly and easily grasped overview of classification, but the process of finding entries for

(continued on page 188)

A SURVEY OF SUMMER TIGER BEETLES ON OHIO RIVER BEACHES IN OHIO AND EASTERN INDIANA[1]

Gene Kritsky,[2] A.J. Savage,[2] S. Reidel,[3] J. Smith[2]

ABSTRACT: A survey of the riparian tiger beetles of the Ohio River Valley from eastern Ohio to eastern Indiana was conducted during May through August of 1995 and 1996. It has provided the first composite analysis of tiger beetle distribution along the river and, combined with the river's recent history, suggested likely causes for declines in riparian tiger beetle populations. The current distribution of *C. repanda* and *C. cuprascens* shows how water management by locks and dams has affected tiger beetle diversity including the extirpation of *C. hirticollis* from the Ohio River Valley and the reduction of *C. marginipennis* to one isolated population in eastern Ohio. The survey also found 6 new county records including the easternmost record of *C. cuprascens* and the first Ohio River record of *C. marginipennis*.

Three species of riparian tiger beetles, *Cicindela hirticollis* Say, *C. cuprascens* LeConte, and *C. marginipennis* Dejean, are currently listed in the special interest category by the Ohio Department of Natural Resources Wildlife listings, which means too little is known about their distribution to allow for a true evaluation as to their abundance. These species are sensitive to habitat destruction and in other states have declined or been extirpated (Graves and Brzoska 1991). Previous efforts to map these species' distributions in Ohio (Graves and Brzoska 1991) and in Indiana (Knisley et al 1987) relied primarily on museum records and inland collecting efforts. To determine the current status of these riparian species we conducted a beach survey of the Ohio River and its tributaries from eastern Ohio to eastern Indiana.

MATERIALS AND METHODS

Because the targeted species, *C. hirticollis, C. cuprascens*, and *C. marginipennis*, are summer species, we concentrated our survey during May through early August of 1995 and 1996. The scouting of potential sites was completed by using 16 and 14 foot speedboats to provide a more accurate coverage of the beaches, bars, and islands along the Ohio River. Once a beach was found, its location was determined using a global positioning system and its tiger beetle fauna was sampled using aerial nets. Voucher specimens were collected and deposited in the Cincinnati Museum of Natural History and Science.

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RESULTS

Nearly 300 miles of the Ohio River and its tributaries were surveyed. Tiger beetles were found at 78 sites. The most common species found was *C. repanda* Dejean (figure 1) which was found throughout the Ohio River Valley. *C. cuprascens* was less common, occurring in 25 localities (figure 2) primarily in western Ohio and eastern Indiana. *C. marginipennis* was found in two widely separated locations (figure 3) in Hamilton and Meigs counties in Ohio. *C. hirticollis* was not found anywhere along the Ohio River. Non-riparian tiger beetles were occasionally collected. *C. sexguttata* Fabricius was collected on narrow sandy beaches that bordered wooded areas and *C. punctulata* Oliver was found on beaches that were adjoining farms or other disturbed habitats. Localities and the species collected are provided as an appendix.

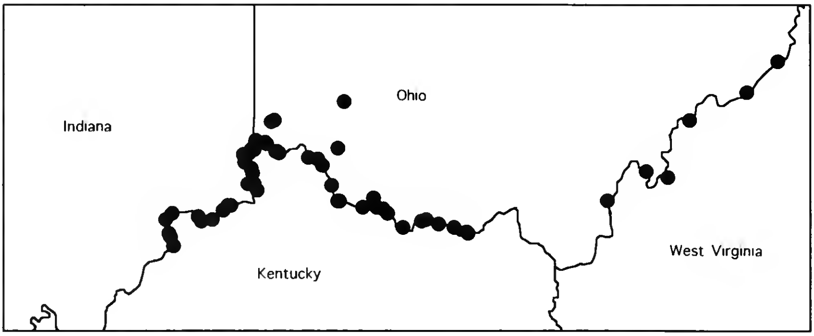

Figure 1. *C. repanda* and its Ohio River distribution.

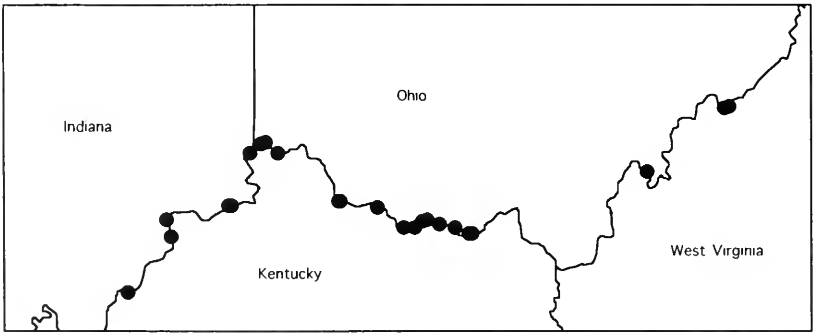

Figure 2. *C. cuprascens* and its Ohio River distribution.

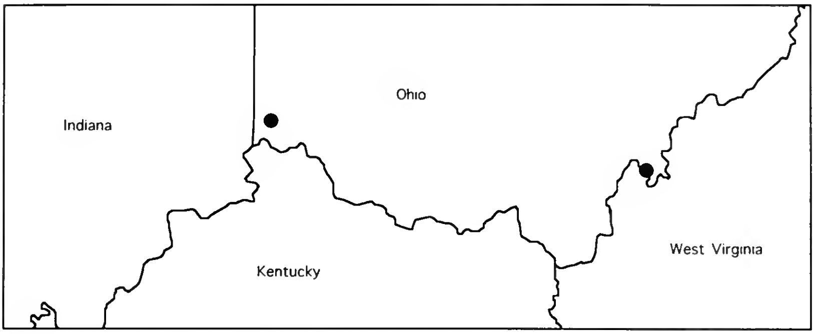

Figure 3. *C. marginipennis* and its Ohio River distribution.

DISCUSSION

This two year survey of tiger beetles along the Ohio river marked the first time the Ohio River was so thoroughly surveyed for tiger beetles. *C. repanda* was collected for the first time in Switzerland and Ohio Counties in Indiana. *C. cuprascens* was collected for the first time from Switzerland and Ohio Counties in Indiana, Meigs County in Ohio, and from Pleasants County in West Virginia. The West Virginia locality is the farthest east that *C. cuprascens* has been reported (Acciavatti et al 1992). *C. marginipennis* was found in Meigs County, Ohio, which was the first time the species has been reported from along the Ohio River. The specific collection information for the new records is presented in bold type in the appendix.

C. hirticollis had been collected in Hamilton County, Ohio in 1911 (voucher specimen in the Cincinnati Museum of Science and History) but was not found during the two years of our survey. We believe it has been extirpated from southwestern Ohio (Kritsky et al 1996).

Graves and Brzoska (1991) warned of declines in populations of *C. hirticollis, C. cuprascens*, and *C. marginipennis* and argued that these species should be better protected. To better understand the specifics of the declines, we studied the history of the Ohio River from eastern Ohio to central Indiana, trying to document changes along the river that would have impacted the abundance of riparian tiger beetles.

The shores along the Ohio River have changed a great deal during the past two centuries. The Navigator (Anon 1814), a publication of river descriptions created to help boat pilots course the Ohio River, indicated that in the early nineteenth century, the Ohio River ran dry during the summer months. Sandy beaches, sandbars, and willow islands were common along the Ohio River from eastern Ohio through east central Indiana. These locations are ideal habitats for *C. hirticollis*, *C. cuprascens*, and *C. repanda*. Areas east of Portsmouth and along what is now Meigs County were apparently more rocky, which is the preferred habitat for *C. marginipennis*.

During the latter part of the Nineteenth Century a series of locks and dams were built on the Ohio River to facilitate river transportation. This construction continued into this century. As new locks were completed, older ones were removed. The most recent locks and dams were completed during the 1990s. The impoundment of water and flood control has had a great effect along the shores of the Ohio. The effect is most severe in eastern Ohio where seven locks and dams are in use. The water impoundment submerged the sandy shores and bars that were present in 1814 and replaced them with high banks.

Today, pockets of sandy beaches occur down river of a lock and dam due to the generally lower water levels, and these beaches have dense populations of tiger beetles. The banks five to ten miles up river from a lock and dam are devoid of sandy beaches and thus have no tiger beetles. Figure 4 shows the effects of the locks and dams on tiger beetle distribution. The current locations of locks and dams are indicated by the black lines and the dots show the locations of tiger beetle inhabited beaches. Every lock and dam from eastern Indiana to eastern Ohio showed the same effects; a few suitable tiger beetle localities immediately down river from the dam and a large span of up to ten miles up river without suitable tiger beetle habitats.

The history of the locks and dams may therefore be the key to understanding the recent tiger beetle history in the Ohio River Valley in southwest Ohio. In 1916, there were seven locks and dams in western Ohio and eastern Indiana that have been since removed, and during the time of their operation, western Ohio and Eastern Indiana had higher river levels and fewer beaches for tiger beetles. One victim of this circumstance was *C. hirticollis*. While the loss of

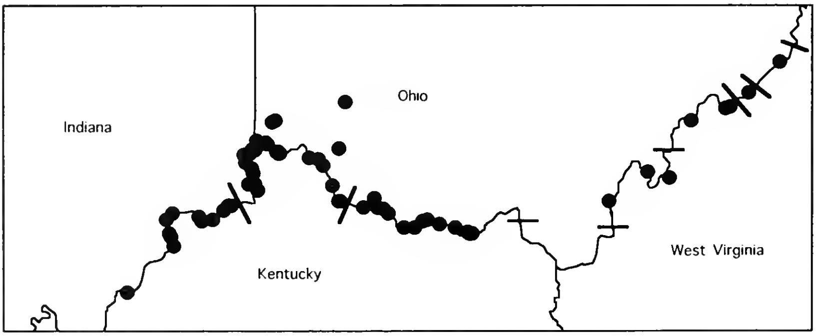

Figure 4. The Ohio River's distribution of the riparian tiger beetles with the locks and dams indicated by black lines.

beaches would have destroyed the tiger beetles' habitat in the area, *C. hirticollis* was not in a position to recover as were the other species. By comparison, *C. repanda* is common along the smaller streams and creeks. If its populations along the Ohio River were reduced or obliterated, it could have moved back to the Ohio River from the streams after the removal of the seven locks and dams later in this century. Similarly, *C. cuprascens* is common on the willow islands found on the Ohio River. While the dams would have caused the submergence of many beaches, the willow islands would have survived and served as refugia for *C. cuprascens* populations to repopulate the reformed beaches after the dams were removed.

C. hirticollis was not as fortunate. Unlike *C. repanda* and *C. cuprascens*, this species is very sensitive to habitat alterations. In areas along Lake Erie where *C. hirticollis* is still present, it is only found in areas where human activity is limited. In the late nineteenth century, the streams in southwestern Ohio were heavily polluted, which would have likely destroyed any *C. hirticollis* populations already present and blocked the dispersal of *C. hirticollis* upstream as the construction of the many locks and dams in southwestern Ohio proceeded. Therefore, when the Ohio River beaches were lost to high river water, so too was *C. hirticollis*. Subsequently, when the locks and dams were removed, there were no *C. hirticollis* populations along the streams and creeks that flow into the Ohio to repopulate the beaches of the Ohio River.

C. marginipennis presents a completely different scenario. Today, *C. marginipennis* is found on cobblestone bars and beaches along the Scioto, Great Miami, and Little Miami Rivers. The 1814 Navigator (Anonymous) indicates that it may have had suitable Ohio River habitats east of Portsmouth and in Meigs County. The presence of *C. marginipennis* in Meigs County may be a remnant of this past habitat. Other cobble beaches along the Ohio River have since been destroyed by the lock and dam systems.

CONCLUSIONS

The tiger beetle survey of the Ohio River Valley from eastern Ohio to eastern Indiana yielded 6 new county records for three species including the easternmost limit of *C. cuprascens* and the first Ohio River record of *C. marginipennis*. The decline in the riparian tiger beetles of the Ohio River is likely linked to the history of the locks and dams used to control flooding and promote river traffic. Suitable tiger beetle habitats are more common immediately down river of locks and dams where river levels are lower. This suggests that river management to protect these sandy beaches would have a positive impact to protect and even promote tiger beetles in the Ohio River Valley.

APPENDIX

Collection data for the Ohio River riparian tiger beetles. Data is divided by state and presented with county, latitude in decimal degrees, longitude in decimal degrees, species collected, and date of collection.

INDIANA: Dearborn, 39.13, 84.8, *repanda*, 7/2/96; Dearborn, 39.11, 84.83, *repanda*, 7/2/96; Dearborn, 39.1, 84.84, *repanda*, 7/2/96; Dearborn, 39.07, 84.89, *repanda*, 7/2/96; Dearborn, 39.34, 84.51, *punctulata*, 8/5/96; Floyd, 38.28, 85.75, *cuprascens*, 7/29/95; Jefferson, 38.72, 85.23, *repanda*, 7/3/96; Jefferson, 38.7, 85.46, *repanda*, *cuprascens*, 7/9/96; Jefferson, 38.62, 85.44, *repanda*, 7/9/96; Ohio, 39.03, 84.88, *repanda*, 6/27/96; **Ohio, 38.99, 84.84, *repanda*, 6/27/96; Switzerland, 38.87, 84.79, *repanda*, 6/27/96;** Switzerland, 38.78, 85.01, *repanda*, *cuprascens*, 6/28/96; **Switzerland, 38.78, 84.98, *cuprascens*, 6/28/96;** Switzerland, 38.75, 85.04, *repanda*, 7/3/96.

KENTUCKY: Boone, 39.09, 84.66, *repanda*, *cuprascens*, 6/9/95; Boone, 39.13, 84.72, *repanda*, 6/9/95; Boone, 39.13, 84.77, *cuprascens*, 6/27/95; Boone, 39.14, 84.74, *repanda*, *cuprascens*, 6/27/95; Boone, 39.09, 84.66, *repanda*, *punctulata*, 7/12/95; Boone, 38.9, 84.86, *repanda*, 6/27/96; Boone, 38.9, 84.81, *repanda*, 6/27/96; Boone, 38.96, 84.83, *repanda*, *punctulata*, 6/27/96; Boone, 39.1, 84.82, *repanda*, 7/2/96; Boone, 39.08, 84.85, *repanda*, *cuprascens*, 7/2/96; Bracken, 38.8, 84.19, *repanda*, *cuprascens*, 6/16/95; Bracken, 38.77, 84.08, *sexgutatta*, 6/30/95; Bracken, 38.77, 84.02, *repanda*, 6/30/95; Bracken, 38.77, 84.02, *repanda*, 6/30/95; Bracken, 38.8, 84.19, *cuprascens*, 7/25/95; Campbell, 39.05, 84.42, *repanda*, 6/15/95; Campbell, 39.01, 84.31, *repanda*, 6/15/95; Campbell, 38.89, 84.24, *repanda*, 6/16/95; Carroll, 38.7, 85.12, *repanda*, 7/3/96; Carroll, 38.69, 85.2, *repanda*, 7/3/96; Lewis, 38.7, 83.55, *cuprascens*, *repanda*, 7/13/95; Lewis, 38.65, 83.34, *repanda*, *cuprascens*, 7/14/95; Lewis, 38.62, 83.24, *repanda*, *cuprascens*, 7/14/95; Mason, 38.77, 83.91, *punctulata*, *repanda*, *cuprascens*, 7/7/95; Mason, 38.76, 83.87, *repanda*, 7/7/95; Mason, 38.82, 83.94, *repanda*, 7/7/95; Timble, 38.6, 85.43, *repanda*, *cuprascens*, 7/9/96; Timble, 38.55, 85.41, *repanda*, 7/9/96; Trimble, 38.73, 85.42, *repanda*, 7/9/96.

OHIO: Adams, 38.69, 83.58, *repanda*, *cuprascens*, 7/13/95; Adams, 38.65, 83.64, *cuprascens*, *punctulata*, 7/13/95; Adams, 38.63, 83.25, *repanda*, *punctulata*, 7/14/95; Adams (Brush Cr. Is.), 38.67, 83.46, *repanda*, *cuprascens*, 7/14/95; Brown, 38.73, 83.83, *repanda*, 7/7/95; Brown, 38.65, 83.72, *repanda*, *cuprascens*, *punctulata*, 7/13/95; Clermont, 39.04, 84.35, *repanda*, 6/15/95; Clermont, 38.8, 84.2, *repanda*, *cuprascens*, 7/25/95; Clermont, 39.11, 84.2, *repanda*, 8/31/96; Hamilton, 39.08, 84.64, *repanda*, *sexgutatta*, 6/9/95; Hamilton, 39.08, 84.64, *cuprascens*, 7/12/95; Hamilton, 39.09, 84.64, *repanda*, 7/18/95; Hamilton, 39.08, 84.63, *repanda*, 7/18/95; Hamilton (Great Miami), 39.27, 84.67, *repanda*, 7/20/95; Hamilton (Great Miami), 39.26, 84.69, *repanda*, 7/20/95; Hamilton (Great Miami), 39.26, 84.69, *repanda*, marginipennis, 7/20/95; Hamilton (Great Miami), 39.26, 84.69, *repanda*, 8/1/95; Hamilton (Whitewater), 39.13, 84.8, *repanda*, 6/27/95; Hamilton (Whitewater), 39.13, 84.8, *repanda*, 7/18/95; Hamilton (Whitewater), 39.13, 84.8, *repanda*, *punctulata*, 7/18/95; Hamilton (Whitewater), 39.15, 84.8, *repanda*, 7/18/95; Hamilton (Whitewater), 39.15, 84.8, *repanda*, 8/1/95; **Meigs, 38.97, 81.92, *marginipennis*, *cuprascens*, 7/26/96;** Meigs, 38.94, 81.76, *repanda*, 7/26/96; Ross, 39.3, 82.94, *punctulata*, *repanda*, 7/11/96; Scioto, 38.62, 83.22, *cuprascens*, 7/14/95; Warren (Little Miami), 39.37, 84.15, *repanda*, 7/27/95.

WEST VIRGINIA: **Jackson, 38.94, 81.76 *cuprascens*, 8/1/96;** Mason, 38.8, 82.21, *repanda*, 7/26/96; Pleasants, 39.34, 81.35, *cuprascens*, 8/1/96; Pleasants, 39.35, 81.32, *cuprascens*, 8/1/96; Tyler, 39.43, 81.18, *repanda*, 8/1/96; Wetzel, 39.6, 80.95, *repanda*, 8/2/96; Wood, 39.27, 81.6, *repanda*, 8/1/96.

ACKNOWLEDGMENTS

We thank Brian Armitage and the Ohio Biological Survey, the Division of Wildlife of the State of Ohio, the College of Mount St. Joseph, and the Indiana Academy of Science for support of this project. This project was also supported with funds donated through the *Do Something Wild!* state income tax checkoff from the Ohio Division of Wildlife. We also thank Robert Waltz, Indiana Department of Natural Resouces, and two anonymous reviewers for their valuable criticism of this paper.

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TICKS OF THE GENUS *AMBLYOMMA* (ACARI: IXODIDA: IXODIDAE) FROM WHITE-LIPPED PECCARIES, *TAYASSU PECARI*, IN NORTHEASTERN BOLIVIA, WITH COMMENTS ON HOST SPECIFICITY[1]

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Susan Rosenberg[3]

ABSTRACT: Adults of the ixodid ticks *Amblyomma cajennense, A. naponense, A. oblongoguttatum*, and *A. pecarium* are reported from Bolivian populations of the white-lipped peccary, *Tayassu pecari*. These are the first published records of *A. naponense* and *A. pecarium* from Bolivia. Infestations of the three most numerous tick species on *T. pecari* are shown to be statistically independent of host age and sex. It is suggested that in some species of *Amblyomma*, host specificity may manifest itself chiefly at the preimaginal level, diminishing or disappearing in adults.

It has often been noted that ticks of the genus *Amblyomma* parasitize all classes of terrestrial vertebrates, but that among those specific to mammals, adults are generally more common on large herbivores, while immatures infest much smaller mammals (e.g., rodents) or even birds (Hoogstraal 1973, Hoogstraal and Aeschlimann 1982, Hoogstraal 1985). Less often reported are data on the frequency or extent of multi-species assemblages of adult *Amblyomma* on large mammal hosts (Fairchild et al. 1966, Matthysse and Colbo 1987, Walker and Olwage 1987). In February of 1996, and again in February of 1997, one of us (WBK) traveled to the Lago Caiman research camp (13.35S, 60.54W), Noel Kempff Mercado National Park, in the northeastern corner of the Department of Santa Cruz, Bolivia, to assess the health of three herds of 15-40 white-lipped peccaries, *Tayassu pecari* (Link, 1795), that had been caught as groups in a 0.405 ha capture corral. *Tayassu pecari* occurs from southern Mexico to northeastern Argentina, but because the large tracts of wilderness on which it depends are rapidly being fragmented, this species has disappeared or become rare in the northern and southern portions of its range and is now listed in appendix 2 (species not necessarily threatened with extinction but that may become so unless trade is subjected to strict regulation) of the Convention on International Trade in Endangered Species of Wild Fauna and Flora

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[1] Received August 7, 1997. Accepted August 30, 1997.

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(Mayer and Wetzel 1987, Nowak 1991, Wilson and Reeder 1993). Accordingly, we decided to collect all tick specimens found on our Bolivian peccaries in order both to document the diversity of species parasitizing *T. pecari* at this locale and to determine whether particular host attributes have a bearing on parasitization. Continuing habitat loss will render such analyses impossible within the working lifetime of contemporary investigators.

METHODS

Over a period of years, one of us (RLEP) developed the Lago Caiman research camp and constructed the peccary capture areas. The lowland forest of Noel Kempff Mercado National Park is broadly classified as subhumid but comprises several forest types; one of these, which includes Lago Caiman, is tall forest with canopy heights of 30-35 m. This part of Bolivia is characterized by a marked dry season in the austral winter, a mean daily temperature of 25°C, and annual precipitation greater than 1500 mm (Killeen 1996).

On 25 February 1996, 13 captured peccaries were randomly targeted for immobilization and tick collection at Lago Caiman. On 17 and 18 February of the following year, an additional 27 peccaries were similarly selected. All peccaries were sedated using a combination of tiletamine hydrochloride and zolazepam administered by projectile syringe dart. Their pelage was then carefully searched for ticks, and virtually complete collections were secured from 35 of the 40 animals. Following recovery from anesthesia, all peccaries were released. Ticks were preserved in 70% ethanol and shipped to RGR for identification.

By means of contingency tests, it was possible to examine whether tick infestations were dependent on particular attributes of individual peccaries, such as age (adults vs. immatures) and sex. Weight was discounted as a testable attribute because of its dependence on numerous variables, including sex, health and season. In all cases, the variety of contingency test used was the log likelihood ratio or G-test, with Yates' correction for small sample sizes (Sokal and Rohlf 1973). Peccaries harboring only preimaginal ticks (larvae, nymphs), which could not be identified to species, were excluded from this analysis. Because all tests were 2 x 2, computed values of G were compared with a critical value of the chi-square distribution of 3.841 (one degree of freedom) at $P = 0.05$.

RESULTS AND DISCUSSION

Adults of four species of *Amblyomma* – *A. cajennense* (Fabricius, 1787) (9♂), *A. naponense* (Packard, 1869) (35♂, 27♀), *A. oblongoguttatum* Koch, 1844 (36♂, 40♀), and *A. pecarium* Dunn, 1933 (35♀) – were found on 31 of 35 parasitized *T. pecari* at Lago Caiman (four peccaries harbored only *Amblyomma* nymphs or larvae). All are relatively common ticks that have previously been reported from this host (Aragão and Fonseca 1961, Hoffmann 1962, Fairchild et al. 1966, Jones et al. 1972). Yet, to the best of our knowledge, these are the first published records of *A. naponense* and *A. pecarium* from Bolivia.

The Field Veterinary Program, Wildlife Conservation Society (formerly New York Zoological Society), has assigned accession numbers WLP 2 through WLP 14 and MEDARKS (Medical Archives) numbers 96-0422 through 96-0435 to the tick collections made at Lago Caiman in 1996; those made in 1997 have received accession numbers WLP 15 through WLP 40 and MEDARKS numbers 97-0546 through 97-0567. All collections are on long-term loan to RGR.

Descriptive statistics for the prevalence and intensity of parasitization by adults of each tick species appear in Table 1. Typically, ectoparasites are contagiously dispersed (overdispersed, clumped) on host populations, a condition in which the zero class is often large (Robbins and Faulkenberry 1982). In the case at hand, of 31 sampled peccaries, only 6 were infested by *A. cajennense*, 15 by *A. naponense*, 23 by *A. oblongoguttatum*, and 19 by *A. pecarium*. However, the range of parasitization was broad, as reflected in the disproportionately large standard deviations and coefficients of variation of each tick species. Also, sex ratios (males/females) differed dramatically among the four species of *Amblyomma*: all male for *A. cajennense*, 1.29 for *A. naponense*, 0.90 for *A. oblongoguttatum*, and all female for *A. pecarium*, perhaps an indication that these species were sampled at different stages of their life cycles on *T. pecari*, or that *T. pecari* is an incidental host for one or more of them. In this regard, it should be noted that while males of *A. cajennense* and *A. pecarium* differ markedly in facies, females of the two species are easily confused. Therefore, throughout this study, no female specimen was accepted as *A. pecarium* unless it met all the differential criteria of Jones et al. (1972): palpal segment II about $2^1/_2$ times as long as segment III; festoons ventrally rugose and relatively poorly defined, first 4 on either side of the median festoon each with a well-

Table 1. Descriptive statistics for adults of four species of *Amblyomma* parasitizing 31 individuals of *T. pecari* from Lago Caiman, Bolivia, 26 February 1996 and 17-18 February 1997, collector W. B. Karesh.

Tick Species	Range (Ticks/Peccary)	Mean with Standard Error	Standard Deviation	Coefficient of Variation
A. cajennense	0-2	0.3 ± 0.1	0.6	200.0
A. naponense	0-34	2.0 ± 1.1	6.1	305.0
A. oblongoguttatum	0-13	2.5 ± 0.6	3.1	124.0
A. pecarium	0-5	1.1 ± 0.3	1.4	127.3

developed tubercle at the posterointernal angle; and internal spur of coxa I broad and blunt.

G-test results for the three most numerous tick species on *T. pecari* appear in Table 2, where the observed statistical independence between tick infestation and host age or sex indicates that factors other than host attributes are responsible for the spectrum of parasitization summarized in Table 1. Because 53 of the world's approximately 104 *Amblyomma* species occur in the Neotropics, host specificity is almost certainly one such factor. But while adults of *A. pecarium* seem to be strict parasites of peccaries (Fairchild et al. 1966), adults of *A. cajennense*, *A. naponense* and *A. oblongoguttatum* are known from a variety of large- and medium-sized mammals (Jones et al. 1972). Clearly, our results lend themselves to any number of explanations, yet we suggest that the presence of four species of *Amblyomma* on but a single species of host may be a sign that host specificity either diminishes or disappears in adults of some amblyommines, manifesting itself instead chiefly at the preimaginal level. However, as has often been stated (Fairchild et al. 1966, Jones et al. 1972, Keirans 1992, Robbins et al. 1997), immature *Amblyomma*, especially in the Neotropics, remain mostly unidentifiable. Until rearing or molecular genetic studies enable us to associate the immatures found on one set of hosts with the adults found on another, definitive explanations for ostensible instances of host specificity will remain beyond our grasp.

Table 2. Tests of association between tick infestation and attributes of *Tayassu pecari*.

Attribute	Tick Species	Results
Age	*A. naponense*	Independent; $G = 0.370$; $P >> 0.05$
	A. oblongoguttatum	Independent; $G = 0.308$; $P >> 0.05$
	A. pecarium	Independent; $G = 1.066$; $P > 0.05$
Sex	*A. naponense*	Independent; $G = 0.016$; $P >> 0.05$
	A. oblongoguttatum	Independent; $G = 0.086$; $P >> 0.05$
	A. pecarium	Independent; $G = 0.348$; $P >> 0.05$

ACKNOWLEDGMENTS

We thank the Bolivian National Secretariat for Protected Areas for permission to work in Noel Kempff Mercado National Park, and the National Directorate for the Protection of Biodiversity for help in acquiring the necessary permits. We are extremely grateful to Robert Wallace, Marcela M. Uhart, Nicolas Tagua, Jose Chuviña and Walter "Piraña" Perez, whose dedication and initiative were exemplary throughout this study. Thanks also to Damian Rumiz and the staff of the Bolivian Sustainable Forestry Project (BOLFOR) and to F.A.N. (Fundación Amigos de la Naturaleza, Santa Cruz, Bolivia) for the logistical support they provided. For their insightful comments on an earlier version of this work, we thank Thomas J. Daniels and Richard

C. Falco of Fordham University's Louis Calder Center in Armonk, New York. And thanks to Lance A. Durden and James E. Keirans, Institute of Arthropodology and Parasitology, Georgia Southern University, Statesboro, for generously providing several important taxonomic references and for critical assistance in distinguishing *A. cajennense* from *A. pecarium*. This study was funded primarily through a grant from the Environmental Program of the Dutch Embassy in Bolivia, by BOLFOR (which is financed by the U.S. Agency for International Development and the Bolivian government), and by the Wildlife Conservation Society. 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 RECORDS OF JAPYGOIDEA (HEXAPODA: DIPLURA) FROM LOUISIANA, WITH NOTES ON BEHAVIOR[1]

Mark A. Muegge[2] Christopher E. Carlton[3]

ABSTRACT: Previous published records of the hexapod order Diplura from Louisiana have documented one species. We provide collection data for seven species of Japygoidea: five within Japygidae and two within Parajapygidae. Two genera and four species of Louisiana Japygidae are undescribed. Members of Japygidae are saprophagous and predatory in feeding behavior. Cerci were not used during any observations of prey capture, but were employed defensively as pincers.

Japygoids are a primitive group of blind, flightless hexapods belonging to the class Diplura. The bionomics of this obscure group of hexapods remain poorly known. Japygoids have been recorded primarily from mesic habitats beneath rocks, rotting logs, leaf litter, humus, and soil. Some species occur in xeric habitats and three species are obligate cavernicoles (Muegge, 1992; Pagés, 1972, 1977).

Japygids are prone to extreme endemism (Allen, 1988; Muegge, 1992; Muegge and Bernard, 1989; Smith, 1960). Their relatively small size, wingless and eyeless anatomy, and the occurrence of most species in edaphic habitats contribute to this tendency toward endemism. Thus, while Diplura and similar cryptic organisms could be useful in providing insight into biogeographic patterns, particularly in identifying areas of endemism, an almost total lack of information about their distributions and regional diversity is a barrier to accomplishing this goal. The information presented here is part of a continuing effort to document the distributional patterns and systematic status of Japygoidea in North America and provide information about their biology.

Voucher specimens of taxa reported here are deposited in the Louisiana State Arthropod Museum and the first author's collection.

BEHAVIORAL NOTES

Observations of behavior and examination of gut contents by one of us (MAM) indicate that japygoids are generally saprophagous and predatory, pursuing and consuming live prey opportunistically. Examinations of the gut

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contents of numerous specimens of several species revealed an abundance of arthropod body parts, primarily from springtails and mites, and a significant amount of undigested, unrecognizable organic matter.

The japygid *Metajapyx remingtoni* Smith and Bolton was observed during prey stalking and capture. The long musculated antennae were used to search for prey. Once a potential prey item was detected, the animal slowly crept to within striking distance, then lunged forward to capture, subdue, and consume the prey. Individuals of *M. remingtoni* were observed capturing and consuming entomobryid springtails. The feeding habits of *Japyx* sp. were studied by Pagés (1951), who reported predation on an isopod, *Platyarthrus hoffmanseggti* Brandt and the following gut contents: isopods, mites (mainly oribatids and gamasids), Symphyla, japygids, Diptera larvae, adult beetles, vegetable debris, and mycelia. Schaller (1968) described the use of forceps during prey capture and depicted it in a pair of drawings, but provided no observational data or references to support the description. Kuhnelt (1976) published a similar drawing depicting the capture of a campodid dipluran using the forceps. Finally, Conde and Pagés (1991) reported that individuals of *Heterojapyx* sp. were observed buried in soil with cerci exposed, waiting to capture small arthropods that came within reach using the cerci. However, they did not state whether they observed the cerci being used in this manner.

Thus, there are numerous reports in the literature suggesting that japygoids use their cercal forceps during prey capture, but these reports are not supported by detailed observational data. We have observed forceps being used in defensive behavior on several occasions, but never during prey capture. The tenth abdominal segment and forceps are heavily sclerotized, musculated, and quite powerful considering the size of the animal. Japygids under duress were observed grasping and completely severing the bodies of other similar sized arthropods using the forceps. These animals were never consumed during our observations.

NEW RECORDS FROM LOUISIANA

(Fig. 1)

Family JAPYGIDAE

Mixojapyx tridenticulatus (Fox). Specimens examined, 21. Avoyelles Parish, near Hamburg, 2 July 1979, H. Lambert, habitat: in soil, 1 female. East Feliciana Parish, Idlewild Research Station, 15 January 1989, M. A. Muegge, habitat: in moist soil at base of *Quercus* sp., mixed oak/pine forest, 1 male, 1 female. Same data, 3 June 1989, base of *Pinus* sp. 1 male. Same data, 23 January 1990, 1 male. Same data, 1 March 1990, 1 female. Same data, 13 February 1991, 2 males, 4 females. Grant Parish, Kisatchie National Forest, 29 March 1992, M. A. Muegge, habitat: moist soil, mixed beech/magnolia forest, 1 male, 3 females. Natchitoches Parish, Kisatchie National Forest, Red Dirt National Wildlife Management Area, 1 April 1989, M. A. Muegge, habitat: in soil beneath rock, primarily long-leaf pine forest. Same data, 10 June 1991, M. A. Muegge, 1 female. St. Landry Parish, Thistlewaite Wildlife Management Area, 14 January 1989, M. A. Muegge, habitat: in moist sandy soil, pine/oak forest, 1 male, 1 female. Same data, 27

January 1990, 1 female. Washington Parish, near Southeast Research Station, 25 January 1990, M. A. Muegge, habitat: about 25 cm deep in moist soil near *Pinus* sp. along roadside, 1 female.

Range. Gulf Coast States.

Comments. *Mixojapyx tridenticulatus* is the only species of this primarily Mexican genus found in Louisiana. It has the widest distribution of any *Mixojapyx* species north of Mexico, occurring in the gulf coastal region from east Texas to Florida. The specimens examined from east of the Mississippi River display slight, but consistent chaetotaxic differences from those west of the Mississippi River. Upon further investigation, these two populations may be found to represent distinct species.

***Metajapyx* undescribed species 1.** Specimens examined. 26. East Feliciana Parish, Idlewild Research Station, 1 March 1990, M. A. Muegge, habitat: moist soil, mixed oak/pine forest, 2 males, 5 females. Same data, 27 February 1990, 3 males, 3 females. Same data, 1-3 March 1991, 4 males, 7 females. Same data, 13 February 1991, except habitat. under rotting log near stream bank, 1 male, 1 female.

Range. Known only from the above locality.

Comments. *Metajapyx* is a widespread genus reported almost exclusively from locations east of the Mississippi River (Reddell, 1983). Rathman et al. (1988) reported an undescribed *Metajapyx* species from eastern Washington State, but some characters needed to confirm the identification were not described. Thus, further study will be required to determine its correct generic placement. Fox (1941) and Smith (1960) reported *M. subterraneus* from Oregon and Stoddard counties, Missouri, respectively, and these are the only reliable records of the genus west of the Mississippi River. In Louisiana, specimens of *Metajapyx* have only been found east of the Mississippi River.

***Metajapyx* undescribed species 2.** Specimens examined, 17. East Feliciana Parish, Idlewild Research Station, 3 June 1989, M. A. Muegge, habitat: in moist soil and litter at base of *Pinus* sp, mixed oak/pine forest, 1 male, 16 females.

Range. Known only from the above locality.

Comments. This and the preceding species are being described in a revision of *Metajapyx* currently underway.

Undescribed genus and species 1. Specimens examined, 1. Caddo Parish. Shreveport, 4634 Dixie Blvd., 12 December 1993, J. T. McBride and V. L. Moseley, habitat: under rotting wood in urban backyard, 1 male.

Range. Known only from the above locality.

Comments. The discovery of this undescribed genus in an urban habitat was unexpected. Chaetotaxy, structure of the subcoxal organs, and structure of the cerci suggest that this individual represents a distinct and undescribed genus.

Undescribed genus and species 2. Specimens examined, 1. Webster Parish, Kisatchie National Forest, 22 March 1990, M. A. Muegge, habitat: soil at base of *Pinus* sp., moist mixed oak/pine forest, 1 male.

Range. Ouachita Highlands of eastern Oklahoma and Arkansas, south to northwestern Louisiana.

Comments. Many specimens representing several species in this undescribed genus have been collected by the authors and others from Arkansas and Oklahoma. The individual collected in northern Louisiana may represent the southernmost limit of the genus' range. Further study is underway to determine the number of species in the genus.

Family PARAJAPYGIDAE

Parajapyx (Parajapyx) isabellae (Grassi). Specimens examined, 62, not sorted by sex. Acadia Parish, 15 October 1964, W. Sonnier, habitat: soil from sweet potato field. Acadia Parish, LSU Rice Research Station near Crowley, 12 June 1994, M. A. Muegge, habitat: soil sample from rice field. Avoyelles Parish, near Hamburg, 2 July 1979, H. Lambert, habitat: soil, 1 specimen. Bienville Parish, near Lake Bistineau, 1 August 1990, M. A. Muegge, habitat: soil, mixed oak/pine forest, 2 specimens. East Baton Rouge Parish, 11 March 1982, P. J. Barbour, habitat: soil/leaf litter berlesate. East Feliciana Parish, Idlewild Research Station near Clinton, 28 May 1989, M. A. Muegge, habitat: sandy soil near stream, mixed beech/magnolia forest, 6 specimens. Same data, 30 July 1989, 11 specimens. Same data, 9 February 1991, 12 specimens from sandy soil near stream, 9 specimens from soil near decaying log. Same data, 30 June 1991, soil near *Pinus* sp. St. Landry Parish, 15 July 1979, C. E. Eastman, habitat: soil. Same, except near Port Barre, 22 June 1982, 2 specimens. Webster Parish, Kisatchie National Forest, 22 March 1990, M. A. Muegge, habitat: in soil near *Pinus* sp., mixed forest, 2 specimens.

Range. Cosmopolitan.

Comments. The only previously published references to Japygoids from Louisiana were made by Ingram (1931), Ingram et al. (1950), and Fox (1957). These specimens were reported only as *Japyx* sp. Ingram (1931) and Ingram et al. (1950) reported that specimens of *Japyx* sp. were commonly found in sugarcane fields, and suggested that they could be potential pests, causing damage by feeding on the root systems of the plant. Although we have not examined any specimens collected by Ingram, we agree with Reddell (1983) that these records represent *P. isabellae*. This species is widespread and common, and is the only japygoid that is commonly collected in agricultural monocultures.

Parajapyx (Grassjapyx) grassianus "maiusculella" Silvestri. Specimens examined, 12. East Feliciana Parish, Idlewild Research Station near Clinton, 9 February 1989, M. A. Muegge, habitat: sandy soil near stream, mixed beech/magnolia forest, 2 specimens. Same data, 30 July 1989, 1 specimen. Same data, 30 July 1991, soil at base of *Pinus* sp., 2 specimens. Same data 9 February 1991, 7 specimens.

Range. Coastal Louisiana to Florida.

Comments. The taxonomic status of the *P. grassianus* is uncertain. The type locality for *P. grassianus* is Córdoba, Veracruz, Mexico (Silvestri, 1911) and it has been recorded only from locations in Mexico. Silvestri (1948) subsequently described one form, "forma vel mutans", and two variations of that form, "maiusculella" and "robustior", from Florida These descriptions were based primarily on cercal dentation. Based on cercal dentation, the specimens

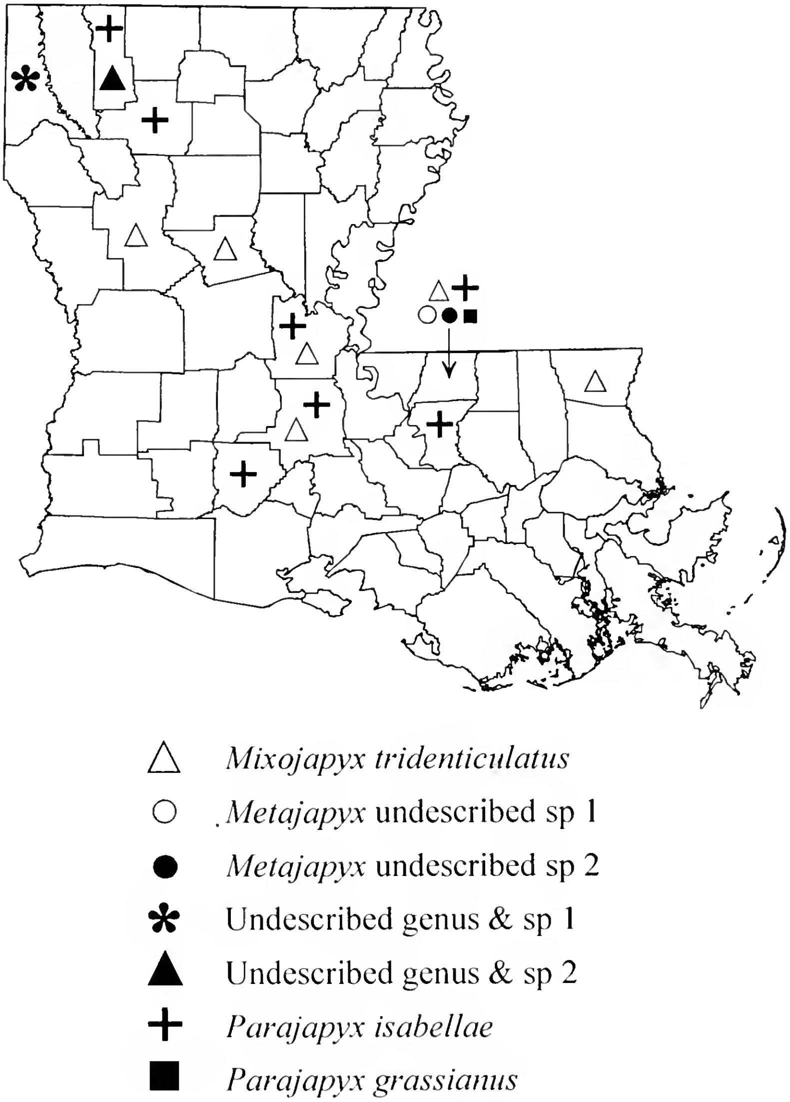

Figure 1. Collecting localities of Japygoidea recorded from Louisiana.

from Louisiana represent the variant "maiusculella". Further study is necessary to determine if the Florida and Louisiana specimens represent undescribed species, or geographical variants of *P. grassianus.*

ACKNOWLEDGMENTS

Publication of this manuscript was supported in part by a grant to the second author from the Louisiana Education Quality Support Fund. We thank an anonymous reviewer for calling our attention to several pertinent references.

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NEW RECORDS OF *ALLOCAPNIA* (PLECOPTERA: CAPNIIDAE) FROM MISSISSIPPI AND LOUISIANA, WITH ACCOMPANYING SCANNING ELECTRON MICROGRAPHS[1]

Mac H. Alford[2]

ABSTRACT: Seventy-one sites were surveyed for *Allocapnia* (Plecoptera: Capniidae) in southwestern Mississippi and three of the Florida parishes of Louisiana. These surveys extended over six major river drainages. New records of *A. virginiana*, *A. recta*, and *A. aurora* are reported, and scanning electron micrographs of the male genitalia are provided for each species.

Small winter stoneflies (Capniidae) constitute the largest family of Plecoptera in North America (Borror, Triplehorn, and Johnson 1989). They have captivated curious minds at least since the mid-nineteenth century (Frison 1929) because they are generally less than 10 mm in length and, unlike most other insects, emerge as adults during the winter or early spring (Ross and Ricker 1971). Most capniids in eastern North America belong to the genus *Allocapnia* Claassen (Borror, Triplehorn, and Johnson 1989). *Allocapnia* is typical of the Capniidae and is distinguished from the other genera of the family by the presence of a straight R_1 of the fore wing just beyond the origin of R_S (Stewart and Harper 1996) and by the presence of a dorsal process on the eighth tergite and a double epiproct in males (Ross and Ricker 1971). Differentiation of species is chiefly based on characteristics of the male genitalia.

METHODS

Adult *Allocapnia* were collected from December 1996 to February 1997 by hand from bridges and by rod and beating sheet from streamside plants. Nymphs were collected by browsing through leaf litter in streams. Specimens were killed and stored in 80% ethanol and were examined and identified using a dissecting microscope. The genitalia of representative male samples were then viewed using an AMRAY 1810D scanning electron microscope and photographed. Specimens were deposited in the entomological collection of B. P. Stark at Mississippi College.

Forty-eight sites were surveyed in the southwestern Mississippi counties of Amite, Franklin, Lincoln, Pike, Walthall, and Wilkinson. Twenty-three sites were surveyed in three of the Florida parishes of Louisiana, namely, East Feliciana, St. Helena, and West Feliciana. The Florida parishes of Louisiana

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are those that occur in the southeastern part of the state east of the Mississippi River. The surveys included collection sites from the Amite River, Bogue Chitto River, Buffalo River, and Homochitto River drainages in Mississippi and the Bayou Sara and Thompson Creek drainages in Louisiana. Also, one small stream in Mississippi and two small streams in Louisiana which flow directly into the Mississippi River were surveyed (Fig. 1).

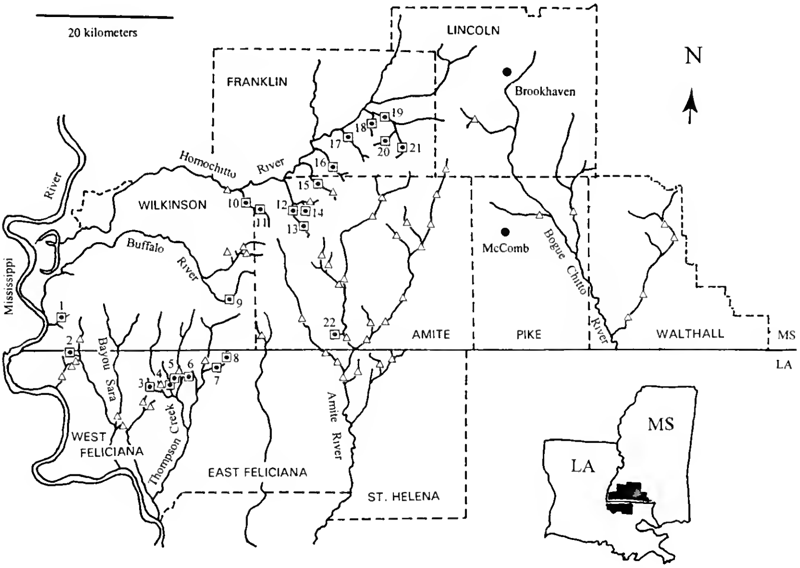


Fig. 1. Map of the study area: southwest Mississippi and three of the Florida parishes of Louisiana. Sites with *Allocapnia* records in the winter of 1996-1997 are indicated by a ⊡ and negative records are indicated by a Δ. Numbered collection sites are further described in the text.

RESULTS AND DISCUSSION

Fig. 1 is a summary map of the sample localities. Sites with *Allocapnia* are numbered as follows:

1. Wilkinson Co., MS, Clark Cr., Clark Cr. Natural Area, *A. recta.*
2. West Feliciana P., LA, Kimball Cr. at Pinckneyville Rd., unresolved ♀ (likely *A. recta).*
3. West Feliciana P., LA, Dry Cr. at LA 421, *A. recta.*
4. West Feliciana P., LA, Mill Cr. at LA 421, *A. recta.*
5. West Feliciana P., LA, Thom Cr. at LA 421, *A. recta.*
6. West Feliciana P., LA, un-named tributary to Middle Fork Thompson Cr. at LA 421,unresolved ♀ (likely *A. recta).*

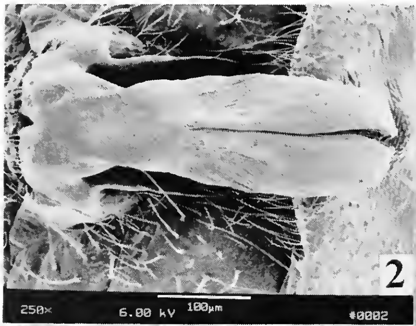
7. East Feliciana P., LA, Hurricane Cr. at Thompson Cr. Rd., *A. recta, A. virginiana.*
8. East Feliciana P., LA, Shady Grove Branch at Thompson Cr. Rd., *A. recta, A. virginiana.*
9. Wilkinson Co., MS, Buffalo R. at Hiram McGraw Rd., *A. recta, A. virginiana.*
10. Amite and Wilkinson Co., MS, Foster Cr. at MS 33, nymph.
11. Amite Co., MS, Foster Cr. at MS 33, *A. aurora, A. virginiana.*
12. Amite Co., MS, Brushy Cr. at Cobb Rd., *A. virginiana.*
13. Amite Co., MS, Brushy Cr. at New Hope Rd., *A. virginiana.*
14. Amite Co., MS, un-named tributary to Birdman Branch at Fox Rd., *A. recta.*
15. Amite Co., MS, Caston Cr. at Oxford-Meadville Rd., *A. virginiana.*
16. Franklin Co., MS, Middleton Cr. at USFS 100, *A. virginiana.*
17. Franklin Co., MS, Porter Cr. at USFS 108, *A. recta, A. virginiana.*
18. Franklin Co., MS, Dry Cr. at USFS 145, *A. aurora, A. recta, A. virginiana.*
19. Franklin Co., MS, McGehee Cr. at low-water bridge, *A. virginiana.*
20. Franklin Co., MS, Cane Mill Branch near Little Springs, *A. aurora, A. virginiana.*
21. Franklin Co., MS, Goober Cr. at Little Springs, *A. virginiana.*
22. Amite Co., MS, un-named tributary to West Fork Amite River, *A. recta.*

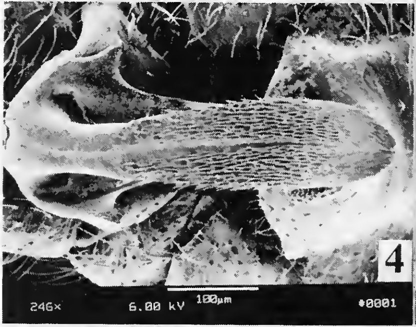
Of the seventy-one surveyed sites, twenty-two (31%) yielded at least one specimen of *Allocapnia.* The majority of these sites (82%) occur in the Homochitto River drainage of Mississippi and the Thompson Creek drainage of Louisiana. No specimens of *Allocapnia* were collected from the Bogue Chitto River drainage. Specimens were collected from one site in the Amite River drainage, one site in the Buffalo River drainage, one site in the Bayou Sara drainage, and one site from a stream which flows directly into the Mississippi River.

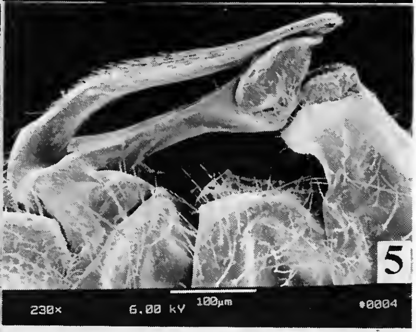
Overall, 188 adults (151♂, 37♀) and 14 nymphs were collected. Of the identifiable specimens (some dehydrated individuals were collected from spider webs and some females could not be resolved), 84 (56%) belonged to *Allocapnia virginiana* Frison, 62 (41%) to *A. recta* (Claassen) Frison, and 4 (3%) to *A. aurora* Ricker. Scanning electron micrographs are provided in Figs. 2-7. *A. virginiana* (Figs. 2-3) is characterized by a large apical segment of the upper limb of the epiproct and by a wide but short dorsal process with a small anterior process. *A. recta* (Figs. 4-5) is characterized by a long, thin apical segment and a dorsal process with a semicircular apical ridge. *A. aurora* (Figs. 6-7) is characterized by a slender apical segment and a dorsal process with widely separated lobes.

Although the data imply a paucity of *Allocapnia* outside of the Homochitto River and Thompson Creek drainages, this is somewhat misleading. Two of the three streams which flow directly into the Mississippi River probably did not produce *Allocapnia* individuals because occasional inundation from the Mississippi River hinders nymphal establishment. The Bayou Sara drainage experiences similar effects from the Mississippi River. Clark Creek, on the other hand, has several high waterfalls in the loess bluffs region and is protected from periodic flooding and backwater.

The Buffalo River probably has more *Allocapnia* than reported. Of the four sites investigated, three fall within company timberland, where the streams have litter composed primarily of pine straw. The Amite River and Bogue Chitto







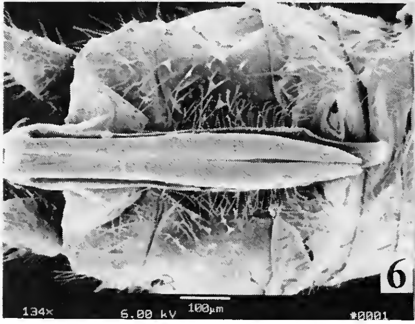


Fig. 2. *Allocapnia virginiana* epiproct, dorsal aspect.

Fig. 3. *Allocapnia virginiana* epiproct, lateral aspect.

Fig. 4. *Allocapnia recta* epiproct, dorsal aspect.

Fig. 5. *Allocapnia recta* epiproct, lateral aspect.

Fig. 6. *Allocapnia aurora* epiproct, dorsal aspect.

Fig. 7. *Allocapnia aurora* epiproct, lateral aspect.

River, however, are somewhat different. Whereas the previous drainages consist primarily of fast-flowing, shallow, sandy streams, the Amite River and Bogue Chitto River drainages consist of deep, slow-flowing, mixed gravel-silt streams. The single record from the Amite River drainage indicates that *Allocapnia* are present and suggests that they are probably limited to localized populations where stream habitat is suitable. Further searches in the Bogue Chitto River drainage are necessary to determine the presence or absence of *Allocapnia* there.

These data indicate a wide distribution of both *A. recta* and *A. virginiana*. *A. recta* appears to predominate in Louisiana while *A. virginiana* appears to predominate in the hilly Homochitto drainage of Mississippi. This apparent discrepancy, however, may be due to collection and emergence timing. B. P. Stark (pers. comm.) has previously collected both species in central Mississippi and *A. virginiana* in the Homochitto drainage. Ross and Ricker (1971) report neither species in Louisiana or southwest Mississippi, but this may be due to little or no sampling in the area. They do, however, report collections of *A. virginiana* from eastern Mississippi and note the abundance of *A. recta* in the Coastal Plain (Ross and Ricker 1971).

Allocapnia aurora was only found in the Homochitto drainage in a few disjunct locations. Stark (pers. comm.) has not collected *A. aurora* southwest of Tishomingo Co., MS, despite intensive collecting in central Mississippi, and Ross and Ricker (1971) report it no farther west than southwestern Alabama. This interesting anomaly of distribution could be the result of dispersal via the Pliocene Tennessee River entering the retreating Mississippi Embayment near southwest Mississippi during a glacial advance. Stern (1976) provides evidence for such an event based on unionid mussel distributions and sums up the geologic evidence. Why no *A. aurora* occur between southwest Mississippi and the southern Appalachians or southwestern Alabama, nevertheless, remains unclear. Regardless, because distributional information is often integrated with phylogeny to construct hypothetical dispersal paths and to speculate about selection pressures, these new records are valuable to an accurate evolutionary understanding of *Allocapnia*.

ACKNOWLEDGMENTS

Mississippi College is thanked for use of the scanning electron microscope facilities, and Dr. Bill Stark at Mississippi College is thanked for verifying species identifications and for helpful comments. Earl Alford of the Mississippi Forestry Commission is thanked for helping to select appropriate collection sites.

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BOOK REVIEW

(continued from page 164)

given genera and species is not so transparent (the indices ameliorate the problem to a considerable extent, however). It should be noted that the classification of Odonata at the level of subfamilies and tribes is currently not very well-founded and is in a state of flux, although this is certainly no fault of either author.

In general, the Steinmann volumes use a much more traditional format, so entomologists accustomed to using catalogs for other groups may feel more at home with them, but I have found that, with a little initial effort, Bridges' catalog is extremely easy to use and provides a number of advantages over the common approach. On the other hand, Steinmann certainly is physically easier to use, as it is printed as two compact volumes, while Bridges is a rather unwieldy tome. Steinmann also provides a slightly more extensive synonymy, and the full references appear with the species to which they pertain, whereas Bridges' citations are numerically coded and the full references appear only in the bibliography. The latter is by far the more extensive and up-to-date, however, with over 6500 entries, and it is accompanied by indices that allow cross-referencing by author and journal. This in itself is an outstandingly useful reference. Bridges provides no indication of range nor does he include diagnoses of any taxa, but the last edition does contain an appendix with figures of wings of most genera.

The major failing of Steinmann's *World Catalog*, especially compared to Bridges', however, is that it simply is not current. It has used Davies and Tobin (1984, 1985) as its starting point, but, although it has added substantially to their work, it has not moved beyond that as it could and should have. Despite considerable, and accelerating, work on the taxonomy of the Odonata over the last decade, almost no species described after 1990 are included here. Also missed were, e.g., Lohmann's (1992) revision of the Cordulegastridae, and the major reanalysis by Carle and Louton (1994) separating a new family, the Austropetaliidae, from the now monotypic Neopetaliidae, with a radically new understanding of the position of the latter. Thus, despite the 1997 publication date, this catalog lags considerably behind Bridges' 1994 edition. Coupled with its astronomical price (over $850 at current exchange rates), this makes it hard to recommend as a practical tool for the study of Odonata, despite its several useful features.

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(concluded on page 194)

FIRST UNITED STATES RECORD OF *DYSCHIRIUS SEXTONI* (COLEOPTERA: CARABIDAE)[1]

Foster Forbes Purrington,[2] Judith A. Maxwell[3]

ABSTRACT: We report the first United States capture of the ground beetle, *Dyschirius sextoni*, at Fort McCoy Military Reservation, Monroe County, Wisconsin (16 July 1996). In addition we newly record from Wisconsin the ground beetles, *Harpalus indianus, H. indigens, Selenophorus planipennis, Cymindis planipennis* and *Helluomorphoides praeustus bicolor.*

Fort McCoy Military Reservation in northern Monroe County, Wisconsin is characterized by glacial outwash plains, with extensive unconsolidated stratified surface gravel and sand. Annual total mean precipitation (1937 to 1959) in Monroe County is 71 cm (Barndt and Langton 1984). This area is located within a circumscribed upper Midwestern drift-less region that remained ice-free during the Wisconsinan glaciation (Curtis 1959).

Vegetational development at Fort McCoy is dominated by scrubby oak barrens, a *Quercus velutina* Lam. and *Q. ellipsoidalis* E.J. Hill co-climax, with associated forbs and grasses such as *Lupinus perennis* L., *Andropogon gerardi* Vitman, *Rudbeckia hirta* L. and *Baptisia leucophaea* Nutt. Scars from military tank traffic persist in many sand and gravel areas, and sand borrow pits present colonization opportunities for several open ground specialist carabid species like tiger beetles. The carabid fauna of tallgrass prairie in the physiographically anomalous drift-less zone was studied by Purrington and Larsen (1996) in northeastern Iowa.

MATERIALS AND METHODS

Water-filled yellow pan traps and automatic blacklight traps (BioQuip, Inc.) were used from May through August in 1995 and 1996 to assay the insect fauna of the unglaciated oak barrens habitat of Fort McCoy. Ground beetles were taken as a consequence of this broad-based synoptic survey.

Voucher specimens of all ground beetle species obtained are held in the University of Wisconsin Department of Entomology Research Collection in Madison.

RESULTS

Sixty-seven species of ground beetles in 15 tribes were obtained in Mon-

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ENT. NEWS 109(3) 189-190, May & June, 1998

roe County at Fort McCoy State Natural Area in 1995 and 1996. Six species (Table 1) are unlisted for Wisconsin and one of these, *Dyschirius sextoni* Bousquet, heretofore unrecorded for the United States (Bousquet and Larochelle 1993), is a rare clivinine described only recently (Bousquet 1987) that until now has been known only from the type locality in Belleville, Ontario, about 1000 km east of Fort McCoy. The four specimens we found were taken on 16 July 1996 by pan trap at a sand quarry in oak savanna.

The five other ground beetles we report as new for Wisconsin (Table 1) are known from various adjoining states and Canada. They are species whose known habitat preferences are reflected in the sandy scrub biotope where they were taken, characterizing much of the Fort McCoy area.

Table 1. Ground beetles new to Wisconsin, collected in Monroe County on the Fort McCoy Military Reservation (1995 and 1996). *Dyschirius sextoni* is also new to the United States.

Clivinini	Trap Date
Dyschirius sextoni Bousquet	16 Jul 1996
Harpalini	
Harpalus indianus Csiki	24 Aug 1996
Harpalus indigens Casey	20 Jul 1995
Selenophorus planipennis LeConte	19 Jun 1996
Lebiini	
Cymindis planipennis LeConte	25 Aug 1996
Helluonini	
Helluomorphoides praeustus bicolor (Harris)	13 Jun 1996

ACKNOWLEDGMENTS

We thank Robert L. Davidson, Carnegie Museum of Natural History, Pittsburgh for his generous help with ground beetle determinations. The effort of Tim Wilder (Endangered Species Section, Environment and Natural Resources Management Division, Fort McCoy Military Reservation) in monitoring traps and curating insects is greatly appreciated.

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TWO NEW SPECIES OF *HYNESIONELLA* (HETEROPTERA: GERRIDAE) FROM SOUTH AFRICA[1]

John T. Polhemus[2]

ABSTRACT: Two new species of *Hynesionella*, *H. karatara*, and *H. slateri*, are described from South Africa.

The following new species of Trepobatinae are described to make the names available for completion of a world overview and checklist of the subfamily, and a key to the known species of *Hynesionella* Poisson is provided. A redescription of the genus *Hynesionella* was given by Polhemus & Polhemus (1994), thus is not repeated here. In that work, the two species described below were listed as "two undescribed species from South Africa."

All measurements are in millimeters.

Hynesionella differs from the other two genera of Naboandelini, *Naboandelus* Distant and *Calyptobates* J. Polhemus & D. Polhemus, in having the posterior margin of the mesonotum definitely carinate medially as well as laterally, the metanotum strongly declivant, the mesonotum excavated behind posterolateral margins in both sexes, the posterolateral mesonotal plates large, almost vertical. *Hynesionella* also differs in having the male fore femur thickened, often distinctly bent, sculptured basally or medially, often with large ventral protuberances, whereas in *Naboandelus* the male fore femur slightly thickened with at most a slight basal protuberance set with very short setae, and in *Calyptobates* the fore femur is slender, very slightly thickened basally and unmodified. In most species sexual size dimorphism is pronounced, the males much smaller. The metasternal scent gland orifice (omphalium) is vestigial or absent, whereas it is present in the other two genera of Naboandelini, although very poorly developed.

Hynesionella karatara NEW SPECIES

Figures 1 - 3

Length, apterous male 2.63 (mean, N = 7; min. 2.55, max. 2.77), maximum width 1.30 (mean, N = 7; min. 1.28, max. 1.39). Length, apterous female 3.14 (mean, N = 3; min. 3.05, max. 3.27), maximum width 1.83 (mean, N = 3; min. 1.72, max. 1.89).

General color black, sides covered with grayish pruinosity, appearing yellowish in certain light. Small elongate spot medially on pronotum brownish yellow. U-shaped marking on base of head extending forward along inner eye margins, brown. Median quadrate region of mesonotum glabrous; entire body set with short pubescence.

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[1] Received July 28, 1997. Accepted September 5, 1997.

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Structural characters. Apterous male. Head set with moderate length black setae, length 0.44, width 0.89; eye width (0.22), about half the width of the interocular space (0.43). Pronotum short, lateral margins rounded, length 0.33, width 0.86; mesonotum long, broad, sides almost straight, posterior margin almost straight, length 0.78, width 1.33 (Fig. 1); pronotum, mesonotum set with numerous black stout moderate length setae dorsally and laterally; metanotum fused with first two abdominal tergites, all three moderately long, weakly indicated laterally, combined length 0.50; abdominal tergites III-VI subequal in length (0.08-0.10), VII longer (0.17). Length of antennal segments I-IV: 0.89; 0.55; 0.33; 0.33; segment I long, weakly fusiform (Fig. 3).

Fore femur curved basally, notched, set with a thick brush of very short setae over most of length, forming a pad on distal half (Fig. 2); fore tibia slightly curved, broader on distal half. Measurements of legs as follows: femur, tibia, tarsal 1, tarsal 2 of fore leg, 1.17, 0.78, 0.06, 0.33; of middle leg, 2.36, 3.50, 1.11, 0.78; of hind leg (tarsal 1 and 2 fused), 2.66, 1.03, 0.44.

Lateral arms of proctiger not prominent, blunt distally, captured between broad lateral margins of tergite VIII and sternite VIII.

Apterous female. Structure, dorsal setae, and coloration mostly as in male, except larger and more robust, with unmodified fore legs; antennal segment I distinctly more slender than in male. Length of antennal segments I-IV: 0.72; 0.55; 0.39; 0.42. Middle femur broad on basal 2/3, flattened.

Type material. Holotype, apterous male, South Africa, Cape Prov., Karatara Pass, CL 968, 22 Feb. 1979, J. T. Polhemus (USNM). Paratypes (all apterous), 2 males, 2 females, same data as holotype (JTPC); 4 males, 2 females, South Africa, Cape Prov., 15 mi. (24 km) NW of Knysna, Phantom Pass Rd., 10 Feb. 1968, R. T. Schuh, J. & S. Slater, M. Sweet (JTPC, AMNH).

Etymology. The name *karatara*, a noun in apposition, refers to the type locality, Karatara Pass.

Comparative notes. The lack of any gray pruinose markings on the mesonotal dorsum separates *karatara* from the four other known species of *Hynesionella*. The sculpturing of the fore femur of *karatara* (Fig. 2) also is diagnostic. *Hynesionella karatara* sp. n. is closest to *H. capensis* (Poisson), as both of these species have the median part of the mesonotum shining black; in *capensis*, however, the median black area is narrow, flanked by gray pruinose, whereas in *karatara* it is broad, without gray pruinose. In addition, *capensis* is unique in having the posterior margin of the female mesonotum curved and extended posteriorly, instead of straight as in all other species of the genus.

Hynesionella slateri, NEW SPECIES

Figures 4 - 5

Length, apterous male 2.42 (mean, N = 3; min. 2.39, max. 2.44), maximum width 1.28 (mean, N = 3; min. 1.28, max. 1.28). Length, apterous female 2.89 (mean, N = 2; min. 2.89, max. 2.89), maximum width 1.58 (mean, N = 2; min. 1.55, max. 1.61).

General color gray, sides covered with grayish pruinosity, appearing yellowish in certain light. Broad depressed quadrate areas on pronotum and mesonotum densely clothed with decumbent, closely appressed whitish gray coarse pubescence underlain with whitish integument, at least on pronotum. Head orange yellow to orange brown, with a dark median wedge on anterior 1/2 to 2/3. Entire body set with short gray pubescence, longer on abdominal tergites. Fore femur orange except extreme base and extreme tip.

Structural characters. Apterous male. Head with moderate length black setae, length 0.33, width 0.83; eye width (0.22), about half the width of interocular space (0.39). Pronotum short, lateral margins rounded, length 0.28, width 0.78; mesonotum long, broad, sides slightly curved, length 0.72, width 1.27; pronotum, mesonotum with numerous black stout moderate length setae laterally and on pleura; metanotum fused with first two abdominal tergites, all three moderately long, weakly indicated laterally, combined length 0.39; abdominal tergites III-VI subequal in length (0.06-0.10), VII longer (0.14). Length of antennal segments I-IV: 0.68; 0.44; 0.33; 0.33; segment I long, very weakly fusiform (Fig. 4).

Fore femur stout, short, curved basally, set with a thick brush of very short setae over most of length, forming a pad on distal half (fig. 5); fore tibia slightly curved, broader on distal half. Measurements of legs as follows: femur, tibia, tarsal 1, tarsal 2 of fore leg, 0.89, 0.67, 0.06, 0.33; of middle leg, 2.77, 3.11, 1.17, 0.72; of hind leg (tarsal 1 and 2 fused), 2.39, 0.94, 0.42.

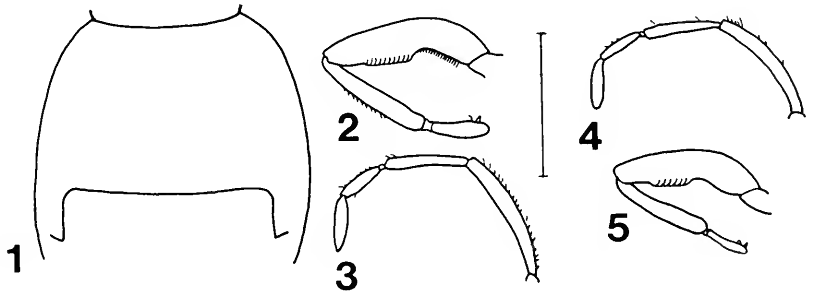
Lateral arms of proctiger not prominent, tapered distally, captured between broad lateral margins of tergite VIII and sternite VIII.

Apterous female. Structure, dorsal setae, and coloration mostly as in male, except larger and more robust, median depressed area of mesontotum not clearly differentiated in color, dorsal pubescence shorter; fore legs unmodified; antennal segment I about as thick as in male. Length of antennal segments I-IV: 0.67; 0.39; 0.33; 0.33. Middle femur not broadened nor flattened.

Type material. Holotype, apterous male, South Africa, Cape Prov., 18 mi. (28 km) NW of Kimberley, 18 Jan. 1968, R. T. Schuh, J. & S. Slater, M. Sweet (AMNH). Paratypes (all apterous), 2 males, 2 females, same data as holotype (JTPC, AMNH).

Etymology. The name *slateri* honors James A. Slater in recognition of his outstanding and voluminous contributions to the study of Heteroptera.

Comparative notes. *Hynesionella slateri* sp. n. is closest to *H. aethiopica* Hoberlandt, but differs in having the fore femur orange with a less pronounced basal notch.



Figures 1 - 3. *Hynesionella karatara* sp. n. 1. Female mesonotum, dorsal view. 2. Male fore leg. 3. Antenna.

Figures 4 - 5. *Hynesionella slateri* sp. n. 4. Antenna. 5. Male fore leg. Scale bar = 1 mm.

Key to the known species of *Hynesionella*

1. Mesonotal dorsum without gray pruinose markings .... *karatara* sp. n.
—— Mesonotal dorsum with gray pruinose markings 2
2. Fore femur with a prominent basal tubercle in both male and female . . . *cobbeni* Linnavuori
—— Male fore femur modified, but without a prominent basal tubercle; female fore femur unmodified 3
3. Fore femur mostly orange in both male and female .... *slateri* sp. n.
—— Fore femur mostly dark colored, not orange 4
4. Male fore femur not excavated basally, not abruptly widened near middle; female mesonotum with posterior margin curved posteriorly .... *capensis* (Poisson)
—— Male fore femur excavated basally, abruptly widened near middle; female mesonotum with posterior margin almost straight .... *aethiopica* Poisson

ACKNOWLEDGMENTS

I am indebted to R. T. Schuh and D. A. Polhemus for their constructive reviews.

The invaluable assistance of Brian Stuckenberg and Dennis Brothers, Pietermaritzburg, South Africa, is gratefully acknowledged. Both aided with guidance and logistics, and without their help the field survey would not have been nearly as successful.

J. A. Slater and R. T. Schuh kindly permitted me to study specimens under their care; the specimens, originally at the University of Connecticut, Storrs, have since been transferred to the American Museum of Natural History, New York.

This research was sponsored by grant 1806-77 from the National Geographic Society, Washington, D. C., and by grant DEB-9528025 from the National Science Foundation, Washington, D. C. I thank these organizations for their continued support of research into the systematics and zoogeography of aquatic Heteroptera. This research was carried out as a faculty affiliate of the Entomology Department, Colorado State University, Fort Collins.

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BOOK REVIEW

(concluded from page 188)

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REASSIGNMENT OF *ISOTOMA LOUISIANA* (COLLEMBOLA: ISOTOMIDAE)[1]

R.D. Waltz[2]

ABSTRACT: The holotype specimen of *Isotoma louisiana* was examined and found to be assignable to the genus *Isotomurus*. The species is distinct among all Nearctic species based on the tuberculate dentes, mucro with a unique ventral tooth, and a unique chaetotaxy. Comparisons and contrasts with other selected isotomid genera are made justifying its inclusion in *Isotomurus*.

The cosmopolitan hydrophilic genus *Isotomurus* Börner is readily distinguished among other Isotomidae by the combination of a quadridentate mucro, presence of long, specialized sensory setae known as bothriotricha, greater than ten ventral manubrial setae, and a characteristic maxillary outer lobe. The genus in North America is comprised of eight nominal species (Christiansen and Bellinger 1980), including this present species, and several species to be described in forthcoming work. In preparation for a review of Nearctic *Isotomurus*, I reviewed the holotype of *Isotoma louisiana* Scott and found it to be assignable to *Isotomurus*. The species is herein redescribed and newly combined as *Isotomurus louisiana* (Scott), n.comb. Some illustrations of the species were provided by Scott (1962); further comparative illustrations will be presented in the forthcoming revision of the Collembola of North America, north of the Rio Grande, by Christiansen and Bellinger (in press) and a review of Nearctic *Isotomurus* species (Waltz, MS). This species is unique among all Nearctic species based on its possession of tuberculate dentes and a strongly excavate ventrobasal projection ("ventral tooth") of the mucro.

Isotomurus louisiana (Scott), NEW COMBINATION

Description: Yellow or green body color in most specimens, with or without strongly contrasting color patterns. Color pattern, when present, with medial and lateral longitudinal stripes and with or without banded posterior abdominal terga. Prominently patterned individuals may also possess a distinct ventral stripe medially on the ventral abdominal segments extending to Th II.

The holotype specimen possesses purple stripes, posterior abdominal bands and a ventral purple stripe medially on a yellow body. Specimens studied from Arizona are light green and without contrasting pattern. Specimens studied from Kansas are very similar to the type material but lack the ventral purple stripe.

Head: PAO less than or subequal to nearest eye. Eyes G and H smaller than remaining eyes. Outer lobe of maxilla with palp bifurcate and with four sublobal setae.

Thorax: Unguiculus without inner tooth. Unguis elongate, without teeth. Tibiotarsi of metathoracic legs without long, outstanding, exterior setae.

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[1] Received October 2, 1997. Accepted October 15, 1997.

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Abdomen: ABD. V-VI without coarse ciliate macrochaetae; common body setae numerous and non-ciliate; bothriotricha of Abd. II-Abd. IV as 3+3+1 pairs; Abd. V S setae (terminology after Deharveng and Lek 1993): *accp 1* is absent, *accp 2, accp 3, accp* 4, and *accp 5* present, *as 1* and *as 2* are present and a third seta here designated as *as X* is present anterior to *as 1* and *2;* ventral tube with 12-22 lateral distal setae; tenaculum quadridentate (not as illustrated by Scott 1962: Fig. 2) with 12-25 setae; dentes tuberculate; mucro with mucronal basal seta and lamella, ventral mucronal tooth present, i.e., with excavate ventromucronal base.

Known distribution: Arizona, Kansas, Louisiana.

Material examined: (Academy of Natural Sciences, Philadelphia) Holotype (#107), on slide, "taken on water, shore of Lake Pontchartrain, approximately 15 feet above mean sea level, Norco, St. Charles Parish, Louisiana, 29-iii-1960, J.H. Eslinger." Label affixed ventrally: *Isotomurus louisiana* (Scott) n. comb. Det: R.D. Waltz 5/97. Additional material examined (Presently in the collection of K.A. Christiansen): AZ: NE of Parker, puddle at edge of Colorado River, 28-x-1986, P. Bellinger (7051). AZ: Pima Co., Santa Rita Mtns, Florida Saddle, SE Tuscon, 7-iii-1989, Olson (7193). KS: Leavenworth Co., 1 mile N Eudora, Kansas River, 8-ix-1988, (52-1-7,12), D.S. Hammer and L.C. Ferrington. KS: Douglas Co., (7072).

Remarks: This species, first described by Scott (1962), was deposited at the Collection of the Academy of Natural Sciences of Philadelphia (Scott 1962; Roback 1981). Bellinger (1985) reviewed the holotype specimen and reported the species as similar to "*Agrenia* (tuberculate dentes) and *Isotomurus* (abdominal bothriotricha)" but commented that it did not fit into any known genus. The location of the remainder of the paratype material cited by Scott (1962) is unknown.

This review of this "striking species" (Bellinger 1985) has resulted in reassignment of this species within *Isotomurus* rather than *Agrenia* Börner or another genus due to the following symmorphic characters shared with *Isotomurus* species: 1) maxillary outer lobe possesses a bifurcate palp and four sublobal hairs (versus bifurcate palp and no sublobal hairs in *Agrenia)* (see Fjellberg 1984); 2) dentes lack the distal elongate setae found in all *Agrenia* species (see Fjellberg 1986, 1988); 3) presence of abdominal bothriotricha (found also in *Hydroisotoma* Stach, *Archisotoma* Linnaniemi, and other Isotomidae but not reported in *Agrenia);* 4) the characteristic *Isotomurus* quadridentate mucro (quite distinct from the mucro of *Agrenia, Archisotoma,* and *Hydroisotoma);* 5) claws that lack the distinct tunica of the ungues (present only in *Agrenia);* and 6) a manubrium with many ventral setae (few only in *Archisotoma).* That *I. louisiana* belongs in *Isotomurus* is strongly indicated by the above characters which are uniquely symmorphic with *Isotomurus* and not shared in combination with other known genera characterized by the possession of abdominal bothriotricha (especially *Archisotoma* and *Hydroisotoma)* or with tuberculate dentes *(Agrenia).* As noted by Bellinger *(op cit) Isotomurus louisiana* differs from other previously described species in the genus by the tuberculate dentes (most *Isotomurus* species bear crenulate dentes; some bear only partially tuberculate dentes).

The combination of tuberculate dentes, the excavate ventral base of the mucro, and the Abd. V chaetotaxy is unique among European (see Deharveng and Lek 1993) and Nearctic *Isotomurus* species and provides the basis for diagnosis of this species.

Partially tuberculate dentes have been reported in at least one Palearctic species, *I. ciliatus* Stach. Several new species are pending description in the Nearctic including species with fully tuberculate dentes and partially tuberculate dentes.

Differences in dental structure have been found to be useful historically in justifying generic or subgeneric status (e.g., subgenera of *Proisotoma* Börner). For the present, elevation of this species and putatively related species bearing tuberculate or partially tuberculate dentes to a subgenus grouping appears to be clearly countered by the existence of intermediate dental types, and an absence of clearly autapomorphic chaetotactic states or other morphology relative to the type species of the genus, *I. palustris* (Müller).

ACKNOWLEDGMENTS

I thank D. Azuma, Academy of Natural Sciences, Philadelphia, for loan of the Holotype slide of *I. Louisiana.* I thank P. Bellinger and K.A. Christiansen for loan of Nearctic collections of this species and preliminary data and Arwin Provonsha, Purdue University, for providing helpful comments on an early draft of this manuscript.

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A NEW HOST RECORD FOR *SPHAEROPTHALMA PENSYLVANICA PENSYLVANICA* (HYMENOPTERA: MUTILLIDAE)[1, 2]

Donald G. Manley[3] T. Paige Carithers[4]

ABSTRACT: Wasps belonging to the family Mutillidae are known to be parasitic on the resting stages of other insects, including other Hymenoptera. However, host records are known for less than five percent of the described species. The mutillid *Sphaeropthalma pensylvanica pensylvanica* has been reported emerging from at least two different species and genera of sphecid hosts (Hymenoptera: Sphecidae). Here we report the emergence of *S. pensylvanica* from yet another species and genus of sphecid host, that being *Isodontia mexicana*. Details are described.

Sphaeropthalma (*Sphaeropthalma*) *pensylvanica pensylvanica* (Hymenoptera: Mutillidae) was first described as *Mutilla pensylvanica* by Lepeletier (1845), based on a male collected in Philadelphia. It is found from North Carolina to central Florida, Louisiana, Missouri, Kansas and Texas. A second subspecies, *S. pensylvanica scaeva*, was described as *M. scaeva* by Blake (1871). The female was described in the same publication as *M. balteola* (Blake 1871). It is found from North Carolina to Massachusetts, Ohio, Illinois, Missouri, Kansas and Texas. A third subspecies, *Sphaerophthalma* (!) *pennsylvanica* (!) *floridensis*, was described by Schuster (1944). It is found only in southern Florida. The females of all three subspecies are indistinguishable.

Members of the family Mutillidae are known to be parasitic on the resting stages (usually the prepupa or pupa) of other insects, including aculeate Hymenoptera. Of more than 4000 described species of Mutillidae, host records exist for less than five percent (Brothers 1972). *Sphaeropthalma pensylvanica* is one of the species for which at least some hosts are known.

Rau (1922) reported a male specimen of *S. pensylvanica scaeva* emerging from a cocoon of the mud dauber *Sceliphron caementarium* (Drury) (Hymenoptera: Sphecidae) in Missouri. He later (Rau 1928) reported males of *S. pensylvanica scaeva* having been reared from the cocoons of both *Trypoxylon* (*Trypargilum*) *politum* Say (Hymenoptera: Sphecidae) and from *Sceliphron* nests.

In 1984, a male mutillid was sent to Manley for identification. The mutillid

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[1] Received September 29, 1997. Accepted October 20, 1997.

[2] Technical contribution no. 4344 of the South Carolina Agricultural Experiment Station, Clemson University.

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ENT. NEWS 109(3) 198-200, May & June, 1998

was determined to be *S. pensylvanica pensylvanica*. It had emerged from the cocoon of a mud dauber (the host cocoon was not sent for determination) on 30 May 1984. The cocoon was collected by J. R. Brushwein in Clemson, South Carolina in March of 1984.

Here, we report the emergence of a male *S. pensylvanica pensylvanica* from a diapaused cocoon of another sphecid wasp, *Isodontia mexicana* (Saussure). This North American wasp ranges throughout the United States east of the Rocky Mountains, south into Mexico and Central America, and has also become established in Hawaii and France (Bohart & Menke 1963). Across this wide range, this species has been observed to nest in such above-ground cavities as hollow plant stems and twigs, rolled leaves, abandoned bee burrows in logs, artificial trap-nests, and the tubular leaves of pitcher plants (*Sarracenia*) (Bequaert 1930). *Isodontia mexicana* is one of the "grass carrier (or carrying) wasps" because the females are often seen carrying blades of grass in their mandibles (Bohart & Menke 1976). The females will then proceed to use these plant fibers to construct their nests.

Nesting by *I. mexicana* in the leaves of pitcher plants has been well documented (under synonym *Isodontia philadelphica* St. Farg.) (Hubbard 1896, Jones 1904, Fish 1976, Rymal & Folkerts 1982). Over 400 *Isodontia* nests in pitcher leaves were reared for a study on the nesting biology of this wasp (Carithers 1998). The male mutillid reported here was reared from an *I. mexicana* nest built in the tubular leaf of the pitcher plant *Sarracenia flava*. The nest was collected on 9 November 1996 in the Apalachicola National Forest in Liberty County, Florida. One intact *Isodontia* cocoon was contained in the one-celled nest. Upon holding the cocoon up to a light source, it appeared to contain a flacid *Isodontia* pre-pupa. A mutillid male emerged from the *Isodontia* cocoon in an environmental chamber on 13 March 1997. Within the *Isodontia* cocoon, the mutillid had spun its own cocoon. This is believed to be the first report of a mutillid parasite from *I. mexicana*, although Bohart and Menke (1976) reported that *Sphaeropthalma* has been bred from the nest of *I. elegans* (F. Smith).

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ODONATA OF THE SOUTH CENTRAL NEARCTIC REGION, INCLUDING NORTHEASTERN MEXICO[1]

John C. Abbott, Kenneth W. Stewart[2]

ABSTRACT: There has not been a concerted effort to document the extent of biodiversity, distribution and geographic affinities of the Odonata of the south central United States and northeastern Mexico. The area is an important boundary for some species representing eastern Nearctic and subtropical faunas, and a mixing zone or dispersal corridor for other species. Since 1993, we have done extensive collecting of all life stages in the seven biotic provinces of Texas, and compiled published and extensive unpublished records from the portions of these provinces of U.S. and Mexican states that join Texas. Here we list 228 species for this region (196 in Texas), indicate their distributions by biotic province, and discuss the regional biogeography and importance of rare species.

Current emphasis on inventorying aquatic insects of the neotropics Paulson 1982; (Gonzalez and Novelo 1991; Novelo and Gonzalez 1991; Quintero and Aiello 1992; Baumann and Kondratieff 1996; Gonzalez and Novelo 1996; McCafferty & Lugo-Ortiz 1996) and realization of the great risk to aquatic invertebrate biodiversity in temperate regions (Franklin 1988; Haffernik 1989, 1992), prompted us to investigate the status of the odonate fauna of the biotic provinces of Texas and adjoining states of the United States and northeastern Mexico that border the Rio Grande River. The odonate fauna of this region is poorly known except from scattered publication records, unpublished reports of collectors, the general documentation and discussion of Mexico's fauna by Gonzalez and Novelo (1996) and Johnson's (1972) work on Texas Zygoptera. There has never been a concerted effort to document the biodiversity and geographic affinities of the Odonata of this area. Over half of the species of Odonata still unknown as larvae are from this region (McCafferty et al. 1990).

The earliest major documentation of Odonata in Texas was by Hagen (1861). A number of species accounts from the state then appeared in Calvert (1901-1908) and Muttkowski (1910). Williamson (1914) listed numerous records for Texas and Oklahoma. Several localized studies within Texas have supplemented these works: Tinkham (1934) and Gloyd (1958) from West Texas and Tucker (1908), Ferguson (1940, 1942), Harwell (1951), Donnelly (1978), Williams (1982), and Laswell and Mitchell (1997) from north central and eastern parts of the state. Abbott (1996) reported the following new species records for Texas: *Aeshna psilus* Calvert, *Gomphus exilis* (Sélys), *Somatochlora georgiana* Walker, *Dythemis maya* Calvert, *Micrathyria didyma* (Sélys), *Sympetrum illotum*

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[1] Received July 18, 1997, Accepted September 20, 1997.

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(Hagen), *Tauriphilia azteca* Calvert, and *Tramea insularis* Hagen. Johnson's (1972) treatise on Texas Zygoptera remains the only comprehensive faunal analysis of that group for the state. Young and Bayer (1979) compiled a list of the dragonfly larvae in the Guadalupe River basin in Texas. Only Kennedy (1921) has made a major effort to describe larvae of several species in the region.

Species lists have been published for the peripheral states of Louisiana (101 spp.; Bick 1957), Arkansas (133 spp.; Harp and Rickett 1977; Harp 1983a,b; Harp 1985; Harp and Harp 1996), Oklahoma (126 spp.; Bick and Bick 1957) and New Mexico (97 spp.; Evans 1995). These lists have been helpful additions to the knowledge of dragonfly and damselfly distributions in this region, but generally have not involved the systematic sampling of stream systems or vegetational or physiographic subregions (except Bick 1957), nor association with abiotic and biotic parameters of occurrence, necessary for biogeographic analysis.

STUDY AREA AND METHODS

The south central Nearctic Region, as we are defining it (Fig. 1), covers approximately 560,000 km^2, of which 412,000 km^2 are in Texas. It includes the seven biotic provinces of Texas and the portions of those provinces from Arkansas, Oklahoma, Louisiana, New Mexico and northeastern Mexico that immediately join Texas. The Mississippi River forms the eastern boundary, and the Navahonian biotic province bounds the western edge of the region. Mean annual precipitation ranges from 25-147 cm/yr, most falling in March-May. Major vegetation types include eastern pines and hardwoods, central prairies and grasslands and western deserts. The seven distinct regional biotic provinces differ in topography, temperature, vegetation, soil type, geology and climate as outlined by Blair (1950), Dice (1943) and Blair and Hubbell (1938). They are: 1) Chihuahuan, 2) Navahonian, 3) Kansan, 4) Balconian, 5) Tamaulipan, 6) Texan, and 7) Austroriparian (Fig. 1). Elevation ranges from sea level to 2,667 meters (Guadalupe Peak, Culberson Co., TX) in the Guadalupe Mountains National Park.

Intensive sampling, with emphasis on Texas, began in September, 1993 and included more than 30 expeditions transecting the biotic provinces or concentrating in such areas as the Guadalupe Mountains National Park of the Navahonian Province. Collection of adults and larvae involved sampling all traversed lotic habitats and selected lentic habitats. Documentation of the fauna of states adjacent to Texas was based primarily on both published and unpublished records of acknowledged collectors and museum holdings, and limited sampling.

Adults were placed in glassine envelopes and submerged in 99% acetone for overnight, then removed and allowed to dry completely before being per-

Figure 1. The six natural biotic provinces of the south central Nearctic Region (modified from Blair 1950, Dice 1943 and Blair and Hubbell 1938).

manently stored in polyethylene envelopes with data cards. Larvae were collected using a Wildco-type 46 x 22.5 cm net with a 1 mm mesh size. Exuviae were hand collected from emergence sites. Both exuviae and larvae were placed in Kahle's solution and then rinsed and permanently preserved in 80% ethanol upon returning to the laboratory. Numerous distribution records were based on reared species; mature larvae were transported alive to the laboratory in portable styrofoam rearing chambers as described by Szczytko and Stewart (1979), and reared in a conditioned Frigid Units Living Stream™ maintained at collection or slightly raised temperatures.

Collections Examined

We examined all regional material from the extensive and previously undocumented Beatty collection, housed at the Frost Entomological Museum of Penn State University (PSU) and from the Arkansas State University Museum of Zoology (ASUMZ), Florida State Collection of Arthropods (FSCA), International Odonata Research Institute (IORI), Sul Ross State University (SRSU) and the Texas A&M Insect Collection (TAMU). Individuals and institutions who donated study material include T.W. Donnelly (Binghamton, New York), S.W. Dunkle (Collin County Community College), J. Gelhaus (Academy of Natural Sciences of Philadelphia), S. Jasper (Texas A&M University), B.C. Kondratieff (Colorado State University), D.R. Paulson (University of Puget Sound) and C.R. Nelson (University of Texas, Austin).

RESULTS

Table 1 lists the 228 species of damselflies and dragonflies currently known from the south central Nearctic biotic provinces (Fig. 1). The classification used here follows that of Garrison (1991), except that in our view *Epicordulia* and *Tetragoneuria* are considered subgenera of *Epitheca* (K.J. Tennessen pers. comm.). The following four species represent new Texas species records, and one, *Neoneura amelia*, is a new U.S. species record:

Neoneura amelia Calvert. TEXAS: Hidalgo Co., Rio Grande River nr. La Lomita Mission, W of Granjeno, 12 May 1997, 3♂, 2♀, Univ. of North TX Collection. New for the US.

Neoerythromma cultellatum (Hagen in Sélys). TEXAS: Hidalgo Co., Rio Grande River nr. La Lomita Mission, W of Granjeno, 12 May 1997, 2♂, Univ. of North TX Collection. New for Texas.

Aphylla williamsoni (Gloyd). TEXAS: Jefferson Co., 12 August 1989, 1♂, photograph taken by R.A. Honig. TEXAS: Montgomery Co., pond @ E side of IH 45 and S of FM 1488, 11 August 1997, 1♀, photograph taken by R.A. Behrstock. New for TX.

Somatochlora filosa (Hagen). TEXAS: Trinity Co., Rt. 94, 1.3 mi W of Angelina County line, 23 August 1995, 1♀, B. Mauffray Collection. New for TX.

DISCUSSION

The south central Nearctic Region (Fig. 1) is important as a boundary (Paulson 1982) for some species of the largely eastern fauna of central and east Texas (Texan and Austroriparian Provinces) that represent a temperate element, and those of south Texas and northeastern Mexico (Tamaulipan Province), representing a subtropical element. However, for other species these provinces are actually a mixing zone, and at least a short distance dispersal corridor; for example, our records indicate that of the 177 species occurring in the Austroriparian and Texan Provinces, 81 species (46%) also occur in the Tamaulipan Province and 59 species (33%) cross the Rio Grande to the south, into northeastern Mexico. Conversely, of the 108 species in the northeastern Mexico states of Tamaulipas and Nuevo Leon, 80 species (74%) cross the Rio Grande, entering Texas and 61 species (57%) occur in the Austroriparian and Texan Provinces.

A similar boundary or mixing phenomenon exists near the Rio Grande River between the more northern Kansan/Navahonian/Balconian and the more southern Chihuahuan Province. Of the 142 species occurring in the Kansan, Navahonian and Balconian Provinces, 84 species (59%) also occur in the Chihuahuan Province and many of these cross the Rio Grande farther south, into northeastern Mexico. Conversely, of the 50 species in the northern Mexico states of Coahuila and Chihuahua, 41 species (82%) cross the Rio Grande, entering Texas with 39 (46%) of them occurring in the Kansan, Navahonian and Balconian Provinces.

The Balconian Province represents diverse species assemblages from the northern and southern provinces bordering or near it. Fifty percent (99) of the 199 species occurring in the northern Navahonian/Kansan/Texan/Austroriparian Provinces occur in the southern Chihuahuan/Tamaulipan Provinces. Conversely, 93 (69%) of the 135 species occurring in the southern Chihuahuan/Tamaulipan Provinces occur in the northern Kansan/Texan/Austroriparian Provinces. These examples and recent discoveries of dispersals across the Rio Grande (Abbott 1996), including *Neoneura amelia* Calvert, *Neoerythromma cultellatum* Hagen in Sélys, *Aeshna psilus* Calvert, *Dythemis maya* Calvert, *Micrathyria didyma* (Sélys), *Tauriphilia azteca* Calvert and *Tramea insularis* Hagen, from Mexico into Texas suggest that the area is indeed a dispersal corridor and that future dispersals across it may occur. These distinct species assemblages and mixing zones undoubtedly relate to the climate and vegetational characteristics defining these provinces. The Rio Grande border is a more effective barrier among certain groups than in others. The cordulegastrids and corduliids are poorly represented in Mexico, Central and South America, while groups such as the coenagrionids, aeshnids and libellulids are much more widely distributed and are well represented in these areas (Paulson 1982).

The large number of Odonata larvae still unknown to science from the southwestern U.S. is attributed in part to relatively less collecting effort (McCafferty et al. 1990) and low species densities in combination with sparse and patchy habitats (Provonsha and McCafferty 1973). The larval descriptions of many of these regional species are insufficient for identification purposes (McCafferty et al. 1990). The rarity and/or local distributions of many species in the eastern part of this region account for the large number of unknown larvae there.

Three species of Odonata in the south central Nearctic Region are listed as "species of concern" by the United States Fish and Wildlife Service. This federal listing identifies species "for which information now in the possession of the Service indicates that proposing to list as endangered or threatened is possibly appropriate, but for which persuasive data on biological vulnerability and threat are not currently available to support proposed rules" (USFWS 1996). Two species, *Somatochlora margarita* Donnelly and *Argia leonorae* Garrison have locally restricted distributions. *Argia leonorae* is known from only five counties in south and west Texas and in northern Mexico. The larva of this species, in its natural habitat, remains undiscovered.

A status survey of *Somatochlora margarita* conducted by the Texas Parks and Wildlife Department (Price et al. 1989) expanded its initial range, a five mile radius in the Sam Houston National Forest, to a now estimated 10,000 square mile area in east Texas and western Louisiana. *Somatochlora margarita* is endemic to the longleaf and loblolly pine forests of southeastern Texas. We are in the process of describing its larva from the exuviae of reared material (donated by S.W. Dunkle). We believe that rigorous sampling in the sandy bottom streams of the Big Thicket of East Texas will lead to the discovery of this larva in its natural habitat, and provide potential insights into its life history.

A third species, *Macromia wabashensis* Williamson, is also listed as Category 2 by the USFWS. Dubious records and the validity of *M. wabashensis* as a distinct species are factors leading to its Category 2 status. Several specimens referred to as *M. wabashensis* have been collected in McLennan and Falls Counties, Texas (Williams 1982). These records are currently thought to be exceptionally yellow forms of *M. taeniolata* Rambur or a hybrid between *M. taeniolata* and *M. pacifica* Hagen (Dunkle pers. comm.; Garrison 1995). It has thus been omitted from our list.

There is considerable taxonomic confusion concerning the *Tetragoneuria* group of this region. We provisionally list *Epitheca (T.) semiaquea* (Burmeister) from Texas and Oklahoma based on determinations made by K.J. Tennessen. Further study including DNA analysis is needed on this group.

Bick (1983) reported 32 species of North American Odonata (8% of that fauna) to be at risk, citing the loss of high-quality, undisturbed streams as the most significant factor endangering odonates in North America. Four of these (*Neoneura aaroni* Calvert, *Gomphus ozarkensis* Westfall, *Somatochlora margarita* Donnelly and *S. ozarkensis* Bird) occur in the south central U.S. and are considered rare (Bick 1983). Effective conservation efforts depend on accurate knowledge of the current distribution of each species (Moore 1991). Continued effort is needed to indicate which strategies should be taken to conserve particular species and which breeding sites should be given priority for protection.

ACKNOWLEDGMENTS

We wish to thank all who provided data and support, especially S.W. Dunkle, T.W. Donnelly, R.W. Garrison, B. Mauffray and G.L. Harp. K.J. Tennessen provided valuable input and verification of specimens of *Epitheca*. We would like to thank S.R. Moulton, II and G.H. Beatty for allowing us to examine the Beatty collection, Frost Entomological Museum at Penn State. R.A. Behrstock and R.A. Honig generously furnished us with photographic records. Valuable field help was provided by J.W. Chirhart, J.O. Martinez, K.V. Moore and M.V. Passanante. We also thank S.W. Dunkle, C.R. Nelson and two anonymous reviewers for comments on earlier drafts of this manuscript.

Table 1. Distribution of the 227 species of Odonata currently known from the south central Nearctic Region. Arkansas (AR), Austroriparian (AUST), Balconian (BALC), Chihuahua (CHI), Chihuahuan (CHIH), Coahuila (COA), Kansan (KANS), Louisiana (LA), Navahonian (NAVA), New Mexico (NM), Nuevo Leon (NLN), Oklahoma (OK), Tamaulipan (TAMA), Tamaulipas (TAM), Texan (TEXA) and Texas (TX). Distributional annotations are noted by: (*) = new state record, (**) = new U.S. record.

	United States					Mexico				Biotic Provinces						
	AR	LA	NM	OK	TX	CHI	COA	NLN	TAM	AUST	BALC	CHIH	KANS	NAVA	TAMA	TEXA
ZYGOPTERA (73)																
Calopterygidae (5)																
Calopteryx dimidiata Burmeister		X			X					X						
C. maculata (Beauvois)	X	X		X	X					X			X			X
Hetaerina americana (Fabricius)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
H. titia (Drury)	X	X		X	X			X	X	X	X	X	X	X	X	X
H. vulnerata Hagen in Sélys			X			X	X	X	X			X		X		X
Lestidae (9)																
Archilestes grandis (Rambur)	X		X	X	X	X		X	X	X	X	X	X	X		X
Lestes alacer Hagen			X	X	X		X	X	X	X	X	X	X	X	X	X
L. disjunctus australis Walker	X	X	X	X	X					X	X	X	X	X	X	X
L. forficula Rambur					X				X		X				X	X
L. inaequalis Walsh	X	X		X	X					X						
L. rectangularis Say	X			X						X			X			X
L. sigma Calvert				X	X			X	X			X			X	X
L. unguiculatus Hagen	X			X						X		X				X
L. vigilax Hagen	X	X		X	X					X						
Protoneuridae (3)																
Neoneura aaroni Calvert					X			X			X				X	
N. amelia Calvert**					*										X	
Protoneura cara Calvert					X				X		X				X	
Coenagrionidae (56)																
Acanthagrion quadratum Sélys					X			X	X		X				X	
Amphiagrion abbreviatum (Sélys)			X	X								X		X		X
Argia alberta Kennedy			X	X										X		X
A. apicalis (Say)	X	X	X	X	X			X		X	X	X		X	X	X
A. barretti Calvert					X			X	X		X	X			X	X
A. bipunctulata (Hagen)	X	X		X	X					X						X
A. cuprea (Hagen)					X			X			X				X	
A. fumipennis Burmeister	X	X	X	X	X			X		X	X	X	X	X	X	X
A. hinei Kennedy			X		X		X					X	X	X		
A. immunda (Hagen)	X		X	X	X	X		X	X	X	X	X	X		X	X
A. leonorae Garrison					X			X			X	X			X	X
A. lugens (Hagen)			X	X	X	X					X	X		X		
A. moesta (Hagen)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
A. munda Calvert			X		X	X						X				
A. nahuana Calvert			X	X	X	X		X		X	X	X	X	X	X	X
A. plana Calvert	X		X	X	X	X	X	X		X	X	X	X	X	X	X
A. rhoadsi Calvert					X			X	X						X	
A. sedula (Hagen)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
A. tibialis (Rambur)	X	X		X	X					X			X			X
A. translata Hagen in Sélys	X		X	X	X	X		X	X	X	X	X	X	X	X	X
Chromagrion conditum (Sélys)	X									X						
Enallagma antennatum (Say)				X												X
E. aspersum (Hagen)	X			X	X					X						X
E. basidens Calvert	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
E. boreale Sélys			X									X	X	X		
E. civile (Hagen)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
E. concisum Williamson		X								X						
E. cyathigerum (Charpentier)			X									X	X	X		
E. daeckii (Calvert)	X	X		X	X					X						
E. divagans Sélys	X	X		X	X					X						X
E. doubledayi (Sélys)					X											X
E. dubium Root		X		X	X					X						

Table 1 (Continued)	United States					Mexico				Biotic Provinces						
	AR	LA	NM	OK	TX	CHI	COA	NLN	TAM	AUST	BALC	CHIH	KANS	NAVA	TAMA	TEXA
E. durum (Hagen)		X			X				X	X					X	X
E. exsulans (Hagen)	X	X		X	X			X	X	X	X	X	X		X	X
E. geminatum Kellicott	X	X		X	X					X						X
E. novaehispaniae Calvert					X			X	X		X	X			X	
E. praevarum (Hagen)			X	X	X	X	X	X			X	X	X	X	X	
E. signatum (Hagen)	X	X		X	X					X	X		X		X	X
E. traviatum westfalli Donnelly	X	X		X	X					X						X
E. vesperum Calvert	X	X		X	X					X						X
Hesperagrion heterodoxum (Sélys)			X		X	X	X	X				X	X	X	X	
Ischnura barberi Currie			X	X	X						X	X	X	X		X
I. damula Calvert			X	X	X							X	X	X		
I. demorsa (Hagen)			X	X	X	X	X					X	X	X		
I. denticollis (Burmeister)			X	X	X	X						X	X	X		X
I. hastata (Say)	X	X	X	X	X			X	X	X	X	X	X	X	X	X
I. kellicotti Williamson	X	X		X	X					X						
I. perparva McLachlan in Sélys			X	X								X	X	X		
I. posita posita (Hagen)	X	X		X	X					X	X	X	X		X	X
I. prognata (Hagen)		X			X					X						
I. ramburii (Sélys)	X	X		X	X	X		X	X	X	X	X	X		X	X
I. verticalis (Say)	X		X	X	X					X			X	X		X
Nehalennia integricollis Calvert		X		X	X					X						
Neoerythromma cultellatum (Sélys)					*				X						X	
Telebasis byersi Westfall	X	X			X					X						
T. salva (Hagen)			X	X	X	X		X	X	X	X	X	X	X	X	X
ANISOPTERA (155)																
Petaluridae (1)																
Tachopteryx thoreyi (Hagen in Sélys)	X	X		X	X					X						X
Aeshnidae (16)																
Aeshna constricta Say	X									X						
A. dugesi Calvert			X		X			X				X	X		X	
A. multicolor Hagen			X	X	X					X	X	X	X	X		X
A. psilus Calvert					X				X		X				X	
A. umbrosa umbrosa Walker	X		X	X						X			X	X		X
Anax amazili (Burmeister)					X						X	X				
A. junius (Drury)	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
A. longipes (Hagen)	X	X		X	X					X	X					X
A. walsinghami McLachlan			X		X			X				X	X	X	X	
Basiaeschna janata (Say)	X	X		X	X					X	X		X			X
Boyeria vinosa (Say)	X	X		X	X					X	X					X
Coryphaeschna ingens (Rambur)	X	X			X					X					X	X
Epiaeschna heros (Fabricius)	X	X		X	X					X	X		X		X	X
Gomphaeschna furcillata (Say)	X	X			X					X						
Gynacantha nervosa Rambur				X					X	X					X	
Nasiaeschna pentacantha (Rambur)	X	X		X	X					X	X		X		X	X
Gomphidae (38)																
Aphylla angustifolia Garrison		X			X			X	X	X	X				X	X
A. protracta (Hagen)					X		X		X	X	X				X	X
A. williamsoni (Gloyd)		X			*					X						
Arigomphus lentulus (Needham)	X			X	X					X						X
A. maxwelli (Ferguson)	X	X			X					X						
A. submedianus (Hagen)	X	X		X	X					X	X					X
A. villosipes (Sélys)	X									X						
Dromogomphus armatus Sélys		X								X						
D. spinosus Sélys	X	X		X	X					X	X					X
D. spoliatus (Hagen in Sélys)	X	X		X	X			X	X	X	X		X		X	X
Erpetogomphus compositus Hag. in Sélys			X		X			X			X	X	X	X	X	
E. crotalinus (Hagen in Sélys)			X			X						X	X	X		
E. designatus Hagen in Sélys	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
E. eutainia Calvert					X				X						X	X
E. heterodon Garrison			X		X	X					X			X		
E. lampropeltis lampropeltis Kennedy			X		X	X					X			X		
Gomphus (Gomphurus) externus Hagen	X		X	X	X					X	X	X	X	X	X	X

Table 1 (Continued)	United States					Mexico				Biotic Provinces						
	AR	LA	NM	OK	TX	CHI	COA	NLN	TAM	AUST	BALC	CHIH	KANS	NAVA	TAMA	TEXA
G. (G.) gonzalezi Dunkle					X										X	
G. (G.) hybridus Williamson	X				X					X						X
G. (G.) modestus Needham	X	X			X					X						X
G. (G.) ozarkensis Westfall	X	X								X						
G. (G.) vastus Walsh	X			X	X					X	X				X	X
Gomphus (Gomphus) apomyius Donnelly	X	X			X					X						
G. exilis Sélys	X	X			X					X						
G. graslinellus (Walsh)	X			X	X					X	X					X
G. lividus (Sélys)	X	X			X					X						X
G. militaris Hagen			X	X	X			X		X	X	X	X	X	X	X
G. oklahomensis (Pritchard)	X	X		X	X					X						X
Hagenius brevistylus Sélys	X	X		X	X					X	X					X
Ophiogomphus westfalli Cook & Daigle	X									X						
Phyllogomphoides albrighti (Needham)			X		X			X	X	X	X	X		X	X	X
P. stigmatus (Say)			X	X	X			X			X	X	X		X	X
Progomphus borealis McLachlan			X		X	X	X				X	X	X	X		
P. obscurus (Rambur)	X	X		X	X					X	X	X	X	X	X	X
Stylogomphus albistylus (Hagen in Sélys)	X			X								X	X			
Stylurus intricatus (Hagen)			X		X							X	X	X		
S. laurae (Williamson)	X	X			X					X						
S. plagiatus (Sélys)	X	X		X	X					X	X		X		X	X
Cordulegastridae (3)																
Cordulegaster erronea Hagen *in* Sélys	X	X								X						
C. maculata Sélys	X	X			X					X						
C. obliqua obliqua (Say)	X	X		X	X					X						X
Corduliidae (24)																
Macromiinae (6)																
Didymops transversa (Say)	X	X		X	X					X	X		X			X
Macromia alleghaniensis Williamson	X									X						
M. annulata Hagen			X	X	X			X		X	X	X	X		X	X
M. illinoiensis georgina (Sélys)	X	X		X	X					X	X		X		X	X
M. pacifica Hagen	X			X	X					X	X				X	X
M. taeniolata Rambur	X	X		X	X					X						X
Corduliinae (18)																
Epitheca (Epicordulia) princeps Hagen	X	X		X	X					X	X		X		X	X
E. (Tetragoneuria) costalis (Sélys)	X	X		X	X					X	X					X
E. (T.) cynosura (Say)	X	X		X	X					X			X			X
E. (T.) petechialis (Muttkowski)			X	X	X					X	X		X	X		X
E. (T.) *semiaquea* (Burmeister)				X	X					X						X
E. (T.) spinosa Hagen	X	X		X						X						
Helocordulia selysii (Hagen)	X	X			X					X						
H. uhleri Sélys	X			X						X						
Neurocordulia alabamensis Hodges		X			X					X						
N. molesta (Walsh)	X	X		X	X					X						X
N. virginiensis Davis	X	X		X						X						
N. xanthosoma (Williamson)	X			X	X					X	X					X
Somatochlora filosa (Hagen)	X	X			*					X						
S. georgiana Walker		X			X					X						
S. linearis (Hagen)	X	X		X	X					X						X
S. margarita Donnelly		X			X					X						
S. ozarkensis Bird	X			X						X						
S. tenebrosa (Say)	X			X						X						
Libellulidae (73)																
Brachymesia furcata (Hagen)					X		X	X	X	X	X	X			X	X
B. gravida (Calvert)	X	X		X	X					X	X		X		X	X
B. herbida (Gundlach)					X				X	X	X					X
Brechmorhoga mendax (Hagen)	X		X	X	X			X	X	X	X	X	X	X	X	X
Cannaphila insularis funerea (Carpenter)					X			X							X	X
Celithemis amanda (Hagen)	X	X			X					X						
C. elisa (Hagen)	X	X		X	X					X	X					X
C. eponina (Drury)	X	X	X	X	X			X		X	X		X	X	X	X
C. fasciata Kirby	X	X		X	X					X	X					X
C. ornata (Rambur)		X			X					X						
C. verna Pritchard	X	X		X	X					X						

Table 1 (Continued)	United States					Mexico				Biotic Provinces						
	AR	LA	NM	OK	TX	CHI	COA	NLN	TAM	AUST	BALC	CHIH	KANS	NAVA	TAMA	TEXA
Dythemis fugax Hagen	X		X	X	X				X	X	X	X	X	X	X	X
D. maya Calvert					X	X		X	X			X			X	
D. nigrescens Calvert					X			X	X		X	X			X	X
D. velox Hagen	X	X	X	X	X	X		X	X	X	X	X	X		X	X
Erythemis collocata (Hagen)			X		X	X	X					X	X	X		
E. plebeja (Burmeister)					X				X		X				X	X
E. simplicicollis (Say)	X	X	X	X	X			X	X	X	X	X	X	X	X	X
E. vesiculosa (Fabricius)				X	X				X	X	X		X	X	X	X
Erythrodiplax berenice berenice (Drury)		X	X		X					X		X	X	X	X	X
E. connata (Burmeister)					X							X				
E. funerea (Hagen)					X			X			X				X	
E. fusca (Rambur)					X				X		X				X	
E. minuscula (Rambur)	X	X		X	X					X	X					X
E. umbrata (Linnaeus)	X	X		X	X			X	X	X	X	X	X		X	X
Libellula auripennis Burmeister	X	X		X	X				X	X					X	X
L. axilena Westwood	X	X								X						
L. comanche Calvert			X	X	X	X						X	X	X	X	X
L. composita (Hagen)			X		X							X	X	X		X
L. croceipennis Sélys			X	X	X			X	X	X	X	X	X		X	X
L. cyanea Fabricius	X			X	X					X	X		X			X
L. deplanata Rambur	X	X		X	X					X						X
L. flavida Rambur	X	X		X	X					X	X					X
L. forensis Hagen			X									X	X	X		
L. incesta Hagen	X	X		X	X					X	X		X			X
L. luctuosa Burmeister	X	X	X	X	X	X				X	X	X	X	X	X	X
L. lydia Drury	X	X	X	X	X			X		X	X	X	X	X	X	X
L. needhami Westfall	X	X			X				X	X					X	X
L. pulchella Drury	X	X	X	X	X					X	X	X	X	X	X	X
L. saturata Uhler			X	X	X	X	X	X		X	X	X	X	X	X	X
L. semifasciata Burmeister	X	X		X	X					X						X
L. subornata (Hagen)			X	X	X	X						X	X	X		
L. vibrans Fabricius	X	X		X	X					X						X
Macrodiplax balteata (Hagen)		X	X		X					X	X	X	X		X	X
Macrothemis imitans leucozona Ris					X			X	X		X				X	X
M. inacuta Calvert					X			X	X		X				X	
M. inequiunguis Calvert					X			X			X					
Miathyria marcella (Sélys)	X	X			X			X	X	X	X				X	X
Micrathyria aequalis (Hagen)					X			X	X						X	
M. didyma (Sélys)					X				X						X	
M. hagenii Kirby	X				X			X	X	X	X	X			X	X
Orthemis ferruginea (Fabricius)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pachydiplax longipennis (Burm.)	X	X	X	X	X		X		X	X	X	X	X	X	X	X
Paltothemis lineatipes Karsch			X		X	X		X			X	X	X	X	X	X
Pantala flavescens (Fabricius)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
P. hymenaea (Say)	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Perithemis domitia (Drury)					X	X		X							X	
P. tenera (Say)	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Pseudoleon superbus (Hagen)			X		X			X	X		X	X		X	X	
Sympetrum ambiguum (Rambur)	X	X		X	X					X			X			X
S. corruptum (Hagen)	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
S. costiferum (Hagen)			X										X			
S. illotum (Hagen)			X		X							X		X		
S. internum Montgomery			X	X										X		X
S. occidentale fasciatum Walker			X	X								X	X	X		
S. vicinum (Hagen)	X		X	X	X					X	X		X	X		X
Tauriphila azteca Calvert					X										X	
Tholymis citrina Hagen					X										X	
Tramea calverti Muttkowski					X						X				X	X
T. carolina (Linnaeus)	X	X		X	X					X		X				X
T. insularis Hagen					X							X				
T. lacerata Hagen	X	X	X	X	X				X	X	X	X	X	X	X	X
T. onusta Hagen	X	X	X	X	X			X	X	X	X	X	X	X	X	X
Totals	127	112	82	132	196	37	24	66	62	157	109	92	95	76	106	139

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SCIENTIFIC NOTE:

NEW DISTRIBUTIONS FOR *RAPTOHEPTAGENIA CRUENTATA* AND *AMETROPUS NEAVEI* (EPHEMEROPTERA: HEPTAGENIIDAE, AMETROPODIDAE)[1]

R.D. Waltz,[2] G. F. Edmunds, Jr.,[3] Gary Lester[4]

Large river habitats possess some of the least known mayfly species in North America (McCafferty et al. 1990). Difficulty in sampling such habitats has undoubtedly contributed to the report of widely disjunct distributions of large river species. Decline in the quality of large river habitat has also possibly contributed to localized extirpations and further increased the apparent disjunction of reported distributions (see Whiting and Lehmkuhl 1987, McCafferty et al. 1990). Herein, two large river species, which are rarely collected, are newly reported from Montana. One of these two species is also newly reported from Minnesota.

Raptoheptagenia cruentata (Walsh) has been reported previously from nine states or provinces in North America based on available literature (see Whiting and Lehmkuhl 1987, Edmunds and Waltz 1995). Reports of larval collections cited in the preceding papers include Arkansas, Illinois, Indiana, Montana, Ohio, and Saskatchewan. McCafferty (1988) designated the neotype of *R. cruentata* based on a larva in Indiana, which is housed in the Purdue Entomological Research Collection (PERC), West Lafayette, IN. Adult collections have been reported from Illinois, Indiana, Nebraska, Tennessee, and Manitoba.

Two *R. cruentata* larvae taken in the Powder River, by G. Romero, with the following collection data: MT: Custer Co., Powder R., 11-XI-1976 (1 larva), and same locale, 11-VIII -1976 (2 larvae) were the source of the previously unpublished Montana record reported by Edmunds and Waltz (1995). In addition a single, nearly mature larva of *R. cruentata* was recently taken in collections made at the Montana state line in the Little Missouri River at MT: Carter Co., Little Missouri River, Sec 12, T 6S, R 62E, 17-VII-1996. An additional new state distribution report for *R. cruentata* is herein given for Minnesota as MN: Sibley Co., Minnesota R. (drift net), 30-VI-1974, C.M. Haynes (1 young larva).

The more rarely reported species *Ametropus neavei* McDunnough, was also collected in the Powder River from MT: Custer Co., Powder River, 11-XI-1976, G. Romero (1 larva). *A. neavei* was previously known from the type locality in Alberta and from Saskatchewan, Canada (Allen and Edmunds 1976) and Michigan (Steven and Hilsenhoff 1979).

The recording of distributions of rare or rarely collected species is important 1) in order to provide data to adequately assess species rarity (e.g., see McCafferty and Edmunds 1997), and 2) to provide local and regional regulatory personnel and ecologists with data potentially critical to large stream management decision making.

The above habitats in Montana are large streams with firm sand substrates. We do not have data characterizing the Minnesota habitat. However, detailed data from the Little Missouri River site is available through monitoring activities reported to us by Warren Kellogg, Watershed Specialist, USDA NRCS, Helena, MT. Kellogg's data characterizes the Little Missouri at this site as

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an intermittent, warm water stream. Channel catfish and carp were present in the immediate area. Physical characters available include: pH 8.6; temp 27^0 C; nitrates < 0.01mg/l; TKN - 0.2 mg/l; OP-0.014 mg/l; TP-0.03mg/l; TSS-26mg/l. The specimen of *R. cruentata* taken was collected by means of a kick screen. The riparian vegetation includes patches of large cottonwoods (*Populus deltoides*) and willows (*Salix* spp.) encroaching on the sand/silt bars. There was little or no shade at the collection site.

We thank Warren Kellogg for providing this data characterizing the collection site.

Vouchers originating from the personal collection of George F. Edmunds, Jr., and the larva from Little Missouri River are deposited at the Purdue University Entomological Research Collection (PERC), West Lafayette, Indiana.

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SCIENTIFIC NOTE:

CLOEODES EXCOGITATUS (EPHEMEROPTERA: BAETIDAE) IN NORTHERN CALIFORNIA[1]

R.D. Waltz[2], Peter Ode[3], Jon Lee[4]

The small minnow mayfly genus *Cloeodes* Traver is found in many different freshwater habitats throughout the Neotropics, Afrotropics, Asia and southern temperate areas of North America. Various revisionary works (Waltz and McCafferty 1987) and systematic works (Kluge 1991; Waltz 1993; Waltz and McCafferty 1994; McCafferty and Lugo-Ortiz 1995) have provided taxonomic data for the genus and added greatly to our knowledge of the world distribution of the genus.

The genus was recognized as having tropical affinities by Waltz and McCafferty (1987), McCafferty and Waltz (1990), and McCafferty et al. (1992). McCafferty and Lugo-Ortiz (1995) and Lugo-Ortiz and McCafferty (1993, 1994, 1995) further added to the known distribution of the genus in the Western Hemisphere, *viz*., southwestern North America, Mesoamerica, and South America.

Herein, we report a remarkable, although possibly not unexpected, distribution record for this primarily subtropical and tropical genus from northern California. Larvae of *C. excogitatus* Waltz and McCafferty were taken in the following site in northern California: CA: Mendocino Co., Williams Crk near Covelo, 29-IX-1996. The above site is characterized by fine silt bottoms mixed with cobble. Stream temperatures are warm in the summer months. The above specimens were taken in low flow conditions near the end of the summer dry season.

Lugo-Ortiz and McCafferty (1994, 1995) extended the known range of *C. excogitatus* from its type locality in Oak Creek Canyon, Arizona, southward to Yavapai County (Arizona) and Mexico. The type locale of *C. excogitatus* was previously the most northern report of the genus in North America. This report extends the known range of this species northward into North America by at least 600 miles reaching the Coastal Biotic Province of California (Usinger 1953) at approximately 40 degrees north latitude. Other northward extensions of primarily tropical genera into North America are also known in other mayfly genera, e.g., the baetid genera *Camelobaetidius* Demoulin and *Paracloeodes* Day (see McCafferty et al. 1992).

Voucher specimens are deposited at the Purdue Entomological Research Collection, Purdue University, West Lafayette, IN and the California Academy of Science, San Francisco.

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[1] Received October 31, 1997. Accepted December 17, 1997.

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[3] Aquatic Biological Assessment Laboratory, California Department of Fish and Game, 2005 Nimbus Road, Rancho Cordova, CA 95670.

[4] 2250 Wilson Street, Arcata, CA 95521.

ENT. NEWS 109(3) 215-216, May & June, 1998

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SCIENTIFIC NOTE

FIRST RECORD OF *ALEIODES DEPANOCHORA* (HYMENOPTERA: BRACONIDAE) FROM BRAZIL

A. M. Penteado-Dias[2]

ABSTRACT: *Aleiodes depanochora* is recorded for the first time from Manaus, Descalvado and Dourado, Brazil.

Aleiodes depanochora van Achterberg belongs to the *Aleiodes dispar* group in which males have peculiar depressions on the second and third metasomal tergites that are absent in females (van Achterberg, 1985). The *Aleiodes dispar* group includes eight species: three from the Old World, *A. excavatus* (Telenga, 1941), *A. takasuae* van Achterberg, 1985 and *A. yasirae* van Achterberg, 1995, and five from the Neotropical region: *A. elliptidepressus* Penteado-Dias & van Achterberg, 1995, from Brazil, *A. longipendulatus* van Achterberg, 1985, from Costa Rica, *A. rugosicostalis* van Achterberg, 1995, from Peru, *A. brevipendalatus* van Achterberg, 1995, from Ecuador and *A. depanochora,* van Achterberg, 1995, from Peru. The localities listed below are the first records for *A. depanochora* from Brazil.

Diagnosis: *Aleiodes depanochora* can be recognized by the following characters: head (except stemmaticum) yellowish-brown dorsally; side of pronotum dark brown or infuscate, paler parts not strongly contrasting with darker parts; metasomal tergites 1-3 partly infuscate; pterostigma evenly dark brown; hind tarsus infuscate or dark brown; length of malar space of male 1.1-1.2 times basal width of mandible and 0.3-0.35 times height of eye; face transversely rugose, dorsal face of pronotum in lateral view distinctly protruding; hind coxa densely transversely striate dorsally; first metasomal tergite more coarsely rugose laterally than medially and somewhat widened posteriorly; fourth tergite of male partly retracted and smooth; depression of second metasomal tergite of male without median carina and slender ovoid; median carina of second tergite of male 0.2-0.4 times length of depression; ratio of forewing veins 1-CUI: 2-CUI = 1: 8 - 12, vein 3-SR of fore wing 1.0 1.3 times as long as vein 2-SR.

Specimens examined: 4 males, BRAZIL, Amazonas, Manaus, B. Klein, November 8,25,29, 1984 (Instituto Nacional de Pesquisas da Amazônia); 1 male, BRAZIL, São Paulo, Descalvado, Fazenda Escaramuças, M. M. Dias, 9.XI, 1985 (light trap); 1 male, BRAZIL, São Paulo, Dourado, Fazenda Morro Chato, L. A. Joaquim, 26.V.1994 (Departamento de Ecologia e Biologia Evolutiva da Universidade Federal de São Carlos, SP).

The specimens from Manaus were collected in the Amazonian rainforest and those from Descalvado and Dourado were collected in Atlantic forest areas (Fig. 1).

The discovery of the same species in the primary rain forest (Peru and Manaus) and in the secondary Atlantic forest (Dourado and Descalvado) is specially interesting. The biology of the *Aleiodes dispar* group species is unknown; the sparse data available on them indicate that they are parasites of lepidopterous larvae living in low vegetation (van Achterberg, & Penteado-Dias, 1995). Same as *Aleiodes yasirae* van Achterberg, 1995 and *A. elliptedepressus* van Achterberg & Penteado-Dias, 1995, we found *A. depanochora* in lowland vegetation, in a gallery forest close to a river. Probably that is the distribution pattern for Brazilian *Aleiodes dispar* group species and there we can find their hosts.

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[1] Received April 19, 1996. Accepted September 8, 1997.

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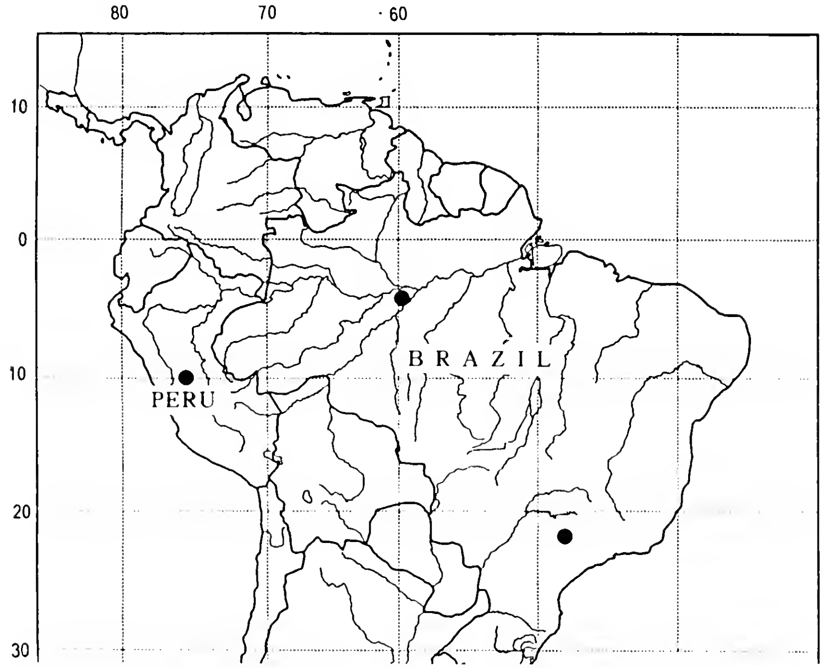

Figure 1. Collection records of *Aleiodes depanochora* van Achterberg.

ACKNOWLEDGMENTS

I wish to thank the Instituto Nacional de Pesquisas da Amazonia for the loan of the listed specimens. This work was supported by Conselho Nacional de Desenvolvimento Cientifico e Tecnologico and Fundação de Amparo à Pesquisa do Estado de São Paulo from Brazil.

I wish to thank also C. van Achterberg, R. A. Wharton and P. Marsh who provided suggestions for improvements to the manuscripts.

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MEMBERS OF THE AMERICAN ENTOMOLOGICAL SOCIETY

December 18, 1997

The previous list of 313 members was published in the September-October 1984 issue of *Entomological News.* That issue celebrated the 125th Anniversary of the Society. This present list contains 412 members from every state in the union (and the District of Columbia), except Alaska, Montana, Oregon and Rhode Island. The largest representation is from Pennsylvania (43). International members represent 16 countries on the five continents.

The format used in this list differs from the previous list in that all types of members appear in a single alphabetical list. Names of both Honorary and Life members are in bold face type. Names of Life members are further identified with an asterisk (*). The date shown is the year of record in our office when each member first joined the Society.

I thank Suzanne McElroy for her assistance in the preparation of this list. Any corrections to this list can be sent to the Corresponding Secretary at the A.E.S. address on the inside front cover of this issue. Corrections will be published in a future issue of *Entomological News.*

William J. Cromartie,
Corresponding Secretary

Surname	Name	Yr.	State or Country
Abbott	John C.	1991	TX
Ahlstrom	Kenneth R.	1996	NC
Ahn	Kee-Jeong	1996	KS
Aime	Cathie	1996	VA
Alexander	Kevin D.	1993	NE
Allen	Robert T.	1988	DE
Allred	Miriam L.	1987	MS
Amrine, Jr.	James W.	1983	WV
Anderson	Robert S.	1968	MD
Armitage	Brian J.	1980	OH
Baker	Charles W.	1980	ID
Ball	George E.	1963	Canada
Balogh	George J.	1987	MI
Barry	Donald W.	1986	ME
Bartlett	Charles R.	1992	DE
Bartow	Dennis H.	1970	PA
Baumann	Richard W.	1970	UT
Baumgardner	David E.	1992	MD
Beal, Jr.	Richard S.	1970	AZ
Beaman	Carol A.	1996	TX
Beckemeyer	Roy J.	1979	KS
Belish	Timberley A.	1997	WY
Bell	Ross T.	1985	VT
Berk	Mary	1989	NJ
Bilby	Peter J.	1993	NJ
Bilyj	Bohdan	1995	Canada
Bohart	Richard M.	1967	CA
Bolton	Michael J.	1987	OH
Boobar	Lewis Reginald	1996	ME
Bouseman	John K.	1984	IL
Bowles	David E.	1985	TX
Boyd	Howard P.	1939	NJ
Boys	Frank E.	1970	DE
Brigham, Jr.	John A.	1986	CA
Brown	John W.	1989	CA
Brown	Kirby W.	1973	CA
Brown	Harley P.	1970	OK
Brown	Wendy S.	1993	CO
Brown	Mark W.	1997	WV
Brown, Jr.	Keith S.	1970	Brazil
Brzoska	David W.	1987	KS
Burbutis	Paul P.	1970	FL
Burdick	Donald J.	1993	CA
Burger	John F.	1980	NH
Burian	Steven K.	1997	CT
Burrows	Weldon L.	1983	WV
Bushey	Sonja Marie	1994	NY

ENT. NEWS 109(3) 219-223, May & June, 1998

Surname	Name	Yr.	State or Country
Butler	Linda	1979	WV
Bystrak	Paul G.	1991	MD
Cancellare	Joseph A.	1977	TX
Canterbury	Lawrence E.	1975	OH
Canton	Steven P.	1978	CO
Carlton	Chris E.	1996	LA
Caron	Dewey M.	1983	DE
Carter	Janet L. Stein	1986	OH
Cauble	Ronald L.	1993	CA
Chandler	Donald S.	1985	NH
Chandler, Jr.	Jack H.	1996	GA
Chiba	Hideyuki	1988	Japan
Chordas III	Steve W.	1997	OH
Ciborowski	Jan J. H.	1978	Canada
Ciegler	Janet C.	1996	SC
Ciurlino	Randolph A.	1994	DE
Clausen	Philip J.	1983	MN
Coher	Edward I.	1994	NY
Conklin, Jr.	Don J.	1988	CO
Conn	D. Bruce	1991	GA
Contreras-Ramos	Atilano	1986	Mexico
Cook	Jerry L.	1995	TX
Cooper	Kenneth W.	1946	CA
Coovert	Gary A.	1997	OH
Courtney	Gregory W.	1991	IA
Covell, Jr.	Charles V.	1969	KY
Cromartie	William J.	1991	NJ
Currie	Charles E.	1992	CA
Cuthrell	David L.	1996	MI
Cutler	Bruce	1991	KS
Dakin, Jr.	Matt E.	1971	AL
Darlington	Mark B.	1994	NJ
Davis	Jack R.	1991	TX
Davis	Link M.	1995	PA
Day	William H.	1966	DE
De Souza Moutinho	Paulo Roberto	1995	Brazil
DeWalt	R. Edward	1991	IL
Deyrup	Mark A.	1978	FL
Dolan	Michael F.	1997	MA
Donelan	Laurence W.	1995	FL
Dougherty	Veronica M.	1984	MD
Dozier	Herbert L.	1958	SC
Drecktrah	H. Gene	1971	WI
DuBois	Mark B.	1988	IL
Duffield	Richard M.	1995	DC
Duncan	Paul M.	1963	PA
Dunkle	Sidney W.	1983	TX
Durfee	Richard	1994	CO
Earle	Jane	1993	PA
Edmunds	George F.	1948	UT
Edwards	Robert L.	1990	MA
Elliott	Douglas E.	1984	CA
Elmali	Meryem	1996	Turkey
Enns	Wilbur R.	1971	MO
Epler	John H.	1976	FL
Erikson	Jeff S.	1994	PA
Estes	William J.	1985	PA
Ettinger	William H.	1986	IL
Ettinger	William S.	1979	PA
Evans	**Howard E.**	**1973**	**CO**
Fall	Louise H.	1985	CA
Fava	Jane F.	1997	PA
Fee	Frank D.	1979	PA
Ferreira	Raul N.	1994	CT
Fisher	Stephen C.	1994	PA
Fisher	Elizabeth	1945	MD
Flemyng	E. Penryn	1986	CA
Flint, Jr.	Oliver S.	1982	DC
Floyd	Michael A.	1991	KY
Forbes	Gregory S.	1977	NM
Foye	Laurene	1994	SD
Franchine	Michael J.	1997	PA
Frank	Kenneth D.	1979	PA
Frank	Susan E.	1979	PA
Fredrickson	Richard W.	1983	PA
Froeschner	Richard C.	1970	DC
Fuester	Roger W.	1965	DE
Fullerton	Stuart M.	1990	FL
Funk	David H.	1987	PA
Gage	Ed	1986	TX
Galford	Jim	1980	OH
Ganeo de Mello	Francisco de Assis	1991	Brazil
Gayubo	Severiano F.	1993	Spain
Gelhaus	Jon K.	1987	PA
Giesecke	Martiin	1979	TX
Gomez-Arias	Luis M.	1992	FL
Goodrich	Michael A.	1989	IL
Gordon	Robert D.	1969	ND
Gottschalk	Steven C.	1996	IA
Graham	Alan C.	1993	VT
Grant	Peter M.	1984	OK
Graves	Robert C.	1967	OH
Greathouse	Zane B.	1997	FL

Surname	Name	Yr.	State or Country
Griffith	Michael B.	1992	PA
Grubbs	Scott A.	1991	PA
Gusten	Robert	1995	Germany
Haack	Robert A.	1996	MI
Halstead	Jeffrey A.	1985	CA
Hamilton	Robert W.	1989	IL
Hamilton	Steven W.	1987	TN
Hanley	Rodney S.	1992	KS
Hansen	Dean	1990	MN
Harrington	Don G.	1989	TX
Harris	Steven C.	1982	PA
Hastriter	Michael W.	1996	UT
Heck	Mary L.	1995	OH
Henry, Jr.	Brad C.	1984	TX
Heppner	John B.	1997	FL
Herbst	David B.	1996	CA
Herrmann	Scott J.	1985	CO
Heth	Robert K.	1996	OK
Hildebrandt	Drew A	1984	MS
Hill	Richard E.	1993	CA
Hill	Russell E.	1987	FL
* **Hilton**	**Donald F. J.**	**1986**	**Canada**
Hodges	R.W.	1960	DC
Hoebeke	E. Richard	1988	NY
Hoffman	Kevin M.	1987	CA
Holdeman	Steven J.	1996	TN
Holzbach	John E.	1975	OH
Horner	Norman	1987	TX
Houghton	David C.	1997	TX
Huckstep	E. Elgin	1990	CA
Hudson	Patrick	1985	MI
Ianni	Charles	1985	OH
Iftner	David C.	1993	NJ
Insley	Sandra Yawetz	1995	OH
Jackson	John K.	1990	PA
Jasper	Sharon Knight	1995	TX
Jennings	Daniel T.	1969	ME
Johnson	Zane B.	1997	TX
Katovich	Kerry	1994	WI
Kavanaugh	David H.	1995	CA
Kearns	Ruth S.	1994	DE
Kedanis	Richard J.	1997	PA
Keiper	Joe B.	1996	OH
Kelley	Richard I.	1988	PA
* **Kennedy**	**James H.**	**1980**	**TX**
Kidd	Kathleen A.	1992	NC
Kingsolver	John M.	1969	FL
Kirchner	Ralph F.	1976	WV
Kirchenstein	Barbara B.	1989	PA
Kistner	David H.	1985	CA
Klubertanz	Tom H.	1997	NE
Knight	Jeff B.	1963	NV
Knisley	C. Barry	1983	VA
Knizeski, Jr.	Henry M.	1985	NY
Koehn	Leroy C.	1996	MS
Kondratieff	Boris C.	1982	CO
Koski	Joseph T.	1962	MA
Krinsky	William L.	1987	CT
Kritsky	Gene	1978	OH
Krombein	**Karl V.**	**1972**	**DC**
Krotzer	Steve	1991	AL
Krysan	James L.	1981	KY
LaBerge	Wallace E.	1961	IL
Lacey	Mark S.	1994	DE
Lago	Paul K.	1981	MS
Lanteri	Analia A.	1991	Argentina
Lantsov	Vladimir I.	1996	Russia
Larsen	Eric	1995	PA
Larson	Omer R.	1982	ND
Lasalle	Mark W.	1979	MS
Ledin	Kathryn E.	1993	SC
Lee	Sharon D.	1995	PA
Leschen	Richard A. B.	1986	Australia
Lester	Gary T.	1993	ID
Levesque	Claire	1985	Canada
Levy	Stephen D.	1992	PA
Lewis	Robert E.	1956	IA
Lewis	Carolyn N.	1997	AR
Lillie	Richard A.	1997	WI
Lingafelter	Steven W.	1997	DC
Linsley	**E. Gorton**	**1962**	**CA**
Lipinski	Daniel R.	1989	NJ
Livingston	Margot	1987	NJ
Livingston	Carl F.	1993	NJ
Livingston	Rosemary A.	1993	NJ
Lowe	Graeme	1988	PA
Mac Neill	C. Don	1995	CA
Mackay	William	1996	TX
Mackenzie	Allen H.	1987	SC
Majerowicz	Eugene I.	1991	CA
Manley	Gary V.	1980	MI
Marquez Luna	Juan	1994	Mexico
Marshall	Brett D.	1997	PA

Surname	Name	Yr.	State or Country
Martinez	Humberto Quiroz	1989	Mexico
Marx	Rainer Peter	1996	Germany
Mason	Charles E.	1976	DE
Mathis	Wayne N.	1977	DC
Matsunaga	Wallace O.	1985	IL
Matta	James F.	1974	PA
May	Michael L.	1992	NJ
McCabe	Tim L.	1997	NY
McCafferty	W. Patrick	1987	IN
McCaleb	John E.	1996	AL
McCauley	Luana M. M.	1995	ID
McHugh	Joseph V.	1989	GA
Michener	**Charles D.**	**1963**	**KS**
Miller	Le D.	1967	FL
Miller	William B.	1993	TX
Miller	Jacqueline Y.	1989	FL
Molnar	Steven A.	1997	NJ
Morrison	Michael W.	1993	ME
Morse	John C.	1980	SC
Moulton II	Stephen R.	1987	CO
Muchmore	William B.	1989	NY
Muniz Velez	M.enC. Raul	1992	Mexico
Munro	James B.	1995	PA
Murphy	Clint	1991	MO
Murvosh	Chad M.	1991	NE
Myles	Timothy G.	1986	Canada
Naczi	Robert F.C.	1983	KY
Namkaidorj	B.	1996	Mongolia
Navarrete-Heredia	Jose Luis	1992	Mexico
Neff	Stuart E.	1988	PA
Nelson	Charles H.	1969	TN
Nelson	S. Mark	1991	CO
Nelson	C. Riley	1984	TX
Nelson	Harry G.	1982	IL
Nielson	M. W.	1992	UT
Novinger	James S.	1991	CO
O'Brien	Charles W.	1993	FL
O'Donnell	Sean	1992	WA
O'Keefe	Sean T.	1991	CA
Ocus	Warren G.	1992	MD
Omer	John R.	1990	WV
Otte	Daniel	1976	PA
Parrott	Rod	1977	Canada
Payne	Randall G.	1993	FL
Pennington	Wendell L.	1985	TN
Penteado-Dias	Angelica Maria	1994	Brazil
Perez Dominguez	Juan Francisco	1988	Mexico
Peters	William L.	1998	FL
Pfadt	Robert E.	1988	WY
Philtower	Ramona	1993	DE
Philips	James R.	1982	MA
Pinter	Lawrence J.	1980	HI
Platt	Austin P.	1988	MD
Plotnikoff	Robert W.	1995	WA
Plummer	John A.	1990	DE
Polhemus	John T.	1996	CO
Porter	Charles H.	1968	GA
Preston	Floyd W.	1980	KS
Price	Michele B.	1997	IL
Purrington	Foster F.	1997	OH
Ranger	Christopher M.	1997	NJ
Rayburn	Brian S.	1997	OH
Rebollar-Tellez	Eduardo A.	1993	United Kingdom
Rentz	David C.F.	1965	Australia
Rhodes	Howard A.	1996	CO
Richards	Austin Brady	1996	CO
Rider	David A.	1987	ND
Riley	Edward G.	1986	TX
Ringgier	Theodore G.	1992	MD
Risley	Lance S.	1989	NJ
Ritter	Karla S.	1979	WI
Robbins	Richard G.	1988	MD
Roberts	Richard H.	1971	FL
Robinson	Jeffrey M.	1995	KY
Robison	Henry W.	1990	AR
Romig	Ronald F.	1979	PA
Roth	Louis M.	1957	MA
Rothschild	Mark J.	1987	MD
Ruesink	William G.	1988	IL
Ruffin	Jane M.	1988	PA
Ruiter	David	1976	CO
Russell	Dana C.	1992	CA
Rust	Richard W.	1974	NV
Sabourin	Michael	1993	WI
Salmon	**J.T.**	**1960**	**New Zealand**
Sandridge	Paul T.	1991	DE

Surname	Name	Yr.	State or Country
Santiago de Bueno	Silvia	1994	Mexico
Sarver	Randy J.	1996	MO
Saunders	Robert D.	1990	Canada
Scarbrough	Aubrey G.	1987	MD
Schaefer	Paul W.	1985	MD
Schesser, Jr.	James F.	1978	KS
Schiefer	Terence L.	1984	MS
Schmidt	Justin O.	1987	AZ
Schmude	Kurt L.	1992	WI
Schroder	Robert F. W.	1993	MD
Schweitzer	Dale	1989	NJ
Seaborg	Norman G.	1963	IL
Seltmann	Katja Chantre	1996	GA
Shapiro	Arthur M.	1967	CA
Sheldon	Joseph K.	1973	PA
Shepard	William D.	1979	CA
Short	Andrew E.	1996	DE
Shubeck	Paul P.	1971	NJ
Sibley	Paul K.	1989	MN
Sikes	Derek S.	1996	CT
Sissom	William David	1995	TX
Skelley	Paul E.	1991	FL
Slayback	Scot E.	1997	MD
Sleeper	Elbert L.	1971	CA
Smith	David R.	1966	D.C.
Smith	Stephen M.	1993	Canada
Sneen	Martin E.	1993	IL
Snider	Richard J.	1985	MI
Sobat	Thomas	1996	IN
Spangler	Hayward G.	1990	AZ
Spokony	Harvey	1997	NY
Spooner	John D.	1986	SC
Springer	Charles A.	1992	NE
Staines	Charles L.	1986	MD
Stallings	Viola N.	1988	KS
Stein	Raymond J.	1988	NJ
Stewart	Kenneth W.	1994	TX
Stidham	John A.	1982	TX
Strassmann	Joan E.	1983	TX
Strazanac	John S.	1984	WV
Sublette	James E.	1990	AZ
Summerville	Keith S.	1996	MI
Surman	Michael A.	1976	LA
Tarter	Donald C.	1972	WV
Taylor	Steven J.	1988	IL

Surname	Name	Yr.	State or Country
Tennessen	Kenneth J.	1996	AL
Thompson	F.C.	1969	VA
Tinerella	Paul P.	1996	ND
Torres	Felix	1993	Spain
Torres-Miller	Laura	1997	WV
Trond	Andersen	1997	Norway
Turnbow, Jr.	Robert H.	1983	AL
Turner	Alan R.	1994	N.C.
Valenti	Michael A.	1985	DE
Ventre	Vincent	1985	PA
Vogtsberger	Roy C.	1989	TX
Wagner	Michael R.	1980	AZ
Wahl	David B.	1984	FL
Walls	Jerry G.	1984	NJ
Waltz	Robert D.	1983	IN
Webb	David K.	1996	MI
Weber	**Neal A.**	**1961**	**FL**
Weber	Richard G.	1986	DE
* **Weisse**	**Theodore H.**	**1987**	NY
Weissmann	Michael J.	1988	CO
Wesson	Laurence G.	1995	PA
Wheatley	John B.	1995	PA
Wheeler	Jeanette N.	1970	FL
White	Harold B.	1975	DE
White	David S.	1976	KY
White	Timothy M.	1996	SC
Whitehead	V.B.	1976	S. Africa
Whitfield	James B.	1993	AR
Whitney	Susan P.	1990	DE
Wiersema	Nick	1997	TX
Wiker	James R.	1990	IL
Willemse	Fer	1968	Netherlands
Williams	David W.	1988	PA
Williams	Roger N.	1991	OH
Williams	J. Logan	1995	NC
Willink	Abraham	1963	Argentina
Wilson	Stephen W.	1992	MO
Wimmer	H. Peter	1979	VT
Wojtowicz	John A.	1983	TN
Wolinski	Jeffrey A.	1988	MD
Wright	David M.	1995	PA
Young	Daniel K.	1980	WI
Young	Orrey P.	1980	MD
Young	Wayne L.	1986	PA
Zeigler	David D.	1990	NC
Zoidis	John	1996	Greece
Zuccaro, Jr.	Anthony E.	1981	MS

SOCIETY MEETING OF NOVEMBER 19, 1997

Dr. Jim Marden
Dept. of Biology
Penn State University

Dr. Marden began by pointing out the evolution of flight is a classic challenge for Darwinian natural selection, for it is difficult to envision how gradual, incremental selection can result in complex traits that function only in their fully developed form. The fossil record offers little help in determining the origin of insect wings and flight, for at the time winged insects first appear in fossils (325mya), they had already radiated and diversified into stem groups of all of the major lineages present today. Thus, we are left to decipher the evolutionary history of insect flight from our judgment of which traits of fossils and extant insects most closely represent the ancestral condition. The emergent view from this body of research is that insect wings arose from moveable, articulated gills of aquatic ancestors, and that the orders Ephemeroptera (mayflies) and Plecoptera (stoneflies) have the most primitive morphology among extant winged insects.

Dr. Marden's laboratory has recently proposed that surface-skimming, a form of nonflying aerodynamic locomotion used by certain modern stoneflies, is a feasible intermediate stage between swimming and flying, and might be a remnant of the ancestral condition for all winged insects. This hypothesis has been lauded as the most reasonable model for a transitional process offered to date, but it has also been criticized for failing to consider the phylogenetic position of skimming stoneflies. In his presentation, he gave an overview of work examining i) functional aspects of various forms of surface skimming, ii) preliminary results of a molecular phylogeny of stoneflies using 18S rDNA sequence data, and iii) the phylogenetic distribution of skimming behavior across the Plecoptera. These results suggest that surface skimming is a primitive trait among stoneflies, and thus a likely candidate for a transitional stage in the evolution of insect flight. The talk was illustrated with many striking slides and a video of surface-skimming flight.

In insect-related news, Jon Gelhaus circulated a specimen of *Dermatobia hominis* larva (Diptera) recently excised from a member of the ANS staff forty-five days after a trip to Guyana. The adult of this parasite catches a mosquito, to which it attaches its offspring, and the mosquito passes it on to a human.

Mention was also made of impending trials of two Lyme disease vaccines by Philadelphia area pharmaceutical firms.

– W. J. Cromartie
Corresponding Secretary

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

Titles should be carefully composed to reflect the true contents of the article, and be kept as brief as possible. Classification as to order and family should be included in the title, except where not pertinent. Following the title there should be a short informative abstract (not a descriptive abstract) of not over 150 words. The abstract is the key to how an article is cited in abstracting journals and should be carefully written. It should be an informative digest of the significant contents and of the main conclusions of the research. The author's complete mailing address, including zip code number, should be given as a footnote to the article. All papers describing new taxa should include enough information to make them useful to the nonspecialist. Generally this requires a key and a short review or discussion of the group, plus references to existing revisions or monographs. Authors must include the name(s) of recognized institution(s) where their voucher specimens have been deposited. Illustrations nearly always are needed. All measurements shall be given using the metric system or, if in the standard system, comparable equivalent metric values shall be included. Authors can be very helpful by indicating, in pencil in the margin of the manuscript, approximate desired locations within the text of accompanying figures, tables and other illustrations.

Illustrations: For maximum size and definition, full page figures, including legends, should be submitted as nearly as possible in a proportion of 4/6. Maximum size of printed illustration, including all legends, is $4^{1}/_{2}$ x $6^{1}/_{2}$ inches. Authors will be charged for all text figures and half-tones at the rate of $20.00 each, regardless of size.

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US ISSN 0013-872X
VOL. 109 SEPTEMBER & OCTOBER, 1998 NO. 4

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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A NEW MEXICAN SPECIES OF *GASTRISUS* (COLEOPTERA: STAPHYLINIDAE)[1]

Jose Luis Navarrete-Heredia[2], Juan Marquez[3]

ABSTRACT: *Gastrisus newtonorum,* new species, is described based on specimens from the states of Mexico, Guerrero, Jalisco and Morelos. One specimen was examined by Bernhauer, however it was misidentified as *G. mimetes* Sharp. The Mexican record of *G. mimetes* in Bernhauer and Schubert's and Blackwelder's catalogs was probably based on this misidentification. The two species are compared, and the aedeagi are illustrated. Distributional and biological data are provided.

Gastrisus Sharp, 1876 is an American genus,with most species in South America. At present, 19 species are recognized: Blackwelder (1944) cited 12 species; Scheerpeltz (1972) moved six species from *Trigonopselaphus* to this genus; and one more is described here.

Gastrisus mimetes Sharp was described based on a single specimen from Costa Rica (Sharp, 1884: 360). Years later, Bernhauer and Schubert (1914) and Blackwelder (1944) recorded this species from Mexico. However, we do not know if the Mexican record was ever published elsewhere. Bernhauer (1912: 39) in his description of *G. venezolanus* mentioned that he had identified the holotype earlier as *G. mimetes*, and that he was comparing it to specimens of *G. mimetes* from Colombia and Peru (country records not included in the catalogs cited above).

One specimen from Guerrero (at FMNH), identified by Bernhauer as *G. mimetes* belongs to an undescribed species. This situation was first recognized by A.F. Newton, Jr. who compared one specimen from Guerrero with the holotype of *G. mimetes* at BMNH (see material examined). Later, he received specimens from G. Ruíz-Lizárraga and L. E. Rivera collected in Guerrero and Jalisco respectively, that he identified as *Gastrisus* n. sp.

Ruiz-Lizarraga (1993), in her excellent contribution on carrion staphylinids, provided descriptions of the species that she collected, and included one for *Gastrisus* n. sp. From that date until now this species has awaited formal description. Upon request, Dr. Newton kindly sent us specimens of the undescribed species from FMNH and four *G. mimetes* from Costa Rica to support this work. Also, Miss G. Ruíz-Lizárraga allowed us to describe this species. The goal of this paper is to describe and provide biological data on this new species.

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ENT. NEWS 109(4) 225-232, September & October, 1998

MATERIALS AND METHODS

Specimens for this study were borrowed from: Field Museum of Natural History, Chicago (FMNH); Colección Entomológica, Escuela Nacional de Estudios Profesionales, Iztacala (ENEPI); and Colección Entomológica, Universidad de Costa Rica (UCR); others were collected by the authors during their research. Acronyms for collections where type material will be deposited are: American Museum of Natural History, New York (AMNH); British Museum, London (BMNH); Canadian National Collection, Ottawa (CNC); Entomología, Centro de Estudios en Zoología, Universidad de Guadalajara, Zapopan (CZUG); Instituto de Biología, UNAM, D.F. (IBUNAM); Snow Entomological Museum, Lawrence, Kansas (SEM); Laboratorio Especializado de Morfofisiología Animal, Fac. de Ciencias, UNAM, D.F. (LEMA); Juan Márquez Luna Collection, D.F. (JML); Jose Luis Navarrete Collection, Zapopan (JLN); and Museo de Historia Natural Ciudad de Mexico, D.F. (MHNCM).

Throughout this paper we refer to abdominal segments by their morphologically comparable names and use roman numerals for these. The first fully visible segment is segment III. Tergum II is usually narrowly visible. Total length was measured from the anterior margin of the head to the apex of abdominal segment IX.

Gastrisus newtonorum Navarrete and Márquez, NEW SPECIES

Figs. 1, 2, 4, 5, 8.

HOLOTYPE MALE: Length 15.6 mm. Black, except abdominal segments VII-IX, last segment of maxillary and labial palpi, and tarsi rufotestaceous. Surface covered with microsculpture consisting of isodiametric meshes, mixed with scattered micropunctures; tempora with irregular waves; neck and abdominal segments with dual microsculpture: isodiametrical meshes at base and irregular waves on apical portion (more distinct on segments VII-VIII).

Head subquadrate; setiferous punctures denser at posterior angles and along medial borders of eyes, dorsal surface without setiferous punctures (Fig. 2). With subocular ridge. First antennal segment slightly shorter than next two segments combined, second segment shorter than third segment; fifth to eleventh transverse, large setae decreasing in number but short setae more conspicuous. Second and third segments of maxillary palpi broader at apex, last segment elongate, subcylindrical, as long as second segment. Last segment of labial palpi as broad as penultimate segment and as long as last segment of maxillary palpi. Mandibles subequal in length to head along midline. Right mandible with a tooth opposite an emargination of left mandible. Gular sutures confluent at middle. Neck with oblique longitudinal line dorsolaterally on each side.

Pronotum slightly larger than head; narrowed toward base; anterior angles rectangular, basal angles obtuse; setiferous punctures scattered, denser at sides, dorsal punctures 3:3, asymmetrical; postcoxal process of the hypomeron translucent. Elytra opaque, with numerous setiferous punctures, with two humeral macrosetae and one near scutellum. Two macrosetae on anterior middle of prosternum. Tibiae with spines, denser on mesotibiae. First four segments of anterior tarsi dilated, as broad as anterior tibiae, with modified pale setae ventrally; last segment as long as previous three segments combined. Middle and hind tarsi similar: first segment as long as following three segments combined, last segment as long as previous two segments combined.

Abdominal segments as shining as head and pronotum; tergites III-IV with impressed line

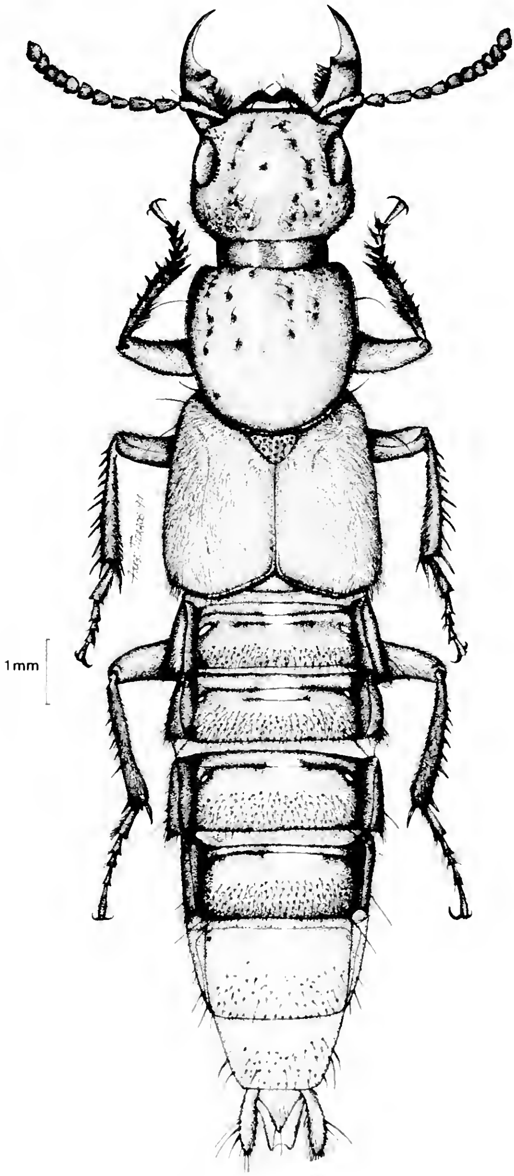
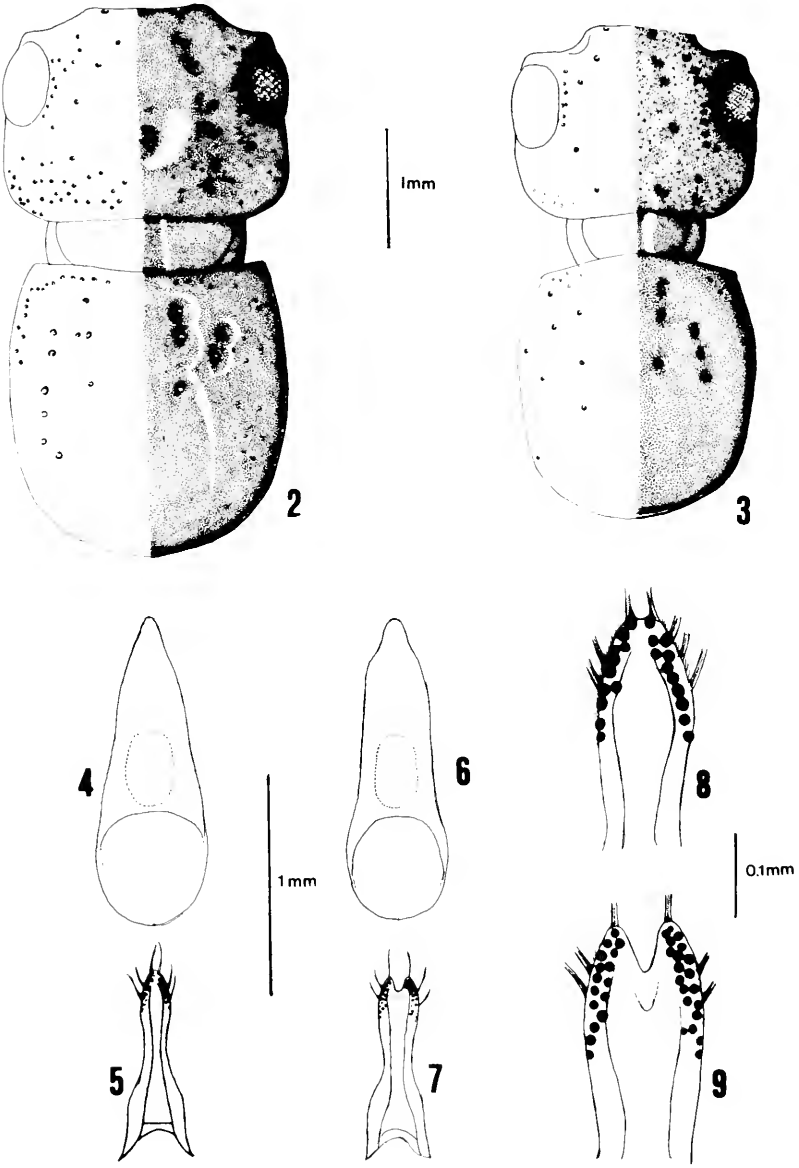


Figure 1. Dorsal view of *Gastrisus newtonorum* Navarrete and Márquez, new species.



Figures 2-9. Morphology of *Gastrisus* spp. *G. newtonorum:* 2. Head and pronotum, 4. Aedeagus (parameres removed), 5. Paramere, 8. Distribution of peg setae on paramere. *G. mimetes*. 3. Head and pronotum, 6. Aedeagus (paramere removed), 7. Paramere, 9. Distribution of peg setae on paramere.

on basal portion. One black macroseta on each side of posterior border of terga III-VI. Sternite VII slightly emarginate at middle; VIII with conspicuous triangular emargination; sternites VII-VIII with three black macrosetae on each side. Sternite IX emarginate, with two black macrosetae. Aedoeagus as in Figs. 4-5, 8. Paramere with apex almost reaching apex of medial lobe.

ALLOTYPE FEMALE: Length 14.1 mm. Similar to holotype, except for: head narrower; first four segments of anterior tarsi slightly less dilated; dorsal setiferous punctures on pronotum 4:4, asymmetrical; abdominal sternites VII-VIII not emarginate, sternite IX with two rufous macrosetae on apex, in addition to two black ones.

Variation: Length 11.9-15.6 mm. Specimens from Guerrero are mostly paler, primarily on prothorax where borders are reddish brown, and with abdominal segments VII-VIII yellow. Also, one specimen examined by Ruíz-Lizárraga (1993) and five examined by us have abdominal segments VII-VIII dark reddish brown. Aedeagi of these specimens are black, their dark color pattern is likely caused by the mixture of liquids used as killing agents. A few specimens have the pronotum and elytra apparently green in dorsal view. One specimen from Morelos has the last segment of the right maxillary palpus black. Dorsal punctures on the pronotum are highly variable: 2:3, 3:3, 3:4, 3:5, 4:2, 4:3, 4:4, 4:5; in some specimens, the last puncture is on the posterior half of the pronotum. The peg setae on the paramere are slightly variable in number.

MATERIAL EXAMINED: **Holotype:** MEXICO: MORELOS, Yautepec, Carretera México-Cuautla, km. 19. Selva baja caducifolia. **ex** excremento. 16-Jun-1996. J. Márquez col. **Allotype:** Tlayacapan, camino a Sta. Catarina. Selva baja caducifolia. Zona 4, 1534 msnm. 1 al 30-VI-1996. **ex** NTP-80 (calamar). J. Márquez col.

Paratypes: MEXICO: MORELOS, Tlayacapan. 31-X-1992. **ex** excremento vacuno. J. Márquez col. (**1♂**). Same data except for: 27-VIII-1995. I. Sánchez y J. Márquez cols. (**2♂**). Same data except for: zona 5, cultivo de temporal y selva baja caducifolia. 1 al 30-VII-1995, **ex** NTP-80. J. Márquez col. (**2♂, 1♀**). Same data except for: 1 al 30-IX-1996 (**1♀**). Same data except for: 1 al 30-VI-1996 (**8♂**). Tlayacapan, camino a Sta. Catarina, zona 4, selva baja caducifolia. 1-VI-1996, **ex** excremento vacuno (**1♀, 1♂**). Same data except for: 9-VI-1996 (**2♀, 4♂**). Same data except for: **ex** frutos podridos (**2♂**). Same data except for: 10-VI-1996, **ex** excremento vacuno (**1♂**). Same data except for: 1 al 30-VII-1995, **ex** NTP-80 (**1♂**). Same data except for: 1 al 30-VIII-1995 (**1♂, 2♀**). Same data except for: 1 al 30-IX-1995 (**2♀**). Same data except for: 1 al 30-VI-1996 (**2♂, 2♀**). Tlayacapan, San José de los Laureles. Bosque mesófilo de montaña perturbado, zona 3. 1 al 30-X-1996, **ex** NTP-80. K. Villavicencio y J. Márquez cols. (**1♀**). Same data except for: 1 al 30-XI-1995 (**1♂**). Cuernavaca, Col. del bosque. Bosque de Pino-Encino. 23-VII-1995, **ex** excremento vacuno, J. Márquez col (**1♂**). Yautepec. Carretera México-Cuautla, km. 19. Selva baja caducifolia. 16-VI-1996, **ex** excremento. J. Márquez col. (**1♂, 1♀**). Tlayacapan, San José de los Laureles, BMM, 1751 m, 21.VII-24.VIII.1991, J.L. Navarrete y G.A. Quiroz, # 941D, NTP-80, (**1♂, 1♀**); same data except for: 29.VI.1991, J.L. Navarrete, #677, ex *Boletus edulis* IV (**1♂**). GUERRERO, 2900 ft. 6 mi El Ocotito. VIII.30-IX.5-1971/ human dung trap 380. A. Newton/ yellow card. *Gastrisus* cf *mimetes* Sharp, comp. Holotype A. Newton, 1989/ *Gastrisus* n. sp. det. Newton 1992 (**1♂**). Same data: (**1♀**). 9 mi NE Iguala. 1340 m. VIII.29-IX.4-1971 A. Newton coll., human dung trap 378. (**3♂, 1♀**). 3100 ft. 7.5 mi N El Ocotito. VIII.30-IX.5-1971, human dung trap 381. A. Newton (**4♂, 4♀**). 9 mi NE Iguala. 4500 ft. VIII.29-IX.4-1971, human dung trap 379. A. Newton (**1♂**). 3200 ft. 10 mi N El Ocotito. VIII.30-IX.5-1971, human dung trap 382. A. Newton (**1♂**). 1464 m. 4 mi W Mazatlan. VIII.30-IX.5-1971. A. Newton coll., human dung trap 383 (**2♀**). 2014 m. 7 mi W Mazatlan. VIII.30-IX.5-1971. A. Newton coll., human dung trap 384 (**1♀**). Chilpancingo, Guerrero, 4600 ft. June. H.H. Smith/ *Gastrisus mimetes* Sharp/ det. Bernhauer. Godman-Salvin col. 1911. 345/ Sharp colln. By Exchange with Brit. Mus. (N. H.)/ F.M.N.H. [green card]/ *Gastrisus* cf. *mimetes* det. A. F. Newton 1989. (**1**). Mochitlan, Acahuizotla, 650 m, tropical subevergreen forest. June-July, 1986. L. Delgado collr. Carrion trap NTP-80, 2 (**2♂**). Sierra del Alquitrán, BEP, 1670m, 20.VII.1990, *ex* NTP-80, J. Blackaller y L. Delgado cols. (**3♂**); same data except for: Encinar tropical, 21.VII.1990, (**4♂**). JALISCO, Sierra de Manantlán, El Tigre, 18-VII-1988. Selva media, nocturna, 3:pescado; L. Rivera./ Exchange ex University of Guadalajara, Mex. FIELD MUSEUM/ *Gastrisus* n. sp. det. Newton, 1996 (1♂). Sierra de Manantlán, Mpio. Casimiro Castillo, El Tigre, 700 m, 18-VII-1988. Bosque trop. subcad., L. Rivera leg./ Exchange ex University of Guadalajara, Mex. Field Museum (1♂). Same data except for: G. Andrade col. (1♂). ESTADO DE MEXICO, Nanchititla, 6/Octubre/1995 1540 msnm. Est. 2. Selva Baja Caducifolia. NTP-80-3. A. Morales col. (1♂, 5♀). Same data except for: 1/Agosto/1995. 1110 msnm. Est. 1. Selva Baja Caducifolia. NTP-80-3. A. Morales col. (1♀). Same data except for: 1/Julio/1995. 1540 msnm. Est. 2. Selva Baja Caducifolia. NTP-80-2. A. Morales col. (3♂, 2♀). Same data except for: 26/Agosto/1995. 1110 msnm. Est. 1. Selva Baja Caducifolia. NTP-80-2. A. Morales col. (1♀). Same data except for: 1540 msnm. Est. 2. Selva Baja Caducifolia. NTP-80-1. A. Morales col. (2♂, 2♀). Same data except for: 1/Julio/1995. 1540 msnm. Est. 2. Selva Baja Caducifolia. NTP-80-1. A. Morales col. (2♂, 1♀). Same data except for: 4/Junio/1995. 1110 msnm. Est. 1. Selva Baja Caducifolia. NTP-80-1. A. Morales col. (1♀). Same data except for: 27/Octubre/1995. 1110 msnm. Est. 1. Selva Baja Caducifolia. NTP-80-1. A. Morales col. (1♀). Same data except for: 21/10/95. Est. 2. Selva Baja Caducifolia. NTP-80-2. A. Morales col. (1♂). Same data except for: 27/Oct/95. Est. 2. Selva Baja Caducifolia. NTP-80-2. A. Morales col. (2♀). Holotype, Allotype and some paratypes will be deposited at CZUG, other paratypes will be deposited at FMNH, ENEPI, LEMA, JML, JLN, MHNCM, BMNH, CNC, AMNH, IBUNAM and SEM.

Etymology. We are pleased to dedicate this species to our friends and academic supervisors A. F. Newton, Jr., and M.K. Thayer, for their kind help and support in the study of Mexican staphylinids.

Gastrisus newtonorum is similar to *G. mimetes* in color pattern, which is probably the reason why Bernhauer misidentified the Mexican specimens as *G. mimetes*. However, *Gastrisus newtonorum* is easily recognized because it has more setiferous punctures on the head and thorax (Fig. 2-3); males with abdominal sternite VII slightly emarginate, sternite VIII emarginate, and primarily by difference in the aedeagus: the paramere is slightly bifurcate at the tip in *G. mimetes*, entire in *Gastrisus newtonorum* (Figs. 4-7, 9). Females are distinguished by the punctation on the head and thorax.

Our description has some important differences from that provided by Ruíz-Lizárraga (1993): head and thorax black-copper; last two abdominal segments red; elytra with conspicuous impressions; second segment of maxillary palp broader and larger than remaining segments; dorsal pronotal punctures 3:3, sublateral punctures 4:4; aedeagus different from *Gastrisus mimetes*. Specimens we examined don't have that color pattern on the head, thorax and abdomen, and have the last two abdominal segments yellow or rufotestaceous. Also, dorsal pronotal punctation is inconstant as already mentioned (see Variation).

Specimens of *Gastrisus newtonorum* have been found on several kinds of decomposing organic matter, such as: carrion, fruits, mushrooms [misidentified as *Xenopygus analis* (Er.) by Navarrete-Heredia, 1996], and human and cow dung. As predators they seek prey there, probably maggots and larvae of other beetles. This behavior is similar to that shown by species of *Platydracus, Belonuchus, Philonthus, Styngetus* and other genera common in these habitats.

Most of the specimens were collected in tropical deciduous and sub-evergreen forest during the rainy season (June-November). At present, the highest abundance is recorded from Acahuizotla, Guerrero (Ruíz-Lizárraga, 1993). She examined 173 specimens, 86 males and 87 females, from carrion traps. In this locality this was the second most abundant staphylinid species, after *Belonuchus* aff. *xanthomelas* Solsky. Specimens were collected between June and October. Highest abundance was in July (Fig. 10).

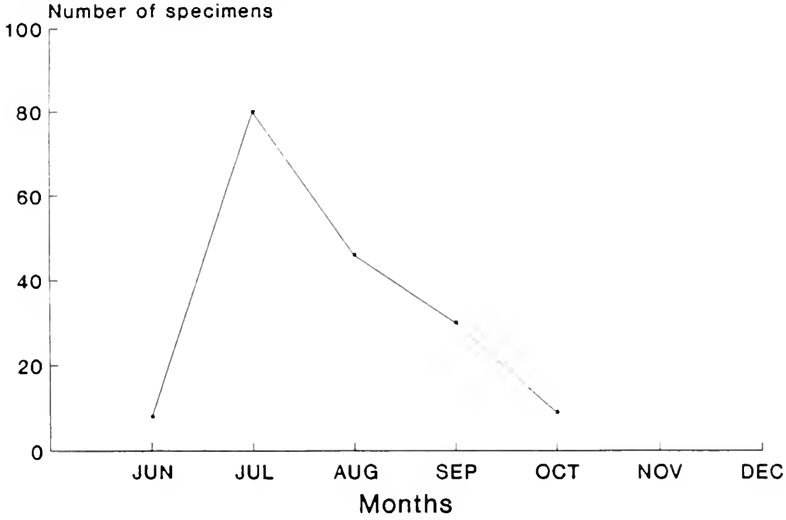


Figure 10. Phenology of *Gastrisus newtonorum* at Acahizotla, Guerrero.

On the other hand, during a systematic survey of necrophilous staphylinids (in prep. by Márquez) five localities were selected and designated (1. pine-*Quercus* forest, 1,874 m; 2. pine forest, 1,930 m; 3. disturbed cloud forest, 1,783 m; 4. tropical deciduous forest, 1,534; 5. corn field-tropical deciduous forest, 1,634 m). Carrion traps were used for this research and were examined each month. As in Acahuizotla, higher abundance was detected in tropical forest with 23 specimens, whereas in locality 3 only two specimens were collected. No specimens were found at higher elevations in coniferous-*Quercus* forest.

We suspect that, as in Acahuizotla, *Gastrisus newtonorum* is an important predator in tropical forests and probably competes with other predatory staphylinid species of genera such as *Platydracus*, *Belonuchus*, *Philonthus*, *Paederomimus* and others whose phenology is similar.

It is clear that *Gastrisus newtonorum* is primarily distributed in tropical forests, so its abundance is probably higher south to Guerrero and widespread west to Jalisco and east to Oaxaca where tropical forests are common. More field data on this species and other staphylinids are necessary to get a better understanding of the distributional pattern. The highest altitudinal record is 2030 m; the lowest is 700 m.

In Mexico and Central America, *Gastrisus* species are recorded from Costa Rica (*G. mimetes* Sharp; Blackwelder 1944), Panama (*G. opaculus* Sharp; Blackwelder 1944). It is interesting to note that at present we lack records of any *Gastrisus* species between Mexico and Costa Rica, an unusual pattern for a Xanthopygina species. Is this widely allopatric distribution for *G. mimetes* and *G. newtonorum*, without records for Guatemala, Belize, Honduras, El Salvador and Nicaragua, real? Possibly, but this may be the result of a lack of intensive field work on staphylinids in this area.

Finally, records of *Gastrisus mimetes* from Colombia and Peru require reexamination of the specimens to verify the identifications, or recognize possible misidentifications or new sibling species as was the case for *G. venezolanus*.

Examined specimens of *G. mimetes* from Costa Rica are labeled as: COSTA RICA: Osa Peninsula, Agua Buena, 1 km NW Boscosa centro,25.VII.1990, Banana plantation, pig dung, leg. K.Vulinec (1♂, 2♀) (FMNH); same data, plus *Gastrisus mimetes* Shp. det Newton 1996 (FMNH); Puntarenas, R.F. Golfo Dulce, 3 km SW Rincon, 10m, V-VI.1992, P. Hanson, *ex* malaise, *Gastrisus* sp. det. J.S. Ashe, 1996 (1♂) (UCR).

ACKNOWLEDGMENTS

The authors thank A.F. Newton, Jr. and G. Ruíz-Lizárraga for permission to describe this species. Special thanks are due to A.F. Newton, Jr. and M.K. Thayer for comments and information that improved the manuscript when the new species lacked name, and to H.E. Fierros-López for the drawings. This paper is a contribution to the project "Estudios básicos de la fauna silvestre del estado de Jalisco: diversidad, distribución y habitat" supported by the Universidad de Guadalajara.

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VOLTINISM IN *NEOGERRIS HESIONE* (HETEROPTERA: GERRIDAE) IN SOUTHERN ILLINOIS[1]

Steven J. Taylor[2], J. E. McPherson[3]

ABSTRACT: Voltinism in *Neogerris hesione* was studied in southern Illinois during 1989 and 1990. This species apparently overwintered as eggs, which hatched during late April and early May. First and second instars were found from late April through late September, third instars from early May through late September, fourth instars from mid-May through late September, fifth instars from mid-May through the third week of September, and adults from late May through early November. The sequences of peaks for instars and adults strongly indicates that this species is trivoltine in southern Illinois.

The waterstrider *Neogerris hesione* (Kirkaldy) occurs from New York, Michigan, and Nebraska south to Florida and Texas; it also occurs in Cuba, Panama (Smith 1988), and Central America (Nieser 1994). Smith (1988) reported it from Alaska, but, judging from Andersen's (1982) world distribution map of the genus (p. 366), this location probably is invalid. It is found throughout the southern two thirds of Illinois (Taylor 1996) and, because it has been collected in central and south central Wisconsin (Hilsenhoff 1986), probably occurs in northern Illinois.

Little has been reported on this insect's life history. It occurs in a variety of habitats but seems to prefer ponds, lakes, and pools of streams (Taylor 1996). It has been collected in September in Wisconsin (Hilsenhoff 1986) and in October in Missouri (Froeschner 1962). Herring (1950), in northern Florida, collected adults from April through December, excluding June, and nymphs in April and from September through November. Kittle (1980), in Arkansas, collected adults from May to November; and Wilson (1958), in Mississippi, collected nymphs as early as 1 April and as late as 15 November. Kittle (1977) reported that of 60 mating pairs collected in northwest Arkansas, 1 pair (2%) was taken in August, and 18 (30%) and 41 pairs (68%) were taken in September and October, respectively. Wilson (1958) observed mating as late as 15 November. Osborn and Drake (1915) believed this species overwinters as eggs.

Drake and Harris (1934) stated that macropterous adults were rare in the North and common in the South. This is supported by Hilsenhoff (1986), who reported apterous adults as common in Wisconsin (macropterous adults pre-

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[1] Received November 17, 1997. Accepted January 12, 1998.

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ENT. NEWS 109(4) 233-239, September & October, 1998

sumably being rare); and by Herring (1950), who reported macropterous adults as common in northern Florida. Kittle, however, stated that of 136 adults from northwest Arkansas (1977) and 182 adults from Arkansas (1980), 92 and 90%, respectively, were apterous, the remainder macropterous. Similarly, Wilson (1958) found that in Mississippi, about 95% of the adults were apterous, the remainder macropterous.

During 1989 and 1990, we studied voltinism in a population of this species at President's Pond on the Southern Illinois University at Carbondale campus, Jackson County, Illinois (see Taylor [1996] for detailed description of pond). The roughly triangular 0.29 hectare (0.71 acre) pond is connected at its northern end to an adjacent lake by a narrow channel (approximately 2-5 m wide, 2 m deep). Water depth along the eastern margin (where the present study was conducted) increased sharply between 1 and 2 m from shore and commonly exceeded 2 m at 2.5 m from shore.

Floating, emergent, and shoreline vegetation associated with the pond was diverse (Taylor 1996). The western margin was bordered by a narrow, dense band of cattails (*Typha angustifolia* L.). The southern border consisted of a riprap dam covered with soil and crossed by a paved road. The eastern margin was bordered by overhanging trees and other vegetation. During the summer, the pond filled with a dense growth of aquatic vascular plants and filamentous algae. Near the shoreline and wherever aquatic plants reached the water surface, duckweeds built up into dense mats. The duckweeds (i.e., *Lemna minor* L., *Spirodela polyrhiza* (L.) Scheiden, and *Wolffia papulifera* Thompson) tended to move around the pond because of air currents unless they were partially anchored in the underlying aquatic vegetation.

This paper presents information on voltinism in *N. hesione*, including times of occurrence of the adults and nymphal instars.

MATERIALS AND METHODS

Samples were collected weekly from 18 March to 25 November 1989, and biweekly from 11 February to 2 December 1990. Sampling was limited to an area along the eastern shore because (1) the cattails along the western shoreline prevented use of the quadrat sampler (see below); (2) the riprap shoreline of the southern border was unnatural and, often, disturbed by fishermen; and (3) the water surface along the eastern shore, which was a mosaic of open water, duckweeds, and emergent stems, supported a diverse gerromorphan fauna.

Four 60 m transects were made parallel to a relatively uniform section of the eastern margin at 0, 0.5, 1.0, and 1.5 m from the shoreline. Each sample was collected with a floating quadrat sampler (0.25 x 0.25 x 0.05 m), with four replicates placed randomly along each transect; the resulting 16 quadrat samples were pooled, providing a broad sampling of the habitat. Prior to each sample, the collector (SJT) stood for approximately three minutes to allow the insects to acclimate to the disturbance; then, the sampler was placed on the surface of the water. Specimens were removed with a fine mesh nylon net, preserved in alcohol, and sorted in the laboratory. Nymphal instars were distinguished by size of the dorsal sclerites on the thorax and abdomen, the overall degree of sclerotization, and, to a lesser extent, body size. Fifth instars and adults were distinguished from younger instars and from each other by the extent of development of the external genitalia and by presence of wings in macropterous adults.

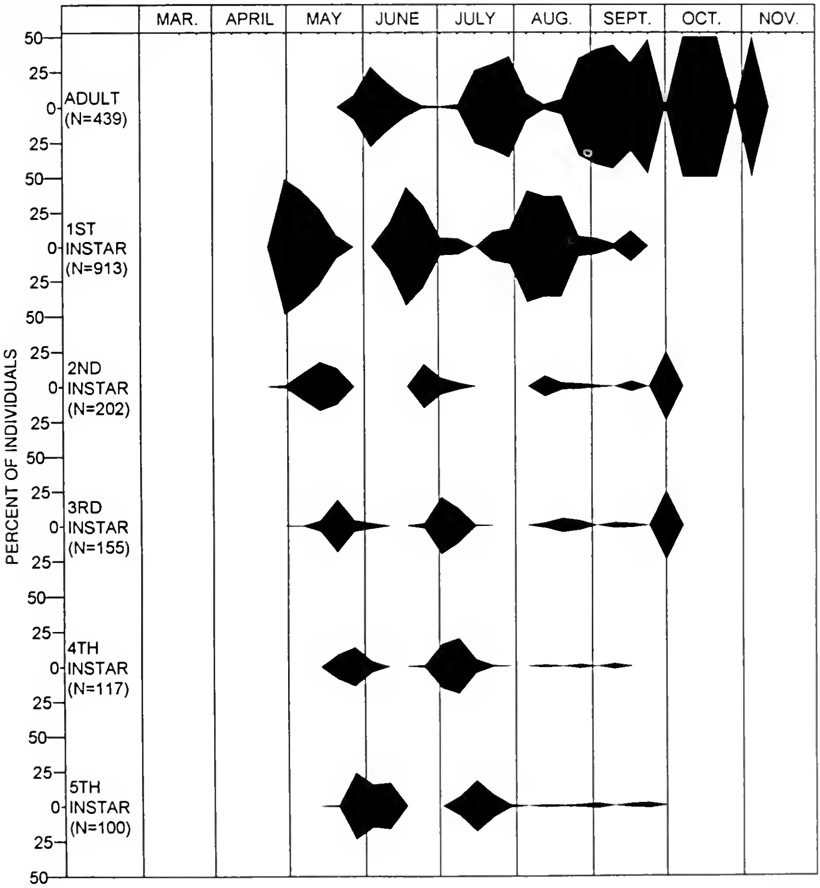

Figure 1. Percent of individuals in each stage per sample of *N. hesione* collected at President's Pond, Southern Illinois University at Carbondale campus, Jackson County, during 1989. Beginning and end points of each shaded area represent sample dates preceeding and following collection of specimens, respectively.

RESULTS AND DISCUSSION

Neogerris hesione, which apparently overwintered as eggs in southern Illinois, was active from late April through early November (Figs. 1-4). First and second instars were found from late April through late September, third instars from early May through late September, fourth instars from mid-May through late September, fifth instars from mid-May through the third week of September, and adults from late May through early November.

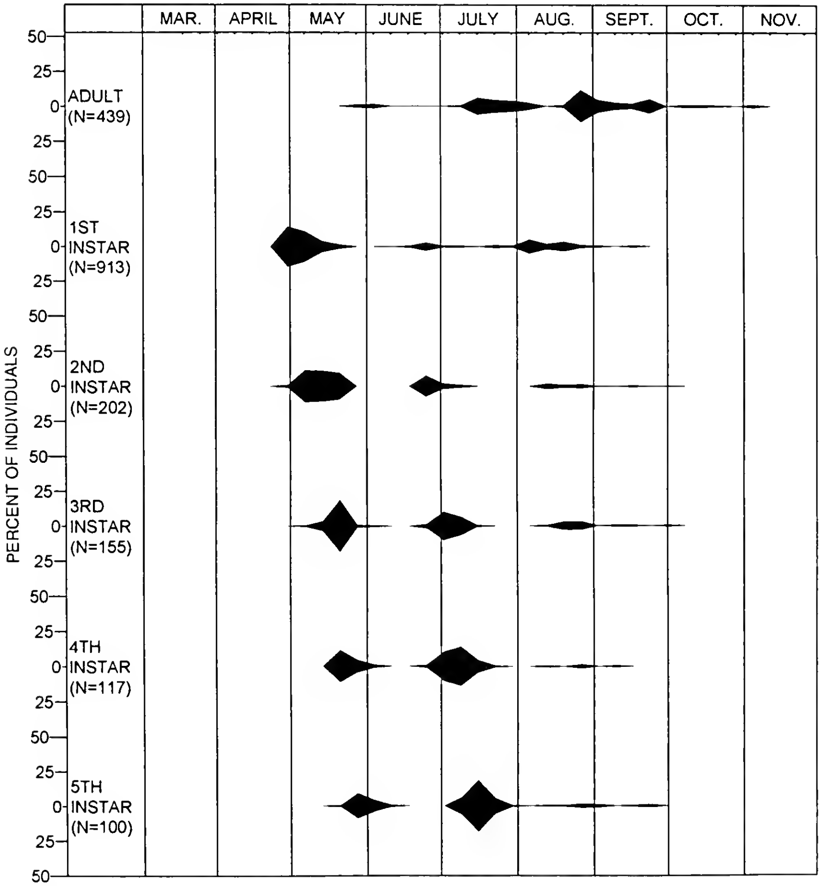

Figure 2. Percent in each sample of total individuals of same stage of *N. hesione* collected at President's Pond, Southern Illinois University at Carbondale campus, Jackson County, during 1989. Beginning and end points of each shaded area represent sample dates preceeding and following collection of specimens, respectively.

This species apparently is trivoltine in southern Illinois. Most fifth instars of the first generation became adults between late May and mid-June. Most first instars of the second generation were found in mid- to late June and became adults during mid- to late July. The third generation was less clearly distinguishable than the first and second, but fifth instars of this generation apparently appeared in August and September and reached adults beginning in late August - early September. Abundance of adults was greatest in the third generation (Figs. 2, 4). These third generation adults, then, laid the overwintering eggs.

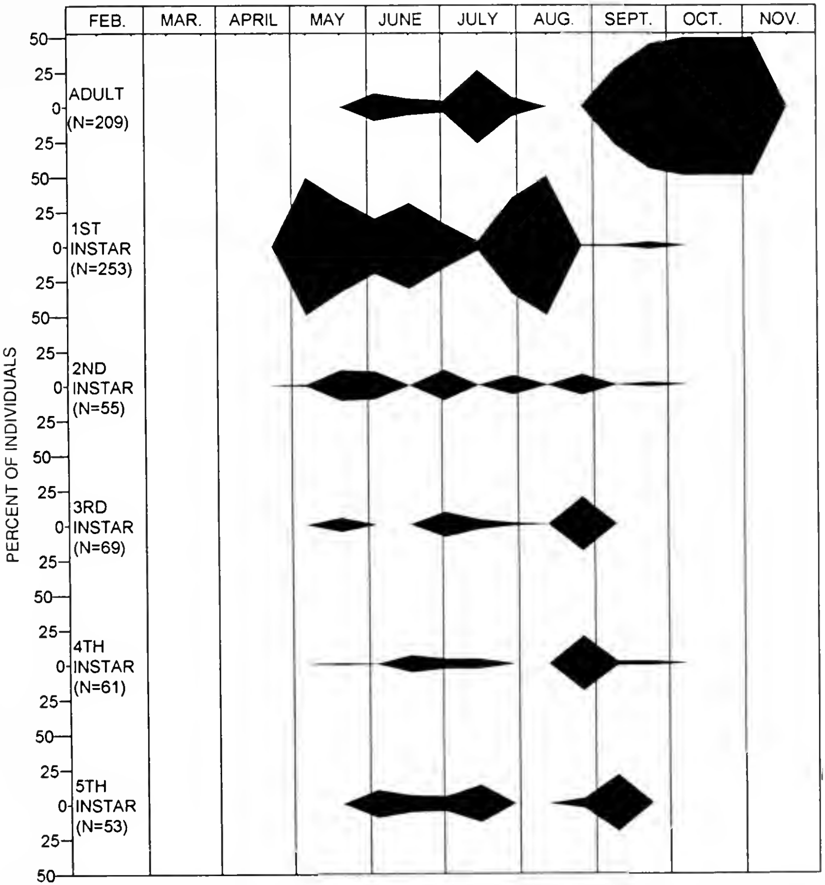

Figure 3. Percent of individuals in each stage per sample of *N. hesione* collected at President's Pond, Southern Illinois University at Carbondale campus, Jackson County, during 1990. Beginning and end points of each shaded area represent sample dates preceeding and following collection of specimens, respectively.

Most individuals were apterous. Of 648 adults collected during this study, only three (0.46%) were macropterous. All three were males collected in 1989, 1 in August and 2 in September. Also, three fifth instars (2♂♂, 1♀) collected in early June 1989 had well developed wing pads and, presumably, would have become macropterous adults.

Riding behavior, typically associated with copulation and pre- and post-copulatory mate-guarding in Gerridae (see literature review by Spence and Andersen [1994]), was observed shortly after the first appearance of adults in late May and again from mid-July through early November.

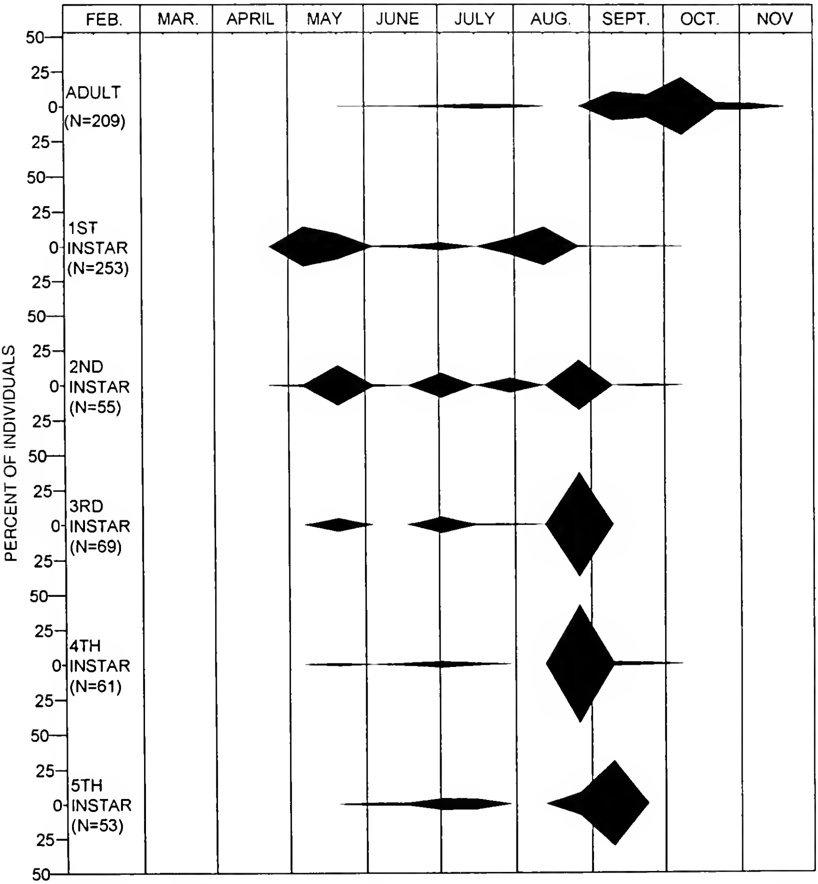

Figure 4. Percent in each sample of total individuals of same stage of *N. hesione* collected at President's Pond, Southern Illinois University at Carbondale campus, Jackson County, during 1990. Beginning and end points of each shaded area represent sample dates preceeding and following collection of specimens, respectively.

The life history observations of Osborn and Drake (1915), Wilson (1958), and Kittle (1977) generally are supported by our data (Figs. 1-4). Differences in the times of occurrence of nymphs and adults reported here and by Herring (1950) and Wilson (1958) probably reflect the geographic locations of the three studies (i.e., southern Illinois, northern Florida, and Mississippi). Finally, the percentages of macropterous and apterous adults reported here are similar to those reported by Kittle (1977, 1980) and Wilson (1958).

ACKNOWLEDGMENTS

We thank the following for their critical review of this manuscript: R. A. Brandon, J. A. Beatty, B. M. Burr, Department of Zoology; D. Ugent, Department of Plant Biology, Southern Illinois University at Carbondale; and D. W. Webb and M. J. Wetzel, Center for Biodiversity, Illinois Natural History Survey.

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A NEW SPECIES OF *PARUROCTONUS* (SCORPIONES: VAEJOVIDAE) FROM BIG BEND NATIONAL PARK, TEXAS[1]

W. David Sissom[2], Richard N. Henson[3]

ABSTRACT. — A new species of the *baergi* microgroup of the genus *Paruroctonus* is described from sand dunes along the Rio Grande River in Boquillas Canyon, Big Bend National Park, Texas. Variation in setal characteristics is summarized.

As a result of taxonomic surveys of scorpions in Big Bend National Park, one of us (RNH) collected specimens of a *Paruroctonus* Werner species in the short stretch of sand dune habitat at the end of the Boquillas Canyon Trail. The specimens were very similar to *P. utahensis* (Williams), which has a wide distribution from southern Utah and northwestern Arizona, through much of New Mexico to the northern portions of the Trans-Pecos in Texas and the Samalayuca Dunes in extreme northern Chihuahua. The site in Big Bend represents a considerable disjunction and, after study, it was ascertained that the specimens represented a new species in the *baergi* microgroup that differs dramatically from *P. utahensis* in several important characters. It is the purpose here to describe this new species.

Accessible sand dune communities are found in only a few locations in the Big Bend region and, thus far, we have found this species only in Boquillas Canyon. Sandy habitats along the Rio Grande in the Big Bend Ranch State Park (e.g., Arenosa, Grassy Banks, Madera Canyon) have been sampled, but this species was not encountered. Dune systems are much more extensive on the Mexican side of the Rio Grande, however, and the new species would be expected to occur there.

***Paruroctonus boquillas*, NEW SPECIES**

(Figs. 1-8)

Type Data. — Adult male holotype from sand dunes in Boquillas Canyon (N29.12.02: W102.55.11), Big Bend National Park, Brewster Co., Texas, USA on 20 May 1996 (R. N. Henson, et al.); deposited in the United States National Museum (Smithsonian Institution), Washington, D. C.

Distribution. — Known only from the type locality.

Etymology. — The specific epithet is derived from the type locality, Boquillas Canyon, and is used as a noun in apposition.

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ENT. NEWS 109(4) 240-246, September & October, 1998

Diagnosis. — Haradon (1983, 1984a, 1984b, 1985) established a number of setal characters that he determined to be of great significance in species recognition in the genus *Paruroctonus*. Utilizing these and other characters listed below, *P. boquillas* clearly belongs in the *baergi* microgroup, a subgroup of the *boreus* infragroup. The *baergi* microgroup was defined (Haradon 1984a) as lacking the mid-retrosuperior seta (*mrs*) on the basitarsus (tarsomere I) of leg II; having pectinal tooth counts usually in excess of 22 in males and 18 in females; having the pedipalp chela with well developed, granulose carinae in adults of both sexes; and having 25-44 primary row denticles on the cutting margin of the pedipalp chela fixed finger and 35-57 such denticles on the movable finger (excluding the basal row in both cases).

In bearing four long retrosuperior setae of equal length on the telotarsus (= tarsomere II) of leg III and an *mrs* seta on the basitarsus of the same leg, *P. boquillas* is most similar to *P. utahensis* and *P. baergi* (Williams & Hadley). It differs from both *P. baergi* and *P. utahensis* in having higher setal counts on most metasomal carinae of segments I-IV (Table 1 summarizes counts for *P. boquillas*) and four external medial setae on the pedipalp femur. Because it has only one retromedial seta on telotarsus III, typically 2 inframedial setae on the pedipalp femur, lower pectinal tooth counts in males (23-28 vs. 29-37) and exhibits slightly more distinct scalloping in the chela fingers (in both sexes), it is readily distinguished from *P. utahensis*. From *P. baergi* it can be further distinguished by having four internal chelal macrosetae (not two) and more subtle scalloping in the chela fingers of the male.

Paruroctonus boquillas is very similar to *P. arenicola* Haradon in terms of its setation patterns. It may be distinguished from that species by having four long retrosuperior setae on telotarsus III (rather than three, or three long and one short setae) and by having fewer setae on the inner aspect of the pedipalp chela fingers. From *P. arenicola arenicola* Haradon of the Amargosa Desert in Nevada, it further differs by having 1, 1, 1-2, 2 setae on the dorsolateral metasomal carinae of I-IV (rather than 1, 3, 3, 3-4) and by having the chela fingers yellowish (rather than orange, contrasting to color of palm). From *P. arenicola nudipes* Haradon of the eastern Mojave Desert in California, it differs by having the *mrs* seta present on telotarsus III and by the setal pattern of the dorsolateral carinae of I-IV (in *P. a. nudipes* there are 0, 1, 1, 2 pairs of setae).

Description: Based on the male holotype. Coloration: Dorsum, metasoma, pedipalps, and legs light yellow; venter slightly paler; pectines whitish; dentition of pedipalp chela fingers, cheliceral fingers, and tip of telson dark reddish brown to reddish black.

Prosoma. Anterior margin of carapace straight, set with four pairs of reddish setae. Entire carapacial surface densely coarsely granular.

Mesosoma. Tergites I-VI: median carina on II-VI present on post-tergite, granular. Tergite VII: median carina vestigial, granular; submedian and lateral carinae strong, irregularly serrated. Pectinal teeth numbering 24-24. Sternites III-VI densely minutely granular laterally; smooth, lustrous, and punctate medially. Sternite VII with pair of moderate crenulate lateral carinae.

Metasoma (Fig. 1). Segment I slightly longer than wide, III 1.43 times longer than wide; segment V 3.21 times longer than wide. Segments I-IV: Dorsolateral and lateral supramedian carinae on I-IV strong, serrate. Lateral inframedian carinae on I complete, strong, irregularly serrate; on II represented by four serrated posterior granules; on III represented by three serrated posterior granules; on IV absent. Ventrolateral carinae on I-II strong, smooth; on III-IV strong, smooth with a few posterior serrations. Ventral submedian carinae on I weak, smooth; II moderate, smooth; on III strong, smooth; on IV strong, smooth with posterior serrations. Carinal setation of segments I-IV (L/R): dorsolaterals 0/1,1/1,1/1,2/2; lateral supramedians 1/0,2/2,2/3,3/3; lateral inframedians 2/2,0/0,0/0,0/0; ventrolaterals 2/2,4/3,4/4, 5/5; ventral submedians 3/3,4/4,4/4,4/5. Segment V: Dorsolateral carinae strong, feebly crenulate; lateromedian carinae present on anterior one-half, strong, irregularly serrate; ventrolateral and ventromedian carinae strong, serrate. Carinal setation of segment V: dorsolaterals 4/4; lateromedians 3/2; ventrolaterals 10/11.

Telson (Fig. 1). Elongate; dorsal surface flattened, smooth; ventral surface essentially smooth, with 12 pairs of larger setae; aculeus weakly curved.

Chelicera (Figs. 2-3). Ventral aspect of cheliceral fixed finger with smooth carina extending length of finger. Ventral margin of movable finger mostly smooth, with one small rounded denticle near the base.

Pedipalp. Trichobothrial pattern Type C, orthobothriotaxic (Vachon 1974). Femur: Dorsointernal, ventrointernal, and dorsoexternal carinae, strong, serrate to serratocrenulate; ventroexternal carina represented by a few spinoid denticles. Internal face with irregularly-spaced large conical granules; three inframedial setae along ventrointernal carina (Fig. 4). External face with four medial setae (Fig. 5).

Patella: All carinae strong, serratocrenulate. Internal face with strong basal tubercle and serrated oblique internal carina. Internal face with two supramedial setae along dorsointernal carina and two inframedial setae along ventrointernal carina.

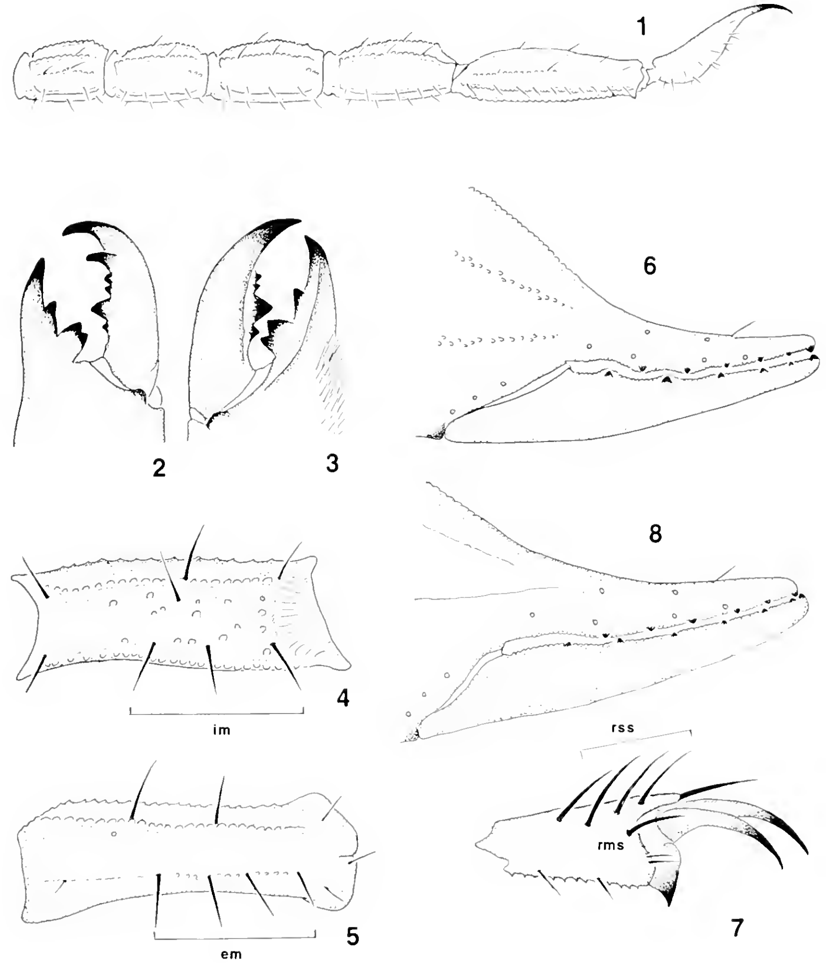
Chela. Octocarinate, with all keels strong, granulose. Dentate margin of fixed finger with primary granular row divided into six subrows by five larger granules; granules of subrows numbering 3, 6, 8, 9, 9, 22; six inner accessory granules. Dentate margin of movable finger divided into seven subrows by six larger granules; granules of subrows numbering 1, 5, 8, 10, 11, 13, 9; seven inner accessory granules. Scalloping of dentate margin of chela fingers moderate (Fig. 6). Chela length/width ratio = 3.03. Fixed finger length/carapace length ratio = 0.77; movable finger length/chela width ratio = 1.87. Internal carinae of palm with 4 macrosetae; fixed finger with 1 macroseta; movable finger with 2 macrosetae.

Legs. Basitarsus II without mid-retrosuperior (*mrs.*) seta; basitarsus III with *mrs*. Telotarsus III with four long retrosuperior setae and one long retromedial seta (Fig. 7).

Measurements of Male Holotype (in mm): total L, 49.3; carapace L, 5.6; mesosoma L (I-VII), 11.8; metasoma L (I-V), 24.8; telson L, 7.1. Metasoma: I L/W, 3.3/3.1; II L/W, 4.1/3.1; III L/W, 4.3/3.0; IV L/W, 5.4/2.7; V L/W, 7.7/2.4. Telson: vesicle L/W/D, 4.2/1.8/1.9; aculeus L, 2.9. Pedipalps: femur L/W, 4.8/1.5; patella L/W, 5.1/2.1; chela L/W/D, 9.4/ 3.1/4.1; fixed finger L, 4.3; movable finger L, 5.8.

Measurements of Female Paratype (in mm): total L, 54.2; carapace L, 6.6; mesosoma L (I-VII), 14.7; metasoma L (I-V), 25.1; telson L, 7.8. Metasoma: I L/W, 3.4/3.3; II L/W, 4.0/3.3; III L/W, 4.3/3.2; IV L/W, 5.4/2.9; V L/W, 8.0/2.6. Telson: vesicle L/W/D, 4.5/2.6/2.2; aculeus L, 3.3. Pedipalps: femur L/W, 5.3/1.8; patella L/W, 5.7/2.5; chela L/W/D, 10.4/3.1/4.0; fixed finger L, 4.8; movable finger L, 6.5.

Variation. — Females differ from males as follows: (1) the carinae of the pedipalp chelae are somewhat weaker, (2) the scalloping of the pedipalp chela fingers is weaker (Fig. 8); (3) body size is somewhat greater; (4) the metasoma is not quite as elongate; and (5) the pectinal tooth counts are lower (see below).



Figures 1-8. — Morphology of *Paruroctonus boquillas*, new species; illustrations are of the holotype male, unless otherwise stated. 1, left lateral aspect of metasoma and telson, showing carinae and setal pattern; 2, right chelicera, dorsal view; 3, right chelicera, ventral view; 4, internal aspect of right pedipalp femur, showing setal pattern (**im** = inframedial setae); 5, external aspect of right femur, showing setal pattern (**em** = external medial setae); 6, external aspect of right pedipalp chela fingers, showing degree of scalloping; 7, retrolateral aspect of right telotarsus III, showing setal pattern (**rss** = retrosuperior setae; **rms** = retromedial seta); 8, pedipalp chela fingers of female paratype

Juveniles possess fairly narrow pedipalp chelae with weakly granulose carinae and no scalloping of the chela fingers. Their setae tend to be finer than in adults, a significant factor in getting counts from the pedipalp chela fingers. The seta of the fixed finger and the distal one on the movable finger tend to be small and fine even in adults, but distinctly pigmented. In subadults and smaller juveniles, the distal diagnostic setae on the fingers tend to be microchaetes and are not included in the counts described below. Other setae in subadults were not problematic, easily determined as macrosetae.

Variation in setal counts is of critical importance to the taxonomy of *Paruroctonus*. Setal counts were taken from 25 specimens, and results are given in Tables 1 and 2. Modal counts for the various setal patterns are as follows: Metasomal setae of I-IV: dorsolaterals 1, 1, 1-2, 2; lateral supramedians 0, 2, 3, 3; lateral inframedians 2, 0, 0, 0; ventrolaterals 2, 3, 4, 5; ventral submedians 3, 4, 4, 5. Metasomal setae of V: dorsolaterals 4; lateromedians 3-4; ventrolaterals 10. Pedipalpal setae: femoral inframedians 2; femoral external medians 4; chela palm internals 4; fixed finger internals 1; movable finger internals 2. As the tables demonstrate, there was considerable variation in many of these counts. Setal counts of the retrolateral aspect of tarsi III appear to be invariable or virtually so, however, with all specimens examined having 4 retrosuperior setae and 1 retromedian seta.

In males, pectinal tooth counts ranged from 23 to 28, with the following distribution: there were 3 combs with 23 teeth, 7 combs with 24 teeth, 17 combs with 25 teeth, 19 combs with 26 teeth, 4 combs with 27 teeth, and 1 comb with 28 teeth. In females, counts ranged from 17 to 23 teeth, distributed as follows: there were 3 combs with 17 teeth, 20 combs with 18 teeth, 24 combs with 19 teeth, 15 combs with 20 teeth, 1 comb with 21 teeth, 1 comb with 22 teeth, and 1 comb with 23 teeth.

Specimens Examined (Holotype and Paratypes). - **USA:** TEXAS: BREWSTER CO.: Big Bend National Park, sand dunes in Boquillas Canyon (N29.12.02: W102.55.11), 23 May 1992 (R. Henson, T. & J. Weseman, R. Soeder), 1 subadult male, 6 subadult females (USNM); 7 June 1992, 6 subadult males, 1 juv male, 2 subadult females, 1 juv female (USNM); 25 May 1994 (R. N. Henson, J. Hosier, H. Husted, E. Kaiser), 6 subadult males, 1 female, 3 subadult females (USNM), 6 subadult males, 1 female, 3 subadult females (CAS); 20 May 1996 (R. N. Henson, et al.), 1 holotype male, 3 females (USNM), 1 male, 2 females, 2 subadult females (RNH), 2 subadult males, 2 females (AMNH), 1 male, 1 subadult male, 2 females, 2 subadult females (WDS). Depositories for materials are as follows: AMNH, American Museum of Natural History, New York; CAS, California Academy of Sciences, San Francisco; RNH, collection of R. N. Henson; USNM, United States National Museum, Washington, D.C.; WDS, collection of W. D. Sissom.

Comments. The junior author was stung on the tip of the middle finger while making one of the collections. The pain was very intense and "hot" for a period of about 10 minutes, which is not unlike many scorpion stings. However, the effects of this sting were somewhat prolonged, with edema developing in the finger that lasted for 3 days. Accompanying this was some stiffness and a throbbing ache. All symptoms disappeared by the fourth day.

Table 1. Variation in setation of the metasomal carinae of segments I-IV in 25 specimens of *P. boquillas*. DL = dorsolateral carinae; LSM = lateral supramedian carinae; LIM = lateral inframedian carinae; VL = ventrolateral carinae; VSM = ventral submedian carinae.

No.	DL				LSM				LIM				VL				VSM			
Setae	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
0	2	1			15					23	24	25								
1	21	19	13		10					2	1									
2	2	4	12	25		22	7		24				23							
3		1				3	18	23	1				2	15	8		20			
4								2						10	17	6	5	21	19	5
5																19		4	6	16
6																				4

Table 2. Variation in setal counts for metasomal segment V and the pedipalps (Ped.) in 25 specimens of *P. boquillas*. DL = dorsolaterals; LM = lateromedians; VL = ventrolaterals; Int. IM = internal inframedians; Ext. Med. = external medials; Int. Palm = internals of chela palm; Fix. Fing. = internals of fixed finger; Mov. Fing. = internals of movable finger.

No.	Metasomal V			Ped. Femur		Ped. Chela	Ped. Chela	Ped. Chela
Setae	DL	LM	VL	Int. IM	Ext. Med.	Int. Palm	Fix. Fing.	Mov. Fing.
0							8	
1							16	9
2		6		16			1	15
3		9		9	1	3		1
4	20	9			24	20		
5	5	1				2		
8			1					
9			1					
10			14					
11			9					

REVISED KEY TO THE *PARUROCTONUS BAERGI* MICROGROUP

Modified from Haradon (1984a)

1. Telotarsus III with two retrosuperior setae .... *P. marksi*
   Telotarsus III with three or four retrosuperior setae 2
2. Telotarsus III with three long, and possibly one shorter subdistal, retrosuperior setae .... *P. arenicola* ... 3
   Telotarsus III with four long retrosuperior setae 4
3. Basitarsus III with *mrs* seta present; paired dorsolateral metasomal setae 1, 2, 2-3, 3-4 .... *P. arenicola arenicola*
   Basitarsus III without *mrs* seta; paired dorsolateral metasomal setae 0, 1, 1, 2 .... *P. arenicola nudipes*
4. Pedipalp femur with four external medial setae; with 1, 1, 1-2, 2 pairs of setae on dorsolateral carinae of metasoma I-IV; with 0, 2, 2, 3 pairs of setae on the lateral supramedians; with 2 pairs of setae on lateral inframedians of metasomal segment I; with 2, 3, 4, 5 pairs of setae on the ventrolaterals of metasoma I-IV .... *P. boquillas*
   Pedipalp femur with two or three external medial setae; with 0, 1, 1, 2 pairs of setae on dorsolateral carinae of metasoma I-IV; with 0, 1, 1, 2 pairs of setae on the lateral supramedians; with 1 pair of setae on lateral inframedians of metasomal segment I; with 2, 3, 3, 4 pairs of setae on the ventrolateral carinae of I-IV.................... 5
5. Telotarsus III with one retromedial seta; closed pedipalp fingers in adult male form wide proximal gap .... *P. baergi*
   Telotarsus III with two retromedial setae; closed pedipalp fingers in adult male form narrow proximal gap .... *P. utahensis*

ACKNOWLEDGMENTS

We would like to thank Mike Fleming, Resource Management Specialist of Big Bend National Park, and the National Park Service for granting permission to conduct research in the park (Permit #BIBE-96-008). We are also grateful to Texas Parks & Wildlife, and in particular David Riskind (Director of the Natural Resources Program) and Luis Armendariz (Superintendent of BBRSP), for permission to collect in Big Bend Ranch State Park (State Park Scientific Study Permit No. 10-96). We are grateful to the following individuals for participating in the field work: K. Adcock, A. Baldwin, H. Bowers, J. Hosier, H. Husted, E. Kaiser, M. Riddle, R. Soeder, J. and T. Weseman, and A. Zamba. Kari J. McWest kindly reviewed the manuscript at our request.

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COMPARISON OF SAND NESTING WASPS (HYMENOPTERA) FROM TWO PINE BARRENS IN UPSTATE NEW YORK[1]

Frank E. Kurczewski[2]

ABSTRACT: Collections of sand inhabiting wasps from the Fort Drum Military Reservation and the Rome sand plains indicate a common fauna with pine inhabited sandy areas in the nearby Black River Valley and elsewhere in upstate New York. There were no pine barren indicator species in the collections.

Pine barrens are an imperiled ecosystem in the northeastern United States. In upstate New York, they comprise depauperate pine-oak woodlands growing on fire swept or otherwise disturbed sandy soils. The nutrient impoverished, water deficient, primarily acidic sandy soils supporting these woodlands historically were often anthropogenically altered. The sparse interrupted canopy is composed of white pine (*Pinus strobus* L.) and/or pitch pine (*P. rigida* Mill.) trees. A tall dense shrub layer dominated by scrub oak (*Quercus ilicifolia* Wangenh.) or, sometimes, stunted white oak (*Q. alba* L.) grows beneath these trees. A low shrub layer often composed of Ericaceae, forbs, and grasses grows beneath the oaks and in interspersed openings (Schweitzer and Rawinski 1988).

The species of sand nesting wasps that inhabit upstate New York pine barrens is poorly known. Two pine barrens areas devoid of wasp collection records are the Fort Drum Military Reservation in Jefferson County and the Rome sand plains in Oneida County (Fig. 1). Fort Drum is situated on a site known historically as the "pine plains." An abundance of white pine, some pitch pine and white oak, and many deciduous tree species grew there on level, dry, sandy soil in the 1790s. These pine plains were located on droughty sands and loamy fine sands north of the large bend in the Black River between the villages of Great Bend and Deferiet. More than 10,000 ha of moderately well to excessively drained sandy soils blanket this section of Fort Drum (USDA 1989).

The Rome sand plains contain approximately 1,200 ha of sandy soil. Half this acreage is moderately well to excessively drained and suitable for psammophilous wasp habitation (USDA 1997 pers. comm.). Although the Rome sand plains contained extensive pine barren acreage at the turn of the last century (Stephens [sic] and Barrus 1911), the predominant vegetation through most of the millenium was a mesophytic deciduous-coniferous forest (Russell 1996).

The purpose of this paper is to: (1) present the results of solitary wasp

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[1] Received September 11, 1997. Accepted November 30, 1997.

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collections from these two localities; (2) relate these results to collection records for this group from other pine inhabited sandy localities in upstate New York; and, (3) determine whether or not pine barrens were part of the ancestral vegetation landscape based upon wasp species.

METHODS

Eighteen trips were made to the Fort Drum Military Reservation during August 2-October 18, 1996 and April 3-October 4, 1997 for the purpose of collecting sand inhabiting wasps. Actual time spent collecting there totalled 70 hours. Collections were made on barren Plainfield sand.

Seven trips were made to the Rome sand plains on June 27, 1992, July 28, 1993, July 13, 1995, and June 2, July 26 and September 10 and 27, 1997 for this purpose. Actual time spent collecting at this locality totalled 35 hours. Collections were made on barren Windsor loamy fine sand.

RESULTS

One-hundred and nine species of Tiphiidae, Mutillidae, Scoliidae, Pompilidae, and Sphecidae were collected at Fort Drum (Table 1). Twenty-two (20.2%) of these species were not sand nesters. Sixty-three species of Tiphiidae, Scoliidae, Pompilidae, and Sphecidae were collected at the Rome sand plains (Table 1). Only five (7.9%) of these species were not psammophilous. Sixty-two species of Tiphiidae, Scoliidae, Pompilidae, and Sphecidae were common to both localities. Forty-seven species of wasps found at Fort Drum were not collected at Rome. Only one species collected at Rome, *Tachytes validus* Cresson, was not found at Fort Drum.

Stictiella emarginata (Cresson), a species rarely found in upstate New York, provisioned nests at Fort Drum with adult moths of the family Noctuidae (pers. obs.). *Philanthus albopilosus* Cresson collected at Fort Drum was at the eastern extremity of its range (Evans 1975).

DISCUSSION

The species of sand inhabiting wasps from Fort Drum and the Rome sand plains were similar to those from the Black River Valley in adjacent Lewis and Herkimer Counties and other localities in upstate New York (Cayuga County: Auburn, Sennett; Oswego County: Granby Center, Mallory Station, Selkirk Shores State Park; St. Lawrence County: Parishville) (Kurczewski 1994; Kurczewski and Acciavatti 1990; pers. obs.).

The absence of *Tachysphex pechumani* Krombein, a characteristic faunal element in the New Jersey and lower Michigan pinelands, implies that the New York State pine barren sites were anthropogenically induced. The overwhelming dominance of pre-Euro-American settlement mesophytic decidu-

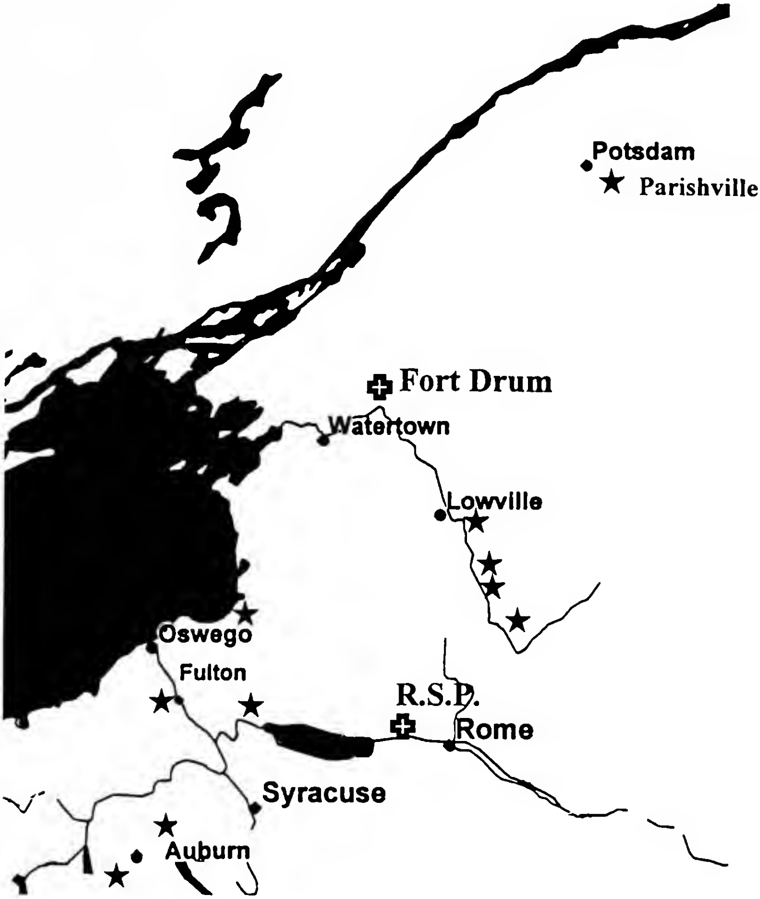

Fig. 1. Sand wasp collection sites in northcentral New York. ✚ designates Fort Drum Military Reservation and Rome sand plains, ★ localities from previous years.

Table 1. Species of solitary wasps collected and/or observed at the Fort Drum Military Reservation and Rome sand plains.

SPECIES	FORT DRUM	ROME SAND PLAINS
TIPHIIDAE		
Tiphia sp.	x	
Paratiphia sp.	x	
Myzinum quinquecinctum (Fabricius)	x	
Methocha stygia (Say)	x	x
MUTILLIDAE		
Timulla vagans (Fabricius)	x	
Pseudomethoca frigida (Smith)	x	
SCOLIIDAE		
Campsomeris plumipes (Drury)	x	x
POMPILIDAE		
*_Priocnessus nebulosus_ (Dahlbom)	x	
*_Priocnemis (Priocnemissus) minorata_ Banks	x	x
Priocnemis (Priocnemis) cornica (Say)	x	x
*_Priocnemis (Priocnemis) germana_ (Cresson)	x	
*_Priocnemis (Priocnemis) scitula relicta_ Banks	x	
Calicurgus hyalinatus (Fabricius)	x	
*_Dipogon papago anomalus_ Dreisbach	x	
*_Dipogon sayi_ Banks	x	
*_Auplopus architectus_ (Say)	x	x
*_Auplopus mellipes variitarsatus_ (Dalla Torre)	x	
Evagetes crassicornis (Shuckard)	x	
Evagetes hyacinthinus (Cresson)	x	
Evagetes parvus (Cresson)	x	x
Episyron biguttatus (Fabricius)	x	
Episyron quinquenotatus (Say)	x	x
*_Anoplius (Lophopompilus) aethiops_ (Cresson)	x	x
Anoplius (Lophopompilus) atrox (Dahlbom)	x	
*_Anoplius (Lophopompilus) carolina_ (Banks)	x	
Anoplius (Arachnophroctonus) relativus (Fox)	x	x
Anoplius (Arachnophroctonus) semirufus (Cresson)	x	x
Anoplius (Pompilinus) cylindricus (Cresson)	x	x
Anoplius (Pompilinus) marginatus (Say)	x	x
Anoplius (Pompilinus) splendens (Dreisbach)	x	x
Anoplius (Pompilinus) subcylindricus (Banks)	x	
Anoplius (Pompilinus) tenebrosus (Cresson)	x	x
*_Anoplius (Anoplius) illinoensis_ (Robertson)	x	
*_Anoplius (Anoplius) nigerrimus_ (Scopoli)	x	
*_Anoplius (Anoplius) ventralis_ (Banks)	x	
*_Anoplius (Anoplius) virginiensis_ (Cresson)	x	
Pompilus (Arachnospila) arctus Cresson	x	
Pompilus (Arachnospila) scelestus Cresson	x	x
*_Pompilus (Anoplochares) apicatus_ Provancher	x	
Aporinellus completus Banks	x	
*_Ceropales maculata fraterna_ Smith	x	
SPHECIDAE		
*_Chalybion californicum_ (Saussure)	x	x
*_Sceliphron caementarium_ (Drury)	x	x
Sphex ichneumoneus (Linnaeus)	x	x
Sphex pensylvanicus Linnaeus	x	x
*_Isodontia mexicana_ (Saussure)	x	
Prionyx atratus (Lepeletier)	x	
Podalonia luctuosa (Smith)	x	x
Podalonia robusta (Cresson)	x	x
Eremnophila aureonotata (Cameron)	x	x
Ammophila harti (Fernald)	x	x
Ammophila nigricans Dahlbom	x	
Ammophila pictipennis Walsh	x	x
Ammophila procera Dahlbom	x	x
Ammophila urnaria Dahlbom	x	x
Mimesa basirufa Packard	x	
Mimesa cressonii Packard	x	
Diodontus franclemonti (Krombein)	x	x
*_Pemphredon lethifer_ (Shuckard)	x	
*_Passaloecus_ sp.	x	
*_Stigmus americanus_ Packard	x	
Astata leuthstromi Ashmead	x	x
Liris argentata (Beauvois)	x	x
Tachytes obductus Fox	x	
Tachytes validus Cresson		x
Tachysphex acutus (Patton)	x	
Tachysphex similis Rohwer	x	
Tachysphex tarsatus (Say)	x	x
Tachysphex terminatus (Smith)	x	x
Lyroda subita (Say)	x	x
Plenoculus davisi Fox	x	x
Miscophus americanus Fox	x	x
Oxybelus bipunctatus Olivier	x	x
Oxybelus emarginatus Say	x	
Oxybelus subcornutus Cockerell	x	
Oxybelus subulatus Robertson	x	x
Anacrabro ocellatus Packard	x	x
Lindenius buccadentis Mickel	x	x
Lindenius columbianus (Kohl)	x	x
Crossocerus maculiclypeus (Fox)	x	
Crabro advena Smith	x	x
Crabro argusinus R. Bohart	x	x
Crabro cribrellifer (Packard)	x	
Crabro latipes Smith	x	
Crabro monticola (Packard)	x	x
Alysson melleus Say	x	x
Nysson daeckei Viereck	x	x
Ochleroptera bipunctata (Say)	x	x
Gorytes canaliculatus Packard	x	x
Gorytes simillimus Smith	x	x
Pseudoplisus phaleratus (Say)	x	x
Sphecius speciosus (Drury)	x	x
Bicyrtes quadrifasciata (Say)	x	x
Bicyrtes ventralis (Say)	x	x
Microbembex monodonta (Say)	x	x
Bembix americana (Lepeletier)	x	x
Bembix pallidipicta Smith	x	x
Stictiella emarginata (Cresson)	x	
Philanthus albopilosus Cresson	x	
Philanthus bilunatus Cresson	x	x
Philanthus gibbosus (Fabricius)	x	
Philanthus lepidus Cresson	x	x
Philanthus politus Say	x	x
Philanthus solivagus Say	x	x
Philanthus ventilabris Fabricius	x	
Aphilanthops frigidus (Smith)	x	x
Cerceris clypeata Dahlbom	x	x
Cerceris fumipennis Say	x	x
Cerceris nigrescens Smith	x	
Cerceris robertsonii Fox	x	x

*Non-sand inhabiting species.

ous and deciduous-coniferous forests on sandy soils in upstate New York (Seischab 1990, 1992; Marks and Gardescu 1992) and the substantial annual amount of evenly distributed precipitation in the region (USDA 1941; Dethier 1966; Garwood 1996) support this contention.

ACKNOWLEDGMENTS

Howard Evans, George Ferguson, Bert Finnamore, Arnold Menke, and Mark O'Brien aided in the identification of some of the wasp species. Anne Johnson provided entry onto the Fort Drum Military Reservation. Hugh Boyle, Tom Conklin, Bud Mayfield, and Ed Stanton collected some of the wasps at Fort Drum and Rome. Tim McCabe and Rick Hoebeke permitted examination of collection records at the New York State Museum and Cornell University, respectively.

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PLEASE SEE ANNOUNCEMENT ON PAGE 276

THE IDENTITY OF *TACHYSPHEX ACUTUS* (HYMENOPTERA: SPHECIDAE), AN UNSOLVED MYSTERY[1]

Frank E. Kurczewski[2]

ABSTRACT: A reevaluation of the identities of *Tachysphex acutus* and *T. similis* is given based upon the species' descriptions of Patton (1881), Fox (1894), Rohwer (1910), and Williams (1914) and examination of museum specimens. Although *T. similis* may be a synonym of *T. acutus*, the continued usage of the specific names, as presently known, is recommended.

The true identify of *Tachysphex acutus* (Patton) remains a mystery. Patton (1881) described "*Larra acuta*" from three specimens collected at Waterbury, Connecticut in August. He indicated that the species is related to *T. terminatus* (Smith), *T. tarsatus* (Say), and *T. montanus* (Cresson), which did nothing more than designate it as a species of *Tachysphex*. Patton's original description fits several dozen all-black Nearctic species in the genus and is totally undiagnostic at the species group level. In addition, his definition of the propodeal dorsum and side as being "uniformly and finely granulated" does not correspond with specimens of *T. acutus* as recognized today (Pulawski 1988). To complicate matters the type specimens of this species, which were placed in the Boston Museum of Natural History, were destroyed by fire around the turn of this century. Although Kohl (1885), Dalla Torre (1897), Ashmead (1899), H. Smith (1908), and J. Smith (1910) all mentioned *T. acutus* in their treatises on sphecid wasps, none of these authors provided an adequate description of the species.

Fox (1894), in his treatment of the genus *Tachysphex*, first delineated diagnostic morphological characteristics for *T. acutus*. However, his description of the species fits better what is currently being called *T. similis* Rohwer than *T. acutus*, especially with regard to the least interocular distance (R. Bohart 1962), punctation of the head and thorax, and width of submarginal cells. Furthermore, Fox (1894) listed *T. acutus* directly after *T. fusus* Fox, *T. terminatus*, and *T. apicalis* Fox, all members of the *terminatus* species group. *T. similis* also belongs to this group. Fox (1894) recorded Georgia and Florida as collection "localities" for *T. acutus* but Pulawski (1988), who examined 184 specimens of this species, found no Georgia locality and only a single, *new* northern Florida locality (Alachua County: Gainesville) for what is now being called *T. acutus*. The Georgia and Florida specimens listed in Fox's (1894) revision proved to be *T. similis*. The following questions arise: Did Fox examine Patton's type specimens prior to his revision of the genus? If not, did he presume that what

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is now being called *T. similis* was Patton's "*Larra acuta*"? A search for additional information is in order.

In 1910 Rohwer described *T. similis* and *T. similans* from eastern Texas specimens. The two species are clearly synonymous, with *T. similis* being the first name put in print (G. Bohart 1951). Rohwer (1910) provided no diagnostic characteristics which would assist in separating these species from others in the genus. Rohwer (1911) also described *T. bruesi* from Milwaukee County, Wisconsin, and this species has been synonymized with what is currently being called *T. acutus* (G. Bohart 1951). Rohwer was notorious for erecting species names *ad nauseam* and, in the process, creating innumerable synonyms. Therefore, one has to question whether *T. similis* is a good species or merely another of Rohwer's synonyms, in this case of *T. acutus*, especially in light of the above information and the fact that the type specimens of *T. acutus* were destroyed by fire before Rohwer described *T. similis*.

Compounding this ambiguity is the fact that Williams (1914), who redescribed the species of *Tachysphex* occurring in Kansas, made no mention of *T. similis* in his redescriptions yet the species was already described (Rohwer 1910) and is abundant in the eastern half of the state (pers. obs.). His representation of *T. acutus* fits the current conception of this species, but some of the morphological characteristics he listed for *T. sepulcralis* Williams agree with those of *T. similis*. [*T. sepulcralis* was designated a synonym of *T. acutus* by Pulawski (1988)]. Williams (1914) recorded *T. sepulcralis* as being related to *T. apicalis* which, like *T. similis*, would place it in the *terminatus* group. He noted that specimens of *T. acutus* matched both Patton's (1881) and Fox's (1894) descriptions of this species, although he admitted he had not seen the type specimens. Williams (1914) remarked that there were at least two species of *Tachysphex* in the series labeled "*acuta*" in the Academy of Natural Sciences of Philadelphia collection! Although both Viereck (1916) and Mickel (1917) delineated *T. acutus* morphologically in their definitions of species of *Tachysphex*, neither worker mentioned *T. similis* or *T. sepulcralis*. Mickel (1917) leaned heavily on Williams' (1914) redescription of *T. acutus* in his own definition. Robertson (1928) recorded females of *T. acutus* taking nectar from nearly a dozen species of flowering plants but did not mention either *T. similis* or *T. sepulcralis*. Pulawski (1988) regarded these records as useless because of the doubtful determination of the wasp species. The omission of *T. similis* from all of these studies is noteworthy because it was described and was common in collections.

Further confusing were several series of specimens that I examined, some with associated handwritten notes, in trays labeled "*T. acutus*" in various museums. Ten specimens in the collection of the North Carolina Department of Agriculture determined originally as *T. acutus* and *T. maneei* Banks by N. Banks were examined by K.V. Krombein in 1950 and some of them proclaimed to be

T. similis (D.L. Wray, pers. comm.). A tray of 10 males and 10 females from Georgia in the Cornell University insect museum were identified as *T. acutus* by J.C. Bradley in 1923. These specimens were redetermined by me in 1963 as *T. similis* and, in 1980, reidentified as *T. similis* by W.J. Pulawski. However, there is a "legitimate" female of what is now being called *T. acutus* identified as such in the same collection (Southampton, Mass.; July 14, 1894; #429) with a very old determination label: "This spcm. ident. as *Tachysphex acutus* Patton♀". A tray of "*T. acutus*" at the U.S. National Museum in 1963 contained specimens identified as both *T. sepulcralis* (= *T. acutus*) and *T. similis* (Det. K.V. Krombein), both species having been determined earlier as *T. acutus* by S.A. Rohwer. These determinations were made after Rohwer described *T. similis* in 1910! There is a note in the tray in Rohwer's handwriting (*teste* K.V. Krombein) that the Florida specimen (*T. similis*) agrees with J.C. Bradley's manuscript notes on *T. acutus* and that (Phil) Rau's specimens (*T. sepulcralis*) are an entirely different species. This note was made the year (1923) that Bradley determined *T. similis* specimens in the Cornell University collection as *T. acutus*. However, neither Bradley in 1963 nor I upon his death in 1975 could locate these notes at Cornell University. If Bradley indeed studied Patton's type specimens, then it would appear that *T. similis* must be a synonym of *T. acutus* and the name *T. bruesi* should be resurrected to accommodate the specimens now being called *T. acutus*. However, the correct interpretation will never be known because Patton's type specimens were destroyed a century ago and the hymenopterists involved in the name continuation or its discontinuity have passed away.

What steps then should be taken to correct this misconception, if one exists? I propose that everything remain *status quo*. R.M. Bohart, H.E. Evans, K.V. Krombein, A.S. Menke, W.J. Pulawski, and other prominent sphecidologists all recognize *T. similis* as presently defined. This species was redescribed in detail by Pulawski (1988) and has a moderate amount of literature associated with its ecology and nesting behavior. *Tachysphex acutus*, as presently accepted, is, on the other hand, less well known, and has been the seat of much past taxonomic controversy. It, too, has a sizeable scattering of literature associated with its identification. Unfortunately, much of this literature probably pertains to what is now being called *T. similis*, but my paper serves to bring this misapplication of information to light. Pulawski (1988) redescribed *T. acutus*, as currently known, and, in the process, designated a neotype specimen. Taking everything into consideration, present usage should prevail over chronology and S.A. Rohwer's probable error. I, therefore, recommend continued usage of the names *T. acutus* and *T. similis* as presently applied, with my paper providing an interpretation of any misconstruances that occurred in the early to mid-20th century.

ACKNOWLEDGMENTS

R.M. Bohart, University of California, Davis, K.V. Krombein, Smithsonian Institution, and W.J. Pulawski, California Academy of Sciences, provided much assistance in identifying specimens of *Tachysphex acutus* and *T. similis*. K.V. Krombein, L.L. Pechuman, Cornell University, and D.L. Wray, North Carolina Department of Agriculture, permitted me to examine specimens at their disposal and provided me with pertinent information on the two taxa. J.C. Bradley, Cornell University, and E.C. Zimmerman, Honolulu, Hawaii answered some of my questions about the location of *T. acutus* type specimens. J.C. Bradley interpreted Cornell University Lot and Sublot listings for me. F.M. Carpenter and S. Shaw, Museum of Comparative Zoology, Harvard University, and B.R. Wiseman, Museum of Science, Boston aided in obtaining information about the disposition of the *T. acutus* type specimens and the Boston Museum of Natural History fire, respectively. R.M. Bohart, K.V. Krombein, A.S. Menke, and W.J. Pulawski reviewed earlier versions of the manuscript.

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SCIENTIFIC NOTE

INCORPORATION OF *BATRACHOSPERMUM GELATINOSUM* (RHODOPHYTA) INTO CASES OF *OCHROTRICHIA WOJCICKYI* (TRICHOPTERA: HYDROPTILIDAE)[1]

J. B. Keiper[2], D. A. Casamatta[3], B. A. Foote[2]

Microcaddisfly larvae (Trichoptera: Hydroptilidae) often incorporate filaments of algae into their cases (Wiggins 1996). Sheath et al. (1995) studied the incorporation of freshwater red algae (Rhodophyta) into the cases of a variety of caddisfly species. They reported that hydroptilid larvae of *Dibusa, Hydroptila,* and *Ochrotrichia* had Rhodophyta incorporated into their cases, but no *Ochrotrichia* were identified to species. To supplement their study, we report the incorporation of the rhodophytan *Batrachospermum gelatinosum* (L.) De Candolle into the cases of *Ochrotrichia wojcickyi* Blickle. Although *B. gelatinosum* has been associated with the cases of midge larvae (Diptera: Chironomidae) (Sheath et al. 1996), this is the first report of *B. gelatinosum* used as caddisfly case material.

Larvae were collected from cobble substrata in an unnamed low order stream located in Salt Fork State Park (40°06'03 N,81°28'41 W), Guernsey Co., Ohio, on 26 May 1997. They were transported to the laboratory, placed in aerated rearing chambers (Keiper and Foote 1996) with field-collected riffle rocks, and the adults reared for species determination. Larvae were never observed to consume *B. gelatinosum* in the laboratory. Living algae covered approximately 5-15% of cases examined.

Sand grains often constitute most of the case material used by larvae of *Ochrotrichia* (Wiggins 1996). The incorporation of *B. gelatinosum* into the cases of the specimens collected suggests that *O. wojcickyi* is not specific in its case material requirements. The fate of living Rhodophyta incorporated into caddisfly cases remains unknown.

ACKNOWLEDGMENTS

We thank the Ohio Biological Survey for supporting the collecting trips of the senior author. L. Boydeletour of the Ohio Department of Natural Resources, Parks and Natural Areas kindly supplied the collecting permit for Ohio state parks. A. Collier and J. A. Johns (KSU) critically reviewed the manuscript.

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CHARACTER VARIABILITY AND A NEW SYNONYM OF *ACERPENNA PYGMAEA* (EPHEMEROPTERA: BAETIDAE)[1]

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

ABSTRACT: An adult of *Acerpenna harti* was reared from a larva and compared with larvae of *A. macdunnoughi*, and *A. pygmaea*. *Acerpenna harti* can not be consistently distinguished as larvae or adults from *A. pygmaea* based on observed variabilities in adult and larval characters. *Acerpenna harti* is reported as a junior subjective synonym of *Acerpenna pygmaea*, new synonymy.

Acerpenna harti (McDunnough) has only rarely been reported by mayfly workers since its description over seventy years ago. The only published keys to incorporate this species in the adult stage are those of Traver (1935, as *Baetis*) and Burks (1953, as *Baetis*). McDunnough (1924) first described *A. harti* (as *Baetis*) based on specimens collected July 11, 1898, from Urbana, Illinois, and housed in the Canadian National Collection, Ottawa. Burks (1953) revised the male description and included additional Illinois records. Waltz and McCafferty (1987) first characterized *Acerpenna* as a genus distinct from *Baetis* Leach but they did not transfer the species *B. harti* McD. or *B. akataleptos* McD. until 1990 (McCafferty and Waltz, 1990). As of this writing, only the larva of *A. akataleptos* remains unknown among the Nearctic *Acerpenna* species. We strongly suspect, but do not have any data to conclude at this time, that *A. akataleptos* is also a synonym of *A. pygmaea*.

McCafferty et al. (1993), although not able to assign a species name to larvae of *Acerpenna* collected in Colorado, alluded to the possible occurrence of *A. akataleptos* in Colorado due to the discovery of *Acerpenna* larvae with gills similar in form to *A. pygmaea* (Hagen) but differing in having both the anterior and posterior margins of gill 7 serrate. This condition is distinctly different from the generally accepted concept of *A. pygmaea* larvae characterized by Ide (1937) and Morihara and McCafferty (1979), in which the gills are asymmetric and only the posterior margins are serrate.

MATERIAL EXAMINED

One of us (DEB) reared one larva from which the adult was identified as *Acerpenna harti*. Collection data for the reared specimen is as follows: OKLA-

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HOMA: Pushmataha Co., Pine Ck @ unnamed rd (old main highway) in Wadena, 16-VII-1993, DE Baumgardner, (DB 93-137), [1 reared male larval exuviae (slide mounted: euparal: abs. alc.) and its adult].

Paratypes: *Acerpenna harti* McDunnough (2 Male adults): IL: Urbana, July 11, 1898, INHS tag No. 24491, CNC Paratype No. 708, housed in Canadian National Collection, Ottawa. 4 specimens labeled Ontario: Ottawa, 7-V-1921, 8-5-1921, 10-V-1920, 17-V-1921, all collected by J. H. McDunnough.
AL: Choctaw Co., Tucklebaum Cr. @ Hwy 17, 12 May 1989, S. Harris, (20 males).
CO: Moffat Co., Green River, Echo Park, Dinosaur NM, 19 August 1993, B. Kondratieff and R. Durfee, (1 larva). CO: Moffat Co., Yampa River, Echo Park, Dinosaur NM, 3 September 1994, B. Kondratieff and R. Durfee, (1 larva). CO: Routt Co., Yampa River, near Steamboat Springs off Rt. 131, 28 July 1991, Kondratieff, Durfee, and Painter, (1 larva). CO: Yuma Co., Chief Creek Co. Road CC North, 25 April, 1993, B. Kondratieff, R. Durfee, (1 reared male and 2 reared females and associated larval exuviae, 1 larva).
MI: Emmet Co., Lake Michigan, Trail's End Bay, VI-6-1994, P. Hudson (1 larval exuviae).
OK: Le Flore Co.; Rock Ck. @ Railroad Road ca. 0.5 mi N of Talihina, 17-III-1993, D.E. Baumgardner, (DB 93-46), (5 larvae). OK: LeFlore Co.; Birney Ck. @ Hwy 63, ca. 5 mi SE of Talihina, 16-V-1993, D.E. Baumgardner, (DB 93-90), (3 larvae). OK: Pushmataha Co.; Beaver Ck. @ Coffee Ck. Rd., ca. 1.5 mi S of Hwy 3 jct, ca. 4 mi W of Antlers, 17-IV-1993, D.E. Baumgardner, (DB 93-49), (1 larva). Same as preceding but, 14-III-1993, (DB 93-27), (2 larvae). OK: Pushmataha Co.; Cedar Ck. @ Snow Ck. Rd. in Snow, 17-III-1993, D. E. Baumgardner, (DB 93-47), (2 larvae). OK: Pushmataha Co.; Kiamichi R @ unnamed rd., 3 mi E of Albion, 18-IV-1993, (DB 93-27), (2 larvae). OK: LeFlore Co.; Unnamed 2nd order trib. of Buzzard Ck. @ unnamed rd., ca. 2 mi. E. of Talihina, 17-III-1993, DE Baumgardner (DB 93-45.5) (6 larvae); OK: Pushmataha Co., Marble Fobb Ck. (?) at main rd. in Kiamichi Wilderness Area, 17-IV-1993, DE Baumgardner, (DB 93-53) (2 larvae); OK: Pushmataha Co., Cole Ck. @ unnamed rd., 3.7 mi. S. of Miller, 14-III-1993, DE Baumgardner, (DB 93-25) (6 larvae). OK: Pushmataha Co., Dry Ck. @ low water crossing @ unnamed rd., ca. 1.5 mi. E. of Tuskahoma, 17-VII-1993, DE Baumgardner, (DB 93-142), 2 larvae). OK: Pushmataha Co., Panther Ck. @Hwy. 2, 3.1 mi. N. of Hwy. 2-3 jct., 11-IX-1992, DE Baumgardner, (DB 92-101), (1 larva). OK: Pushmataha Co., Tenmile Ck. @ Hwy. 2 N. of Antlers, 5-VIII-1994, DE Baumgardner, (DB 94-005), (1 larva).

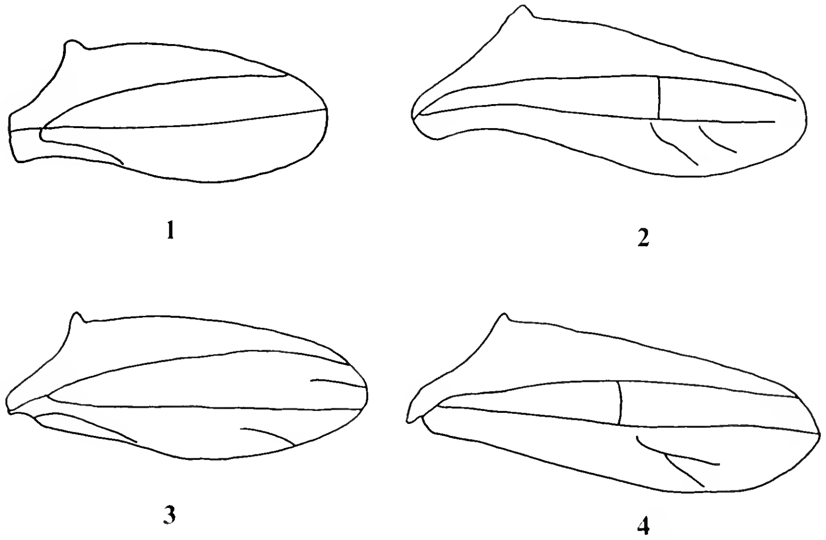
Slide mounted voucher material (Euparal: abs. alc.) and alcohol preserved material is deposited at Purdue University, Entomological Research Collection, West Lafayette, Indiana, and at University of North Texas, Denton, Texas.

DISCUSSION

A male larva from Oklahoma, for which the reared adult was readily identified as *A. harti*, possessed setulae on the anterior margin of the gill, thereby giving the gill a distinctly serrated appearance so that one might conclude that serration existed on both margins of gill 7. In all other respects this larva was found to be morphologically identical to *A. pygmaea*. Our examination of additional collections [above] of non-reared and reared larvae identified as *A. pygmaea* from Colorado, Oklahoma, Alabama, and Michigan indicated that development of the setulae on the anterior margin of gill 7 was extremely variable within populations, ranging from well developed to absent.

In adult specimens, we found hindwing characters to be highly variable. Previously published keys have used characters such as hindwing venation

(Burks 1953) and development of the costal process (Traver 1935) to separate adults of *A. pygmaea* from *A. harti*. Adult specimens examined from Alabama and Colorado showed variation in both of these characters. The costal process varied from acute and well developed to blunt and poorly developed (Figs. 1-4). Traver (1935) considered the presence of an acute well-developed costal process to be typical of *A. harti* while *A. pygmaea* possessed a small, blunt costal process. Burks (1953) separated *A. pygmaea* from *A. harti* by the presence or absence of marginal intercalary veins in the hindwing. The hindwing of *Acerpenna pygmaea* was considered to possess 1-2 marginal intercalary veins, whereas *A. harti* completely lacked intercalary veins in the hindwing. Series of adult specimens from Alabama and Colorado varied from 0-2 marginal intercalaries in the hindwing, with the location of the intercalaries being highly variable (Figs. 2-4). Additionally, some adults possessed hindwings with a weakly developed third longitudinal vein (Figs.1, 3), while other adults possessed a cross vein between the two longitudinal veins (Figs. 2, 4), or possessed intercalaries along the outer margin (Fig. 2-4), or intercalaries in both the outer margin and between the longitudinal veins (Fig. 3); at least one specimen demonstrated intersected intercalaries (Fig. 4).



Figs. 1-4. Hindwing (hw) variations in *A. pygmaea*. 1) hw with blunt costal process and third vein (Alabama specimen), 2) hw with two free marginal intercalaries (Colorado specimen), 3) hw with basal, third vein and intercalaries (Alabama specimen), 4) hw with intersected intercalaries (Colorado specimen).

Similar to our findings of venational variations in the hindwings of this species, Durfee and Kondratieff (1993) reported nearly identical venational variations of hindwings in their study of *Baetis magnus* McCafferty and Waltz and *B. tricaudatus* Dodds. Based on these studies, workers should use caution in separating at least some species of baetids traditionally discriminated on hindwing characters alone,including species discriminations based on minor differences in wing venation and color (e.g., Waltz 1995).

Based on the above data, including our examination of the reared male compared with the adult paratypes of *Acerpenna harti*, we conclude that *Acerpenna harti* is a junior subjective synonym of *Acerpenna pygmaea*, new synonymy.

ACKNOWLEDGMENTS

The senior author especially thanks Ed C. Becker, Canadian National Collection, Ottawa, for providing access to the types of *Acerpenna harti* and *A. akataleptos* as well as other non-type material of these species. We also thank B. Kondratieff and W.P. McCafferty for loan of other *Acerpenna* material. We thank W. P. McCafferty and A.V. Provonsha for comments on an early draft of this manuscript.

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PLEASE SEE ANNOUNCEMENT ON PAGE 276

REARED ASSOCIATION AND EQUIVALENCY OF *BAETIS ADONIS* AND *B. CAELESTIS* (EPHEMEROPTERA: BAETIDAE)[1]

W. P. McCafferty[2], E. L. Silldorff[3]

ABSTRACT: The examination of reared larvae and adults of a southwestern North American small minnow mayfly species (Ephemeroptera: Baetidae) belonging to the *rhodani* group of the genus *Baetis* indicates that larvae previously referable to *B. caelestis* are actually *B. adonis*. The species names are synonymized, the adult description of *B. adonis* is expanded, and other data associated with this previously poorly known species are updated.

Morihara and McCafferty (1979), in their revision of the *Baetis* species of North America, described the distinctive larvae of three species from western North America that they did not name at the time, but designated simply as species A, B, and C. Those authors were reluctant to assign formal names to those distinctive larval forms because numerous *Baetis* species in western North America remained known only as adults, and there was a reasonable chance that the newly discovered larvae were associated with one of those nominal species.

In the absence of any adult association, Allen and Murvosh (1983) applied the name *B. caelestis* Allen and Murvosh to *B.* sp. A Morihara and McCafferty. Later, Allen and Murvosh (1987) applied the names *B. libos* Allen and Murvosh to *B.* sp. B Morihara and McCafferty, and *B. notos* Allen and Murvosh to *B.* sp. C Morihara and McCafferty, both in the absence of adult associations. In the meantime, however, McCafferty and Waltz (1986) had already named *B.* sp. B as *B. magnus* McCafferty and Waltz because they had associated (by time and location, not rearing) distinct adults with the species that were apparently not previously described, thus suggesting the validity of the species. Based on reared materials, Durfee and Kondratieff (1993) were able to provide the first descriptions of the distinctive adults of *B. magnus*, showing that indeed the species was not known under a prior nomen. Durfee and Kondratieff (1995) later also reared *B. notos* and provided a description of the adult. There remains a slight possibility that *B. notos* is a synonym of the prior name *B. caurinus* Edmunds and Allen (which was based only on adults). Adult characterization associated with the latter two names is possibly within an expected range of variation, and *B. caurinus* has yet to be associated with any larvae.

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Baetis sp. A, as *B. caelestis*, has become better known with recent new reports of larvae from Arizona (Lugo-Ortiz and McCafferty 1995), Chihuahua, Mexico (Lugo-Ortiz and McCafferty 1996), New Mexico (McCafferty et al. 1997), and Texas (McCafferty and Davis 1992). However, because larvae were never reared to adult, the question has remained as to whether or not the name would prove to be a synonym.

Recently, eggs taken from Mission Creek, Santa Barbara County, California, were reared to the larval stage identifiable as *B. caelestis*, and also to the adult stage. Examination of those reared adults has indicated, however, that they are referable to *B. adonis* Traver. *Baetis adonis* is a species that has been known only as adults and was originally described by Traver (1935) from material collected in the San Gabriel Mountains of southern California. The only substantiated subsequent report of that species was that of McCafferty *et* al. (1997) from the Pecos River drainage of eastern New Mexico. Recent examination of alate material on which Day (1963) had based a report of *B. adonis* from Sonoma County in northern California indicated that that material was not referable to *B. adonis*, but probably was *B. diablus* Day.

Morihara and McCafferty (1979) had indicated that the larvae of *B.* sp. A was a member of the *rhodani* species group of *Baetis*, and *B. adonis*, by having the so-called *moffatti* type of genitalia (Traver 1935), would also by definition be placed in the *rhodani* group. Several species besides *B. adonis* were initial candidates for association with *B.* sp. A based on 1) their belonging to the *rhodani* group, 2) being unknown in the larval stage, and 3) being distributed in a reasonable vicinity of southern California. These included *B. palisadi* Mayo, *B. parallelus* Banks, *B. persecutor* McDunnough, *B. piscatoris* Traver, and possibly *B. diablus* Day, *B. sulfurosus* Day, and *B. thermophilos* McDunnough (the species group relationship of the latter three remains in some doubt). *Baetis caurinus* Edmunds and Allen, known only from Oregon and unknown in the larval stage, was easily excluded as a possibility on the basis that it is a member of the *fuscatus* group of species (Edmunds and Allen 1957, Morihara and McCafferty 1979). All others, except *B. adonis* could be excluded on the basis of various characteristics, particularly male genitalia, that were not within the expected range of variation of the characterization expressed by the reared adults under question. The color pattern that Traver (1935) described for *B. adonis* matched well with that of the reared adults. The tone of colors and the body and forewing size did not precisely match, but were within a range of expected variation. Although Traver (1935) did not illustrate or adequately describe the male genitalia of *B. adonis*, identification of reared *B. adonis* from southern California was confirmed by morphological comparisons with type material of that species.

This new association necessitates the following nomenclature adjustment: *Baetis adonis* Traver [= *Baetis caelestis* Allen and Murvosh], **n. syn.** An adequate description of the larvae of *B. adonis* may be found in Morihara and McCafferty (1979:160) as *B.* sp. A, and the basic adult color patterning and hindwing venation is adequately described by Traver (1935:680). The adult description of *B. adonis* is augmented below to include minor variation in size and color traits and a first description of the male genitalia.

Baetis adonis Traver

Material examined. 12 larvae, 55 final-instar larval exuviae, 73 subimagos, 17 male adults, and 12 female adults (all alates reared), California, Santa Barbara County, Mission Creek, VI,VII-1997, E. Silldorff, deposited in the Purdue Entomological Research Collection (PERC). Male adult holotype, allotype, and one male and three female paratypes, California, Los Angeles County, San Gabriel Mountains, VI-3-1932, C. D. Michener, deposited in Cornell University Collection (all type material in alcohol and in very poor condition, with many types broken and deteriorating). One male adult and five female adults, New Mexico, San Miguel County, 5 mi north Pecos, Dalton Fishing Site, VII-13-1969, Koss, McCafferty, Provonsha (PERC).
Male adult. Body length, 5.0-7.0 mm. Forewing length, 5.0-6.5 mm. Base color of head and antennae light reddish brown to medium brown. Dorsal face of turbinate eyes vivid orange, columnar basal area cream (in alcohol). Base color of thorax reddish brown to medium brown to dark olive-brown. Abdominal segments 1-6 ranging from light yellow-brown to medium brown to medium olive brown, varying from pale to intense; segments 7-10 always slightly to considerably darker shade of same colors of segments 1-6, sometimes also appearing opaque. Male genitalia as in Figure 1; base of forceps segment 2 evenly expanding basally and apically into conspicuous more or less symmetrical medially bulbous region, in some bulbous basal area separated from longer narrow portion of forceps segment 2 by somewhat darkened band, or in some entire bulbous basal area of forceps segment 2 darker than remainder of segment; forceps segment 3 relatively short and with demarcation from segment 2 appearing more notched laterally and more fused medially; distal margin between base of forceps segments straight to slightly convex and not notched or emarginate medially.
Distribution. Arizona; Baja California, Mexico; Chihuahua, Mexico; southern California; New Mexico; west Texas.

Remarks. Based on comparisons of male genitalia, it appears that *B. adonis* is related to *B. persecutor*, both of which are very similar with respect to the basal area of forceps segment 2. *Baetis persecutor* is known only from Alberta and British Columbia and remains unknown as larvae. Color patterning in the male adult of *B. persecutor* is quite different than that of *B. adonis*, as is the terminal area of the forceps. The terminal region of the forceps of *B. adonis* is similar to that of *B. diablus*, which is known from the central California coastal area, but otherwise the two species are very distinct.

The mature larvae of *B. adonis* from Santa Barbara are slightly larger than others that have been seen from the Southwest. This may be related to the fact that they were reared for their entire life under ideal laboratory conditions, and were provided with laboratory cultured algae at all times. This slight size increase is possibly reflected in the adult size of approximately 7.0 mm vs. the

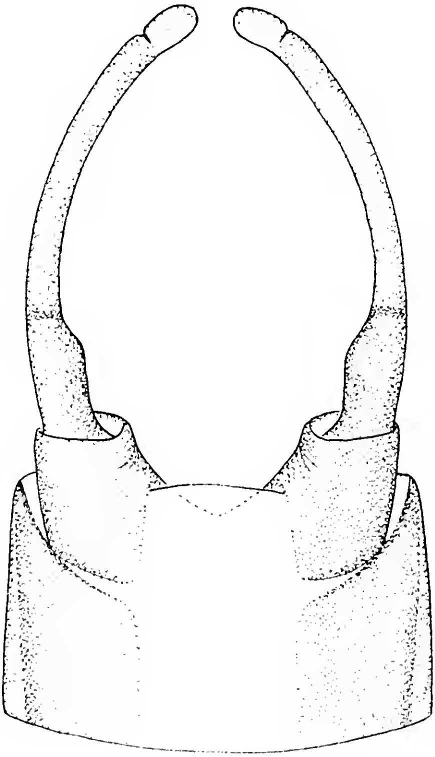

Fig. 1. *Baetis adonis*, male adult, genitalia (ventral view).

5.0 mm of the original type material of this species. We do not know if the predominate olive brown color of the Santa Barbara adults (vs. the yellow-brown of the original material) may also have been related to rearing conditions. Reared females were predominantly reddish brown (quite reddish), and although Traver (1935) described most females of *B. adonis* that she had seen as being yellow-brown or pale reddish brown, she did note that one paratype was wholly reddish brown.

ACKNOWLEDGMENTS

We thank Richard Hobeke (Ithaca, New York) for the loan of type material, Arwin Provonsha (West Lafayette, Indiana) for illustrating the male genitalia, and Carlos Lugo-Ortiz (West Lafayette, Indiana) for his assistance. This paper has been assigned Purdue Agricultural Research Program Journal No. 15610.

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BOOK REVIEW

SPINELESS WONDERS. STRANGE TALES FROM THE INVERTEBRATE WORLD. Richard Conniff. 1997. Owl Books, Henry Holt & Co. NY. 232 pp. $12.95 ppbk.

In this small book, nature writer Conniff offers engaging, yet sophisticated discussions on the natural histories of the invertebrate world, from earthworms, leeches, slime eels, and giant squids, to tarantulas, dragon flies, ground beetles, fleas, moths, mosquitoes, house flies, and fire ants.

For each subject, Conniff obtained the advice and counsel of well recognized authorities and further prepared himself by participating in several ongoing, scientific, field research experiences, often in remote, native environments around the world. Thus, in addition to being interestingly and cleverly written, these are scientifically accurate discussions. *Spineless Wonders* takes one directly to the creepy, crawly frontier of natural science, to the hazards of being around invertebrates, to the bizarre adaptations that enable them to survive in this world, and to the astonishing work they do – work that ultimately enables us to survive.

An adequate bibliography is provided. It is unfortunate the publisher did not see fit to provide a cover that does not curl back on itself when not weighted down.

H.P.B.

ADDITIONS AND CORRECTIONS TO EPHEMEROPTERA SPECIES OF NORTH AMERICA AND INDEX TO THEIR COMPLETE NOMENCLATURE[1]

W. P. McCafferty[2]

ABSTRACT: Heretofore unpublished additions, deletions, and changes to the main checklist of valid North American Ephemeroptera species are provided as are corrections and additions to the nomenclatural index of all names historically associated with them. Index modifications include the addition of 44 new entries and corrections to 21 previous entries.

Subsequent to the appearance of "The Ephemeroptera Species of North America and Index to Their Complete Nomenclature" (McCafferty 1996), certain omissions and minor errors have been discovered. These emendations have come to light primarily as a result of preparing the database of Nearctic Ephemeroptera reflected in McCafferty (1997a), which is strictly predicated on original orthography of species, and of close scrutiny of the literature associated with the Canadian fauna currently under study. Data revealed specific synonyms that had not appeared previously as well as additional name usage (spelling and combinations) found for certain species. In order to maintain the highest degree of utility of the North American index to mayfly species nomenclature (McCafferty 1996), these pertinent modifications are presented below. Additional recent significant changes and corrections to the list and index not covered below can be found respectively in the revision of *Ameletus* by Zloty (1996) and adjustments to names by McCafferty (1997b); however, for all changes published since McCafferty (1996), particularly with regard to occasional new species and synonyms being published, the regularly updated "The Mayflies of North America" found at the Mayfly Central World Wide Web cite <http://www.entm.purdue.edu/entomology/mayfly/mayfly.html> should be consulted. Additions and corrections are given below both for the main numerically sequenced checklist of species and for the alphabetical index. In the index, species names appear in italics only for the current valid form of the name as per the McCafferty (1996) format.

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MODIFICATIONS TO THE NUMERICAL CHECKLIST

Delete

003. *Choroterpes ferruginea* Traver, 1934
004. *Choroterpes fusca* Spieth, 1938
005. *Choroterpes hubbelli* Berner, 1946
132. *Brachycercus floridicola* Soldán, 1986
137. *Brachycercus pini* Soldán, 1986

Corrections

016. *Leptophlebia bradleyi* Needham, 1932
363. *Baetis moffatti* Dodds, 1923
574. *Heptagenia adaequata* McDunnough, 1924
636. *Rhithrogena notialis* Allen & Cohen, 1977
671. *Stenonema terminatum terminatum* (Walsh), 1862

MODIFICATIONS TO THE ALPHABETICAL INDEX

Additions

Baetis curiosus (McDunnough), 1923 - 432
Baetis moffati Dodds, 1923 - 363
Baetis pallidula McDunnough, 1924 - 357
Baetis persecuta McDunnough, 1939 - 367
Blasturus cupidus (Say), 1823 - 018
Blasturus grandis Traver, 1932 - 019
Brachycercus pallidus (Ide), 1930 - 133
Callibaetis tessellatus (Hagen), 1861 - 399
Campsurus manitobensis Ide, 1941 - 092
Cloeon chlorops McDunnough, 1923 - 355
Cloeon punctiventris McDunnough, 1923 - 371
Cloeon virilis McDunnough, 1923 - 378
Ecdyonurus fuscus (Clemens), 1913 - 672
Ecdyonurus peterseni Lestage, 1930 - 542
Ecdyonurus werestschagini (Tshernova), 1952 - 619
Ecdyurus hyalinus Esben-Petersen, 1916 - 542
Epeorus undulatus Banks, 1924 - 642
Ephemerella fuscata (Walker), 1853 - 179
Eurycaenis pallida Ide, 1930 - 133
Heptagenia abnorme Tshernova, 1949 - 542
Heptagenia abnormis Tshernova, 1949 - 542
Heptagenia adequata McDunnough, 1924 - 574
Heptagenia luridipennis (Burmeister), 1839 - misidentification of 667
Heptagenia verticis (Say), 1839 - 085
Heptagenia werestschagini Tshernova, 1952 - 619
Iron petulans Seemann, 1927 - 635
Isonychia annulata Traver, 1932 - 515
Isonychia aurea Traver, 1932-524
Isonychia thalia Traver, 1934 - 515
Leptophlebia concinna (Walker), 1853 - 018
Leptophlebia hebes (Walker), 1853 - 018
Leptophlebia ignava (Hagen), 1861 - 018
Leptophlebia pallipes (Walker), 1853 - 018
Oreianthus sp. 1 Traver, 1937 - 126
Paraleptophlebia compar Traver, 1934 - 033
Paraleptophlebia pallipes (Hagen), 1875 - 049
Potamanthus rufus Argo, 1927 - 082
Pseudocloeon virilis (McDunnough), 1923 - 378
Rhithrogena fusca (Walker), 1853 - 634
Rhithrogena imanica Bajkova, 1972 - 619
Siphlonurus bernice McDunnough, 1923 - 509
Siphloplecton basalis (Walker), 1853 - 477
Stenonema carolina (Banks), 1914 - 646
Stenonema tessellata (Walker), 1853 - 672

Corrections

Ameletus montis Mayo, 1952 - 313
Baetis moffatti Dodds, 1923 - 363
Brachycercus floridicola Soldán, 1986 - 129
Brachycercus pini Soldán, 1986 - 134
Brachycercus sp. A Berner, 1950 - 129
Choroterpes ferruginea Traver, 1934 - 002
Choroterpes fusca Spieth, 1938 - 002
Choroterpes hubbelli Berner, 1946 - 002
Cinygma deceptiva McDunnough, 1924 - 555
Cloe mollis Hagen, 1861 - 051
Cloeon vicinum Hagen, 1861 - 471
Epeorus humeralis Morgan, 1911 - 573
Heptagenia adaequata McDunnough, 1924 - 574
Leptophlebia bradleyi Needham, 1932 - 016
Paraleptophlebia bradleyi (Needham), 1932 - 016
Pseudocloeon carolina (Banks), 1924 - 335
Pseudocloeon cingulatum McDunnough, 1931 - 353
Rhithrogena hespera Banks, 1924 - 561
Rhithrogena notialis Allen & Cohen, 1977 - 636
Rhithrogena petulans (Seemann), 1927 - 635
Thraulus albertanus McDunnough, 1931 - 077

ACKNOWLEDGMENTS

I would like to thank Manny Pescador (Tallahassee, Florida), Bob Waltz (Indianapolis, Indiana), and Boris Kondratieff (Fort Collins, Colorado) for calling my attention to certain information. This paper has been assigned Purdue University ARP No. 15537.

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SCIENTIFIC NOTE

ADDITIONS TO IOWA MAYFLIES (EPHEMEROPTERA)[1,2]

W. P. McCafferty[3], Todd Hubbard[4]

Klubertanz (1995) recorded 66 nominal species of mayflies from the state of Iowa. Thirty-nine of those records represented new state records. Herein we add 10 new Iowa records. Newly reported materials are deposited at the Purdue Entomological Research Collection, West Lafayette, IN (PERC) or the University of Iowa Hygienic Laboratory, Des Moines, IA (IHL).

New state records include *Baetisca obesa* (Say) [larvae, Black Hawk Co, falls access, VI-9-1973 (PERC)]; *Homoeoneuria ammophila* (Spieth) [larvae, Ida Co, Maple R, VIII-5-1997 (IHL)]; *Labiobaetis dardanus* (McDunnough) [larvae, Ida Co, Odebolt Cr, VIII-5-1997 (IHL)]; *Leucrocuta juno* (McDunnough) [adults, Story Co, Ames, VIII-1-1991 (PERC)]; *Procloeon irrubrum* Lowen and Flannagan [all larvae, all IHL: Dickinson Co, Little Sioux R, IX-4-1996; Webster Co, Lizard Cr, IX-11-1996; Kossuth Co, Black Cat Cr, VIII-13-1997; Shelby Co, West Nishnabotna R, VIII-15-1997; Warren Co, Whitebreast Cr, VIII-1-1997]; *Procloeon rufostrigatum* (McDunnough) [larvae, Webster Co, Lizard Cr, IX-11-1996 (IHL)]; *Procloeon viridoculare* (Berner) [all larvae: Buchanan Co, Bear Cr, VIII-8-1996; Winnishiek Co, Canoe Cr, IX-9-1997 (IHL)]; *Rhithrogena jejuna* Eaton [larvae, Winnishiek Co, Upper Iowa R nr Kendallville, IX-22-1991 (PERC)]; *Stenacron candidum* (Traver) [adults, Black Hawk Co, Cedar Falls, VII-1-1973 (PERC)]; and *Stenacron carolina* (Banks) [adults, Black Hawk Co, Cedar Falls, VI-10-1973 (PERC)].

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Klubertanz, T. H. 1995. Survey of Iowa mayflies (Ephemeroptera). J. Kans. Entomol. Soc. 68: 20-26.

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[1] Received April 3, 1998. Accepted April 4, 1998.

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TAXONOMIC NOTES ON EVANIODINI (HYMENOPTERA: BRACONIDAE), WITH REDESCRIPTION OF *EVANIODES SPATHIIFORMIS* AND DESCRIPTION OF A NEW SPECIES[1]

S. M. Barbalho[2], A. M. Penteado-Dias[3]

ABSTRACT:.The monobasic *Pariodes* (Hymenoptera: Braconidae, Doryctinae, Evaniodini) is synonymized with *Evaniodes* Szépligeti, 1901, thus *P. spathiiformis* Szépligeti, 1901 is returned to *Evaniodes*. Redescription and illustrations of male and female *Evaniodes spathiiformis* are provided as well as a description of a new species, *Evaniodes marshi*.

The tribe Evaniodini (Hymenoptera: Braconidae, Doryctinae) was created by Fischer (1981) for two species described by Szépligeti (1901) from Brazil, and characterized by the elevation of the metasoma above the hind coxa. One of these species, *Evaniodes areolatus* Szépligeti, is known only from the female while the second species, *E. spathiiformis* Szépligeti, is known from the male and female. Szépligeti (1901) differentiated the two species primarily by the shape of the first metasomal tergite (T1) (4 times longer than wide in *spathiiformis;* 3 times longer than wide in *spathiiformis*) and by color (*spathiiformis* reddish-yellow with black head and antenna and bicolored wings; *areolatus* more extensively black with wings almost hyaline). Roman (1924) noted that both sexes of *E. spathiiformis* had a closed 1st subdiscal cell in the fore wing and lighter body color; the female was larger and the male had a more compact hind wing venation illustrated by him as from *spathiipennis.* He also described *areolatus* as being smaller than *spathiiformis;* with body color black with reddish-brown areas and the fore wing brachial cell more or less open.

Because of the pronounxced differences between the two species, Fischer (1981) described a new genus, *Pariodes*, with *spathiiformis* (male) as its type and only included species. He did not mention the female used by Roman (1924). His redescription of *E. areolatus* indicates that the propodeum has a pentagonal cell and the hind wing has more complete venation compared to *P. spathiiformis.* Differences between the two include eye height in comparison to temporal height; clypeus height; notauli (rounded or straight, deep or not deep); venation of hind wing; fore wing 1st subdiscal cell open in *E. areolatus* and closed in *P. spathiiformis;* size of fore wing; T1 height versus apical width and size of the body.

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Belokobyl'skiy (1993) also treated these two species as being valid for the tribe Evaniodini and shows the following characters for the tribe: elevated abdomen; thorax short and swollen; notauli complete; sternauli not developed; propodeum with or without areola; fore wing 1st subdiscal cell closed; hind coxa with an antero-ventral basal tubercle; T1 pedicellate and T2 and T3 smooth. Marsh (1993) incorrectly included both *E. areolatus* and *P. spathiiformis* in the group of Braconidae with no antero-ventral basal tubercle on the hind coxa.

Based on the study of male and female specimens of *E. spathiiformis* and the male of a new species from Brazil, we propose to synonymize *Pariodes* Fischer with *Evaniodes* Szepligeti, thus returning *spathiiformis* to the genus *Evaniodes*. We compared male and female *Evaniodes* specimens with the descriptions in the literature and found the only difference between them was in the hind wing venation (Figs 1,2) with M+CU and cu-a meeting at junction of SC+R1, R1, SR and 2-M, with 1-M and r-m absent in the male and veins M+CU, 1-m and 1r-m distinct, SC+R1 reaching R1 before the middle of the wing in the female.

For the morphological terminology used in this paper, see van Achterberg (1993).The following abbreviations are used to indicate deposition of specimens: (INPA), Instituto Nacional de Pesquisas da Amazonia, Brasil, (INPA), Instituto Nacional de Pesquisas da Amazonia, Brasil, (MPEG), Museu Paraense Emélio Goeldi, Brasil, (DCBU) Departamento de Ecologia e Biologia Evolutiva da Universidade Federal de São Carlos, Brasil.

Evaniodes spathiiformis Szépligeti, 1901

(Figs 1-4)

Female

Head.- 2.3 times wider than long, 1.5 times wider than mesonotum; occipital carina present; gena smooth, face height and width equal, possessing transverse striation; clypeus transversely striated, 2.5 times broader than height, rounded ventrally; face as broad as basal width of mandible; very large eyes occupying most of head; in lateral view, eye height 1.35 times greater than length and 3.6 times longer than gena; antenna length shorter than body length; antennae with 46 antennomeres; first flagellomere length 1.7 times longer than second, succeeding antennomeres gradually shorter and thinner, placodes evident.

Mesosoma.- Length 1.2 times longer than width; mesonotum 1.3 times wider than long; tegula trapezoidal; deep and light-crenulate notauli touching each other in rugose area at base of mesonotum, with accompanying sparse hairs; scutellar sulcus with 5 cross carinae; scutellum smooth with setae in apical area; propodeum smooth with no pentagonal areola and sparsely setose; pronotum smooth with posterior sulcus; mesopleuron smooth; sternaulus not deep, epicnemial carina present extending to medium area of mesopleuron; metapleuron with sparse hairs; metasternum large and long; hind coxa with weakly distinct antero-ventral basal tubercle; first tarsomere about 2 times longer than second, second 1.2 times longer than third plus fourth, fourth 2 times longer than third, fifth 2.5 times longer than fourth; apical tibial spurs short (1/6 of basitarsus) (Fig. 1).

Fore wings.- Not reaching end of metasoma; 6.4 mm in length; stigma moderately broad , 6.7 times longer than vein r; r almost as long as stigma width; 3-SR length 1.4 times longer than 2-SR vein; SR1 straight and 2.5 times longer than 3-SR; SR1 vein reaching end of wing; m-cu straight and interstitial; 2b cell square-shaped; 2-CU1 length 2.8 times longer than m-cu; cu-a vein postfurcal; 4a cell closed at apex, vein CU1b present and distinctly meeting 2-1A; CU1a vein arising below middle of 4a cell (Fig. 2).

Hind wings.- Veins M+CU, 1-M and 1r-m distinct; SC+R1 reaching R1 before middle of wing; M+CU as long as 1-M; 1-M 2 times longer than m-cu; m-cu almost reaching posterior side of the wing (Fig. 3).

Metasoma.- Inserted high on the propodeum, distance between insertion of metasoma and hind coxa about equal in length to hind coxa; T1 long and thin, 3.3 times longer than apical width, apical width slightly longer than basal one; T1 striated only at apex; T2 striated and wider than long as well as remaining tergite; T3 striated at base and rugose at apex; remaining tergites smooth.

Ovipositor.-Much longer than body length.

Color.- Head black; mandibles yellow with apical area black; yellow palps; antennae brown; thorax fully yellowish; legs brown (only mesocoxa is yellow); metasoma with basal third light brown and apical area black; wing membrane infuscated, stigma and veins yellow.

Variation in female.-Head black with dark-brown gena and occiput; eye height greater (varying between 3.4 to 3.6) than gena; notauli very deep; 2 sulci in pronotum, dorsal smooth, ventral crenulated; apical width of T1 varying between 3.0 to 3.2 times longer than basal width; T2 and T3 fully striated with no rugose area; body length between 7.0 and 8.9 mm.

Variation in male.- Clypeus 1.7 to 2.25 broader than its height; eye height 2.3 to 3.1 longer than gena, 2.3 to 3.1; wings (Fig. 4) slightly longer than body, between 6.4 to 7.1 mm; in hind wing veins 1-M and r-m absent, M+CU and cu-a meeting at junction of SC+R1, R1, SR and 2-M; T1 3.8 to 4.3 times longer than its apical width; body length 6.0 to 7.4 mm.

Distribution.- Known only from Brazil : Belem (Para State), Manaus (Amazonas State), and Mato Grosso State.

Material examined. 1 female (INPA), "Est. Cemat. R. Humb. MT, 26.IX.1975"; 1 female (MPEG), "Amazonas, Manaus, 1Km W Taruma, Falls, 14.II.1981, 100 m G. Okis, primary forest"; 1 female (DCBU), "Reserva Ducke, Manaus, Amazonas, E.V.Silva & A. Faustino, 3. V. 1968", 1 male (INPA), "Est. Am 1, Km 101, Mn.Am., Brasil, V. 1968, col. several"; 1 male (MPEG) "Brasil, Pa, Belem, Mocambo, 31.VIII.1986"; 1 male (DCBU) , "F. Esteio, Res. 1112, Manaus, ZF3, Km 23, B. Klein, col., 3. I. 1986".

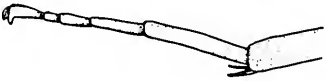
Evaniodes marshi Barbalho & Penteado-Dias SPEC. NOV.

(Fig. 5)

Male

Head. - with many hairs; 1.5 times longer than wide, 1.5 times wider than mesonotum; occipital carina present; gena smooth, face height and width equal, possessing transverse striation; clypeus transversely striated, as broad as long , straight ventrally; face as broad as mandibular base width; very large eyes occupying most of head; in lateral view, eye height 1.2 times greater than length and 3.6 times longer than gena; first flagellomere length 1.9 times longer than second, succeeding antennomeres gradually shorter and thinner.

Mesosoma.- Length 1.6 times longer than wide; tegula elliptical; shallow and light-crenulate notauli not touching each other at base of mesonotum, with accompanying sparse hairs; mesoscutum smooth and shining; scutellum smooth with setae in the apical area; propodeum rugose with no pentagonal areola and with many hairs; mesopleuron smooth , with many hairs, as well as middle coxae; sternaulus absent, epicnemial carina present extending to medium area of mesopleuron; metapleuron with many hairs; hind coxa without an antero-ventral basal tubercle; first tarsomere about 2 times longer than second, second as long as third plus fourth, fourth 2.4 times shorter than third, fifth 2.1 times longer than fourth; apical tibial spurs short (1/6 of basitarsus); hind femora with a large blister like swelling anteriorly near base (Fig. 5).



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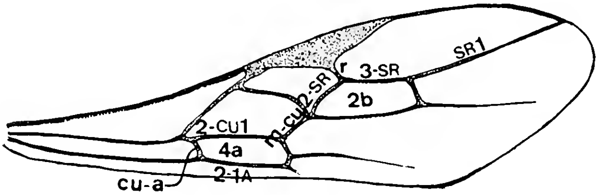

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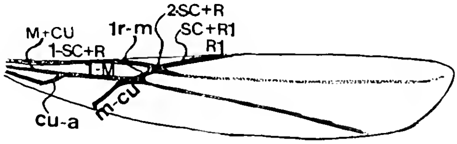

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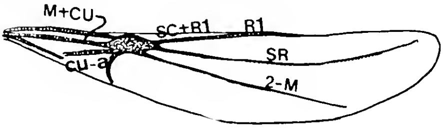

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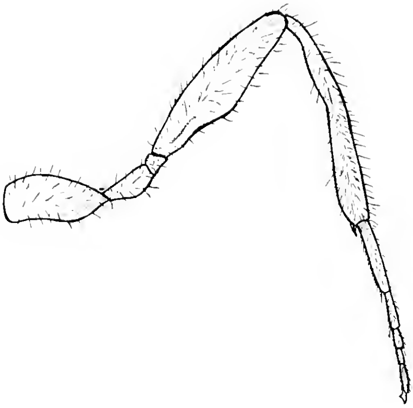

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Figures 1- 4. *Evaniodes spathiiformis* .1, female, hind tarsus; 2, female, fore wing; 3, female, hind wing; 4, male, hind wing.
Figure 5. *Evaniodes marshi* spec. nov. .male, hind leg.

Fore wings.-Not reaching end of metasoma; 5.7 mm in length; stigma moderately broad , 4.6 times longer than vein r; r shorter than stigma width; 3-SR as long as 2-SR vein; SR1 straight and 2.5 times longer than 3-SR; SR1 vein reaching end of wing; m-cu straight and joining 2M before 2 RS; 2b cell square-shaped; 2-CU1 length 2.6 times longer than m-cu; cu-a vein postfurcal; first subdiscoidal cell closed at apex, vein CU1b present and distinctly meeting 2-1A; CU1a vein arising below middle of 4a cell .

Hind wings.- Veins 1-M and r-m absent, M+CU and cu-a meeting at junction of SC+R1, R1,SR and 2-M.

Metasoma.- Inserted high on propodeum, distance between insertion of metasoma and middle coxa about equal in length to middle coxa; T1 long and thin, 2.7 times longer than apical width, apical width slightly longer than basal width; T1 striated only at apex; T2 striated and wider than long ; T3 striated; remaining tergites smooth.

Color.- Head black; mandibles yellow with apical area black; yellow palps; antennae black; thorax fully black; fore and middle legs yellow (except middle coxa brown), hind legs dark brown; metasoma brown; wing membrane lightly infuscated, stigma and veins brown.

Material examined.- Holotype, Brazil, Amazonas, Jurua, Mineruazinho. 1 male , 25/I/96 (deposited in INPA). Female unknown.

Etymology.- Named for Paul M. Marsh because of his contributions to the knowledge of Doryctinae wasps .

Key to species of *Evaniodes.*

1a- Propodeum with a pentagonal cell; 1st subdiscal cell open .... *E. areolatus* Szépligeti
1b- Propodeum without a pentagonal cell; 1st subdiscal cell closed. .... **2.**
2a- Body fully black and with many hairs; hind femora with a blister like swelling anteriorly near base (known only from male)............. *E. marshi* spec. nov
2b- Body fully yellow and with sparse hairs; hind femora without a blister anteriorly near base.................................... *E. spathiiformis* Szépligeti

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ZORCADIUM BERGROTH, AN OBJECTIVE JUNIOR SYNONYM OF *PSEUDOBEBAEUS* FALLOU (HETEROPTERA: PENTATOMIDAE)[1]

D. A. Rider[2], Christian Fischer[3]

ABSTRACT: *Zorcadium* Bergroth, 1918, is placed as an objective junior synonym of *Pseudobebaeus* Distant, 1911 based on study of their respective type species, *Pseudobebaeus goyazensis* Distant, 1911, a junior synonym of *Euschistus truncatus* Fallou, 1888.

While working on a catalog of the Pentatomidae of the world, a number of nomenclatural problems have been discovered. Many of these problems have already been corrected (Rider & Rolston 1995, Rider 1997). The problem dealt with in this paper concerns two monotypic genera that were at one time placed in separate families, but their respective type species are here shown to be conspecific.

Pseudobebaeus Distant, 1911

Pseudobebaeus Distant, 1911: 254; Kumar, 1974: 20; Fischer, 1996: 83-87. Type species: *Pseudobebaeus goyazensis* Distant, 1911, by monotypy.

Zorcadium Bergroth, 1918: 307-308; Rolston & McDonald, 1981: 259, 269; Rider, 1994: 194, 217-218. Type species: *Euschistus truncatus* Fallou, 1888, by monotypy. **New Synonymy.**

Description: See Rolston & McDonald (1981) and Rider (1994) for detailed descriptions of this taxon under the name *Zorcadium*. Also, see Fischer (1996) for descriptive notes on *Pseudobebaeus*.

Pseudobebaeus truncatus (Fallou, 1888), NEW COMBINATION

Euschistus truncatus Fallou, 1888: 36.

Euschistus trancatus [sic]: Bergroth, 1892: 263.

Thoreyella truncata: Lethierry & Severin, 1893: 176; Kirkaldy, 1909: 137.

Pseudobebaeus goyazensis Distant, 1911: 255; Fischer, 1996: 83-87, figs. 1-6. **New Synonymy.**

Zorcadium truncatum: Bergroth, 1918: 308; Rolston & McDonald, 1981: 269, 270, figs. 32-39; Rider, 1994: 218, figs. 136-148.

Description: See Rolston & McDonald (1981) for detailed description under the name *Zorcadium truncatum*, and Fischer (1996), for descriptive notes under the name *Pseudobebaeus goyazensis*.

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ENT. NEWS 109(4) 274-276, September & October, 1998

Distribution: Brazil, Peru.

Specimens Examined: 2♂♂, 3♀♀. 1♂, Brazil, UZMH; 1♂, Brazil: Mato Grosso: 10°25' S, 59°28' W, 17-22-III, DAR; 1♀, Brazil: Goiás [lectotype of *Pseudobebaeus goyazensis*], BMNH; 1 ♀ PERU: Andres Avelino Caceres: Satipo, 10-VIII, USNM; 1♀, Peru: Andres Avelino Caceres: Tingo Maria 1km E of town, forested eastern foothills of the Andes, 5-VIII, BMNH.

DISCUSSION

Fallou (1888) described *Euschistus truncatus* from Minas Gerais, Brazil. Although this species is brown and superficially resembles other species of *Euschistus* Dallas, Bergroth (1892) suggested that it probably belonged in a new genus related to *Thoreyella* Spinola. He later (1918) described *Zorcadium* to hold this single species. This is the position in which the senior author (DAR) treated this taxon in his (Rider 1994) conspectus of the tribe Procleticini.

Distant (1911) described *Pseudobebaeus goyazensis* apparently from a single female specimen from Goiás, Brazil. Although Distant did not specifically state that this species belonged with the acanthosomatids, it is obvious that this was his intended placement. His paper does not contain any subheadings below Pentatomidae; it does treat (in order) scutellerids, pentatomids (pentatomines), pentatomids (asopines), and acanthosomatids. He placed *Pseudobebaeus* between the asopines and the acanthosomatids and stated that it was "allied to *Bebaeus*, Dall., in general appearance and structure of head and lateral pronotal angles; ..." *Bebaeus* Dallas is properly a member of the Acanthosomatidae. Kumar (1974) followed Distant in placing this species in the family Acanthosomatidae and further placed it in the Blaudusinae: Lanopini. The junior author (CF), after examining the female lectotype, presented convincing evidence that this species did not belong in the Acanthosomatidae (Fischer 1996), but its specific placement within the Pentatomidae remained a mystery.

DAR, while reviewing the above paper by CF, noticed that the illustrations of *Pseudobebaeus goyazensis* were similar to his own illustrations of *Zorcadium truncatum* presented in the procleticine conspectus. Further discussion, and a re-examination by DAR of the lectotype of *Pseudobebaeus goyazensis* confirmed that the two species were conspecific. Although the holotype of *Euschistus truncatus* is apparently lost (Rolston and McDonald 1981), its identity has not been in question; a voucher specimen designated by Rolston and McDonald (1981) was examined. *Pseudobebaeus* has priority over *Zorcadium*, but *P. goyazensis* will fall as a junior synonym of *Z. truncatum*. Thus the proper combination is *Pseudobebaeus truncatus* (Fallou, 1888). Its proper placement is within the tribe Procleticini in the Pentatomidae.

Note: The first line on p. 217 of the diagnosis for *Zorcadium* in Rider (1994) should read "Juga contiguous anteriorly; ..." with the "not" omitted.

ACKNOWLEDGMENTS

We thank the following individuals for their help in lending specimens pertinent to this project (acronyms are those used in the text; DAR is senior author's collection): Janet Margerison-Knight, British Museum (Natural History), BMNH; T. J. Henry, Systematic Entomology Laboratory, USDA, c/oUnited States National Museum of Natural History, USNM; A. Jansson, Zoological Museum, University of Helsinki, UZMH. We also thank J. E. Eger, DowElanco, Tampa, FL, and L. H. Rolston, Baton Rouge, LA, for their reviews of an early draft of the manuscript.

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MASS APPEARANCE OF LADY BEETLES (COLEOPTERA: COCCINELLIDAE) ON NORTH CAROLINA BEACHES[1]

C. A. Nalepa[2], K. R. Ahlstrom[2], B. A. Nault[3], J. L. Williams[4]

ABSTRACT: A mass appearance of lady beetles on the North Carolina coast was investigated in May of 1996. Six species of lady beetles were identified, with *Hippodamia convergens* and *Coccinella septempunctata* predominating. It is suggested that the insects were first-generation adults dispersing from senescing grain fields.

Several publications document the sudden appearance of hordes of lady beetles (Coccinellidae) on the beaches of oceans and large lakes (Oliver, 1943; Hagen, 1962; Rothschild, 1971;Yan et al., 1983; Majerus and Majerus, 1996). These sporadic mass appearances are not associated with dormancy or aggregation and are usually attributed to the weather. Wind patterns concentrate masses of flying beetles and drop them into bodies of water; large numbers of beetles subsequently wash up on beaches as the result of wind and tides. The number of beetles involved can be staggering. Oliver (1943), for example, described a drift line of dead *Coccinella undecimpunctata* L. at least 13 miles long with 70,000 beetles per linear foot. In the United States the phenomenon has been reported by Lee (1980) in the Great Lakes of the upper midwest, and by Schaefer et al. (1987) along the coast of Delaware. Hagen (1962) reported that masses of *Hippodamia convergens* Guérin-Méneville are occasionally deposited in the Pacific Ocean.

We had the opportunity to investigate reports of a large number of coccinellids washed up on a beach in the city of Kitty Hawk (36.07°N, 75.72°W) on one of North Carolina's barrier islands. Local residents reported that the lady beetles arrived in large numbers on 18 May 1996. On 25 May 1996 we collected and identified 919 insects from debris east of the primary dune. Of these, 96% were predaceous coccinellids, 3% were other Coleoptera, and 1% were assorted Hemiptera and Diptera. Seven percent of the insects were alive when collected, and all but the Diptera were identified to species (Table 1). Six species of lady beetles were collected, with *Hippodamia convergens* and

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ENT. NEWS 109(4) 277-281, September & October, 1998

Coccinella septempunctata L. dominating (55.8% and 41.5% of Coccinellidae collected, respectively).

To determine if this mass appearance was a localized anomaly, one week later (1 June 1996) we visited Wrightsville Beach, NC (34.21°N, 77.80°W), 281 km south of Kitty Hawk. Seventy-two dead beetles were collected in debris at this location: *H. convergens* (51.4%), *C. septempunctata* (44.4%), *C. munda* (2.8%), and *C. maculata lengi* (1.4%). The three non-coccinellids collected were identified as *Chrysomela scripta* (Fabricius). These beetles were all dead and infrequently encountered. We suspect that the insects collected at both Kitty Hawk and Wrightsville Beach were remnants of the same phenomenon, but most of the beetles at the latter location had washed or blown away by the time we visited.

The species collected at Kitty Hawk are a common assemblage of lady beetles in North Carolina and are reported in varying proportions from crops and ornamental plantings (Kidd, 1996; Nault, unpublished data; Nalepa, unpublished data). All are aphidophagous to varying degrees, conforming to the prevailing hypothesis that mass appearances of lady beetles on beaches are related to the nature of their aphid diet (Hodek, 1973; Hodek et al., 1993). Aphids rapidly increase in number under favorable conditions, but this abundance is sporadic and ephemeral in most habitats (Hodek, 1973). Aphidophagous lady beetles, in turn, have evolved two traits that predispose them to tracking prey of this nature. First, they are able to respond to an abundance of prey with spectacular increases in population size (Hagen, 1962; Hodek, 1973; Hodek and Honek, 1996; Majerus and Majerus, 1996). Dickson et al. (1955), for example, estimated that nearly 54,000 adult coccinellids emerged from one acre of alfalfa heavily infested by aphids. Second, aphidophagous lady beetles are more nomadic than species that use other food sources, and may switch among several habitats with suitable prey during one vegetational season. They are especially prone to fly when hungry (Ewert and Chiang, 1966a,b; Hodek et al., 1993; Hodek and Honěk, 1996; Majerus and Majerus, 1996).

In explaining the mass shoreline appearances of aphidophagous coccinellids, Hagen (1962) proposed a plausible chain of events subsequently echoed and endorsed by other authors (Hodek, 1973; Hodek and Honěk, 1996; Majerus and Majerus, 1996). Favorable environmental conditions, i.e., massive aphid populations and optimal weather, allow for a high fecundity of female coccinellids and a low mortality of larvae and pupae. Juvenile populations build quickly, and when the young adult beetles of this generation emerge, there is stiff competition for remaining prey. Hunger increases their mobility, and a hot day may bring them into the air by the millions; beetles in flight may be further concentrated by thermals and prevailing winds. The insects are brought back to earth *en masse* by air currents at the coast and perhaps a reluctance to cross expanses of water. Those that land in water are washed back onto the coast by wave action and tides.

Hodek and Honěk (1996) consider the species composition of these mass appearances purely accidental "pseudo-communities" that may not resemble coccinellid communities of any habitat in the vicinity; they cite Klausnitzer's (1989, 1992) work on the German coast of the Baltic Sea. This researcher compared relative abundance of coccinellid species from seashore collections with those present in nearby pine forests and found little correlation. The timing and species composition of the mass appearance of coccinellids on North Carolina beaches in 1996, however, suggests the possibility that these originated in grain fields prevalent in the eastern half of the state. First, nearly 700,000 acres of small grains were harvested in this area of North Carolina during 1995; harvest typically begins in late May and early June (Meadows, 1996). Second, adults of the first generation of coccinellids emerge in late May, at about the same time grain is senescing (Kidd, 1996; Nault, unpublished data). Third, over most of North Carolina prevailing winds near the earth's surface blow from the southwest. The direction may be interrupted and reversed due to offshore storms or diurnal fluctuations (Hardy et al., 1967). Fourth, two of the major species comprising the beach population were also abundant in nearby grain fields. Lady beetles swept from wheat at the Tidewater Research Station near Plymouth in Washington County on 3 May 1996 consisted of 38.3% *C. septempunctata*, 30.4% *H. convergens*, and 31.3% *C. maculata* (n = 240) (Kidd, 1996).

The presence of *C. septempunctata* and *H. convergens* at the beach is not difficult to explain. *C. septempunctata* is primarily an aphid predator (Gordon, 1985) prone to population explosions (Hodek and Honěk, 1996; Majerus and Majerus, 1996), is a strong flier (Marriner, 1939), and is the dominant species collected from mass aggregations on coastlines (Rothchild, 1971; Yan et al., 1983; Schaefer et al., 1987). During the breeding period, the most important movements of *C. septempunctata* in Europe occur after aphids disappear from cereal stands, when the emergence of new adults more or less coincides with a decline in aphid populations in the fields (Hodek and Honěk, 1996). *H. convergens* represented a higher proportion (55.8%) of our beach collection than has been reported in the past. In the coastal collection described by Schaefer et al. (1987), for example, just 5.3% were identified as *H. convergens*. This coccinellid is strictly aphidophagous, and can be the most abundant species present in cereals (Gordon, 1985; Hodek and Honěk, 1996: Table 5.16). If the lady beetles that appeared on the North Carolina coast in 1996 indeed originated from small grain, then *Coleomegilla maculata* is conspicuous by its relative absence from the beach. Although its scarcity might be due to variation in demographic parameters (i.e., adults of the first generations of *C. septempunctata* and *H. convergens* may have emerged and flown while *C. maculata* were still pupae), we think a better explanation lies in host range differences among species. While the primary food source of *C. septempunctata* and *H. convergens* is aphids, *C. maculata* is perhaps the most polyphagous lady beetle known, feeding on aphids, other insect prey, insect eggs, fungi, and pollen (Hodek, 1973; Hilbeck and Kennedy, 1996). Up to 50% of the diet of *C. maculata* can be composed of pollen from various plants (Forbes, 1883). As such, the life history of this species is not strongly tied to aphid demographics (Ewert and Chiang, 1966b), and it is less prone to long distance movements (Hodek and Honěk, 1996). After the collapse of aphid populations in small grain, new adults of *C. maculata* can support themselves on nearby alternative food instead of undertaking a risky dispersal flight in search of aphid prey. Voucher specimens have been deposited in the North Carolina Department of Agriculture Insect Collection, Raleigh.

Table 1. Insect species collected from beach debris at Kitty Hawk, North Carolina, on 25 May 1996 (*n* = 919 insects; 7 Diptera were not identified).

Family	*Species*	*No.*
Coccinellidae	*Hippodamia convergens* Guérin-Méneville	493
	Coccinella septempunctata L.	367
	Cycloneda munda (Say)	15
	Harmonia axyridis (Pallas)	6
	Coleomegilla maculata lengi Timberlake	2
	Anatis labiculata (Say)	1
Scarabaeidae	*Macrodactylus angustatus* (Beauvois)	3
Chrysomelidae	*Diabrotica undecimpunctata howardi* Barber	8
	Chrysomela (*Microdera*) *scripta* (Fabricius)	7
	Leptinotarsa decemlineata (Say)	5
	Calligrapha (*Coreopsomela*) *californica coreopsivora* Brown	2
Saldidae	*Saldula major* (Provancher)	1
Pentatomidae	*Neottiglossa* (*Texas*) *cavifrons* Stål	1
Cydnidae	*Sehirus cinctus* (Beauvois)	1

ACKNOWLEDGMENTS

We thank Robin Goodson and George Kennedy for commenting on the manuscript, and alert citizen Jenny Rand for reporting the coastal coccinellid convergence.

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PLEASE SEE ANNOUNCEMENT ON PAGE 276

BIOLOGICAL AND MORPHOLOGICAL NOTES ON *DASYHELEA PSEUDOINCISURATA* (DIPTERA: CERATOPOGONIDAE)[1]

Lawrence J. Hribar[2]

ABSTRACT: *Dasyhelea pseudoincisurata* larvae were collected from a waste tire and a bucket. Larvae presumably fed in algae in these containers, but after collection they fed only on dead insects. Larval thoracic pigmentation is described. Pupae move rapidly across the substrate with the aid of abdominal spicules. The mean pupal period was 2.1 days. Attempts to recover eggs from reared adults were unsuccessful.

Little is known about the immature stages of many biting midges (Ceratopogonidae), and even basic details of life history, including larval habitat and feeding behavior, are poorly understood for most species. During a survey of containers for *Aedes albopictus* (Skuse), a number of biting midge larvae were collected from an old tire and from a plastic bucket. These larvae were placed into a plastic petri dish along with water from the larval habitat. Pupae were collected and placed into separate dishes to await adult emergence. The adults reared from these larvae were identified as *Dasyhelea pseudoincisurata* Waugh & Wirth (1976).

Dasyhelea spp. larvae may be found in a number of different habitats, including natural cavities. *Dasyhelea pseudoincisurata* has been collected from treeholes and cavities in rocks (Waugh & Wirth 1976). Wirth & Waugh (1976) found other *Dasyhelea* spp. larvae in cavities in tree stumps. Collections of *Dasyhelea* larvae from artificial containers are not often reported, but they are by no means unknown. For example, Remmert (1953) described *Dasyhelea tecticola* from specimens collected in rain gutters.

When *D. pseudoincisurata* larvae were collected, their alimentary tracts were filled with a green material. This material was believed to be algae, however, microscopic examination of one larva's alimentary tract revealed mostly unidentifiable debris, although fungal spores were present. During rearing, larvae were fed dead mosquito, chironomid, and psychodid larvae, mosquito pupae, and a gravid adult female bibionid. These were first killed by crushing them with forceps, after which all were consumed by the *Dasyhelea* larvae. The *Dasyhelea* larvae began feeding at the wound site, and one *Dasyhelea* larva pulled a mosquito's alimentary tract outside of its body and began feeding on its contents. Other *Dasyhelea* larvae ignored the prey's alimentary canal and instead fed on fat body and muscle tissue of the mosquito. The feeding behavior of the *Dasyhelea* larvae resembled that of some *Bezzia*

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ENT. NEWS 109(4) 282-284, September & October, 1998

larvae (Hribar & Mullen 1991). Some *Dasyhelea* larvae used their anal crochets to hold themselves in place while feeding. It appeared that only the third and fourth instar *Dasyhelea* larvae fed on mosquitoes. Twice, younger larvae were seen attempting to feed, but these were pushed aside by the vigorous feeding of the older larvae. Younger larvae are probably not strong enough to compete against older larvae. *Dasyhelea* larvae most often are said to feed on algae and fungi (Mullen & Hribar 1988). However, Lee & Chan (1985) reported that *Dasyhelea ampullariae* Macfie larvae fed on mosquito larvae in the same habitat. Mosquitoes and *Dasyhelea grisea* (Coquillett) can coexist in the same habitat with no apparent harm to either species (Baumgartner 1986).

Thoracic pigmentation of the larvae was a brown coloration present on the dorsal aspect which extended toward the ventral surface on the prothoracic and mesothoracic segments. On these segments the pigment was distributed in an easily recognizable pattern (Fig. 1), but the prothorax was more strongly

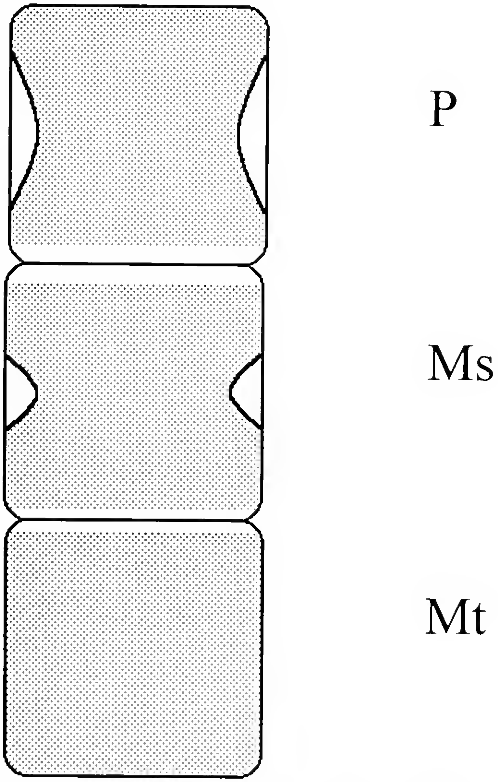

Fig. 1. Thoracic pigmentation of *Dasyhelea* larvae collected in waste tire; P - prothorax, Ms - mesothorax, Mt - metathorax.

pigmented than were other thoracic segments, with less pigmentation present on the abdominal segments. The crochets on the anal segment were large and arranged in a starburst pattern. The larva of *D. pseudoincisurata* is undescribed, and these characters may permit larvae to be distinguished from those of other species.

Pupae were placed into separate plastic petri dishes lined with moist filter paper at ambient room temperature, which varied from 23° C to 26° C (74° F to 78° F). Pupae were active and used their large distinctive spicules to move rapidly across filter paper. Average length of the pupal stage was 2.1 days; 23 adults were reared. Adult males used their foretarsi to groom their antennae. There are long spines at the base of the tarsus, and perhaps these also are used for grooming. Adults were provided with 10% sucrose solution as an energy source for possible mating and oviposition, but these attempts to collect eggs were not successful.

While laboratory conditions do not duplicate natural conditions, *D. pseudoincisurata* larvae will feed on a range of offered prey. The distinctive pattern of the larvae may be useful for species identification. I thank W.L. Grogan, Jr., Salisbury State University, for identifying the midges. D.A. Shroyer, Indian River Mosquito Control District, and G.L. Miller, USDA, commented on the manuscript

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PLEASE SEE ANNOUNCEMENT ON PAGE 276

EASTWARD RANGE EXTENSION IN CANADA OF THE ALDERFLY *SIALIS VELATA* (MEGALOPTERA: SIALIDAE), AND THE POTENTIAL OF THE GENUS AS A CONTAMINANT MONITOR[1]

Isabelle Roy[2], Landis Hare[3]

ABSTRACT: We report on a range extension for *Sialis velata* (Megaloptera: Sialidae) in eastern Canada and assess the potential of the genus as a metal biomonitor.

Sialis velata Ross is reported from the province of Quebec for the first time since its original collections (Ross 1937). Ours is the first record of any *Sialis* species from the province since 1937. All previous collections of the five *Sialis* species known from the province (*S. velata, S. iola, S. itasca, S. mohri* and *S. vagans*) were from the extreme southwestern corner near the city of Montreal (≈ 44°N, 73°W) (Ross 1937; Whiting 1991). It is now possible to extend the range of *S. velata*, north to the 47th parallel, and east to the Quebec City region (71°W). Ours is the most easterly record for *S. velata* in Canada. Only two *Sialis* species are known to occur in Canada east of Quebec City, i.e., *S. mohri* (New Brunswick) and *S. vagans* (New Brunswick and Nova Scotia) (Ross 1937, Whiting 1991). Because we have found *Sialis* larvae in the majority of the Quebec lakes that we have visited, the lack of collection records in eastern Canada is likely a consequence of a lack of effort in collecting adults and rearing larvae rather than the rarity of the genus in eastern Canada.

Adults of *S. velata* (five males, three females) were reared from a large number of larvae collected on May 18 1997, from soft mud at a depth of 5 m in a Shield lake (Lake St-Joseph; 46°55'N, 71°40'W). *Sialis* larvae for rearing were held individually in small plastic containers, in 50 ml of water that was renewed weekly, and fed live chironomid larvae. Gut content analysis indicated that larvae in the field fed largely on chironomids and oligochaetes, as has been reported by previous investigators (Azam and Anderson 1969, Pritchard and Leischner 1973, Canterbury 1978). When individual larvae exhibited agitated swimming behavior at the water surface they were transferred to a small plastic container filled with a mixture of sand and soil for pupation. In the laboratory, pupation and adult emergence were highly successful at room temperature (10% mortality), but not at 10°C (100% mortality). Our results are consistent with those of Elliott (1996), who found that pupation success could be described by a quadratic equation with a threshold at approximately 7°C and an optimum at 15°.

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ENT. NEWS 109(4) 285-287, September & October, 1998

Our interest in the larvae of *Sialis* relates to their potential as a contaminant biomonitor by virtue of the following properties (with quotations from Phillips and Rainbow 1993):

1. **Widespread and abundant** «Biomonitors should be abundant throughout the study area.» The genus occurs throughout the Holarctic region. In our studies, larvae were collected in 21 of 34 Quebec and Ontario lakes sampled in a cursory manner. This ease of collection suggests that larvae are abundant when present.

2. **Easily kept in the laboratory** «The organism used should be easy to sample and hardy enough to survive under laboratory conditions.» We have captured *Sialis* larvae using both grabs and diver-operated benthic nets. We can keep *Sialis* larvae for periods of up to 3 months at 10°C in the laboratory in water alone (no sediment) with weekly feeding of live chironomid larvae. Given this ease of maintenance in the laboratory, *Sialis* larvae could be used to probe mechanisms of contaminant accumulation and toxicity.

3. **Large size** «The organism should provide sufficient tissue for contaminant analysis. » We have successfully measured several trace metals in whole individual larvae as well as in various larval tissues (pooled samples of several individuals; Hare et al. 1991).

4. **Contaminant tolerant** «Contaminants should be accumulated without lethal impacts to the species employed.» An effective biomonitor should be found along the full range of contaminant concentrations encountered in nature. *Sialis* species are found in lakes influenced by acid mine drainage (e.g., Gatewood and Tarter 1983), or metal smelters (Hare and Tessier, unpublished), both of which tend to be characterized by low pH's (down to pH 4) and high concentrations of trace metals (e.g., up to 14 nM total dissolved Cd). This is a clear indication of metal and hydrogen ion resistance in *Sialis*.

5. **Relation between animal and contaminant concentrations** «A simple correlation should exist between the contaminant content of a biomonitor and the average contaminant concentration in its ambient environment.» Initial analysis of data from 17 lakes suggests that Cd concentrations in *Sialis* are directly related to those of the free metal ion, Cd^{2+}, when the competitive effect of hydrogen ions on biological uptake sites is taken into account (e.g., Hare and Tessier 1996).

Given the above-described characteristics of *Sialis* larvae, their potential as a contaminant biomonitor seems high. However, the effective use of these larvae as metal biomonitors could be improved by acquiring more information on their: (i) Feeding: we do not know how *Sialis* larvae obtain trace metals, i.e. from the water in contact with their gills, or from the food they eat. This information will help us to determine if food-related variables such as prey type, trophic position and metal assimilation rates (at present largely unknown) should be included in the development of predictive bioaccumulation models; (ii) Burrowing: because *Sialis* larvae are burrowers (Charbonneau et al. 1997), more information on the depth, form and rate of burrowing could be useful in understanding their exposure to sedimentary metals.

ACKNOWLEDGMENTS

We thank Michael F. Whiting for the identification of *S. velata*. For their technical assistance, we thank M.-R. Doyon, J.P. Baillargeon, B. Patry, and R. Rodrigue. Funding is acknowledged from Fonds pour la formation de Chercheurs et l'aide à la Recherche (F.C.A.R.) and Human Resources Development Canada.

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GYNANDROMORPH OF *HELICOVERPA ARMIGERA* [LEPIDOPTERA : NOCTUIDAE][1]

A. Josephrajkumar, B. Subrahmanyam, V.V. Ramamurthy[2]

ABSTRACT: A gynandromorphic moth was observed in a laboratory culture of the American bollworm, *Helicoverpa armigera,* with external characters of female on the left and of male on the right side. Dissection revealed the presence of a testis and an ovary on the trans-lateral positions of the moth, respectively.

A gynandromorph is an individual in which one part of the body is masculine and the other is feminine. Among insects, bilateral gynandromorphs are most frequent, in which the left and right halves are of different sexes (Mayr and Ashlock, 1991). However, anteroposterior gynandromorphs and forms with irregular mosaic-like distributions of sexual characters also are known (Richards and Davies, 1977).

In *Drosophila melanogaster* of XX chromosomal constitution, a gynandromorph arises through the loss of one X chromosome in one of the early cleavage nuclei of the embryo, so that deficient (XO) cells form male tissue while those with a full complement of sex chromosomes yield female tissues (Wilbert, 1953). Gynandromorph also can result from the "double fertilization" of abnormal eggs possessing two nuclei, one of which gives rise to male and the other to female tissues (White, 1968). Some parasitic Hymenoptera yield many gynandromorphs at unusually high temperatures (Bowen and Stern, 1966).

Lepidopteran gynandromorphs have been recognised in species with sexual dimorphism where the male has coloration and/or pattern elements that typically differ from those of the female. Hence, notable sexual differences in phenotype appear on the two halves of the adult. An extraordinary hybrid gynandromorph containing wing-pattern genes from at least three subspecies of *Heliconius melpomene* (Lepidoptera : Nymphalidae) was reported by Emmel and Boender (1990). A rare gynandromorph of *Nacophora quernaria* (Lepidoptera : Geometridae) from Florida showed a perfectly bilateral division between the male and female with different antennae, the thorax, and the posterior anal tufts of the abdomen (Kutis and Heppner, 1990).

At the Division of Entomology, Indian Agricultural Research Institute, New Delhi, a gynandromorph of *Helicoverpa armigera* arose for the first time in a laboratory colony reared on the artificial diet of Singh and Rembold (1992). Incidentally, this has been observed in a routine experiment with plumbagin, a napthaquinone of plant origin having insect growth regulatory activity, where the larva received a dose of 100μg g^{-1} applied topically.

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[1] Received August 25, (1997). Accepted December 17, 1997.

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Over 20 generations, the normal coloration of the moths in the laboratory culture is unaffected by the diet and they perfectly resembled those collected at light or those emerged from larvae collected from chickpea, pigeonpea and cotton fields. The female moth of *H. armigera* is dull orange-brown with a 'V' shaped marking on forewing and dull black border on the hindwing. Forewing of male is greyish-green and poorly marked beyond the transverse posterior line (Hardwick, 1965).

The single gynandromorph specimen observed had an orange-brown colored forewing on the left side and greyish-green colored forewing on the right. The color pattern fits perfectly with that of a female on the left and male on the right. The posterior anal tufts of the abdomen were prominent on both sides [Fig. 1]. Dissection of the moth revealed the presence of a testis and accessory glands on the left side and an ovary and colleterial glands on the right side [Fig. 2]. The placement of sex organs is therefore opposite to that of the sexual differences in the external color pattern. The specimen is unique in this regard. Though the moth survived for over one week on 10% honey solution, it is not known if the moth might have been reproductively viable. Examination of the moths of this species from the National Pusa Collection of our Division has not revealed the occurrence of any specimen with such a mosaic of external coloration.

Fig. 1 Gynandromorph of *Helicoverpa armigera* (Hubner) Left side forewing : female pattern, right side : male pattern (Scale line = 0.5 cm).

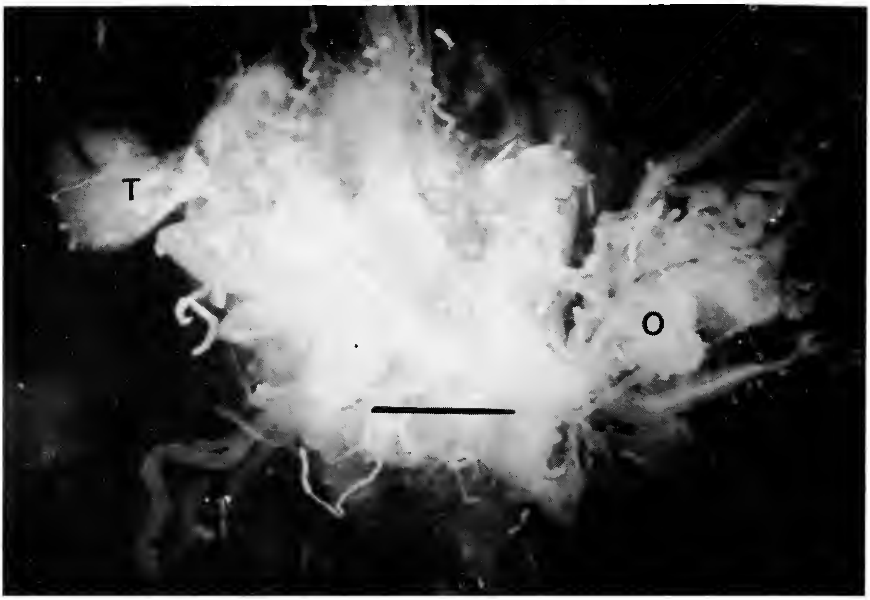

Fig. 2 Reproductive organs of the gynandromorph (Note the testis (T) on the left side and the ovary (O) on the right side, the opposite placement of the wing pattern) (Scale line = 2.0 mm).

DISCUSSION

Females of Lepidoptera are heterogametic (ZW) whereas males are homogametic (ZZ). The chromosomal constitution of eggs, rather than the sperm cells, determine the sex of the progeny. Gynandromorphs may arise due to loss of the Z chromosome during early zygotic divisions or due to double fertilization of binucleate (ZW) eggs. The loss of a Z chromosome in ZZ zygotes is a major cause of gynandromorphism (Robinson, 1971). This results in an embryo that is both female (ZO) and male (ZZ). The gynandromorph noticed in this study is an interesting case and deserves careful analysis. We found no reference to such a condition in the literature on gynandromorphs.

Mitotic spindle orientation at the first zygotic division is always random. In *D. melanogaster* subsequent mitotic products of the first two daughter nuclei do not intermingle before they migrate to the cellular blastoderm. Consequently, a half male/female gynandromorph shows large contiguous patches of male/female tissue, whose pattern of distribution is governed by the orientation of the first zygotic spindle. A left versus right symmetrical distribution of male versus female cuticular tissue in this *H. armigera* gynandromorph specimen demonstrates that early blastoderm cells in *H. armigera* do not intermingle as in *D. melanogaster.*

Gynandromorphs are powerful tools for following the clonal history of cells and producing fate maps of the blastoderm (Hotta and Benzer, 1972). The adult wings are derived from wing imaginal discs while the male and female somatic reproductive structures are mesodermal in origin. Ferrus and Kankel (1981), in a mosaic analysis of cuticular and muscular tissues in *D. melanogaster,* showed that wing epithelial cells often attach to clonally unrelated muscle cells. Even though the converse was not stated by Ferrus and Kankel (1981), it implies that clonally unrelated cells come to occupy extrinsically-related positions due to extensive cell movement in *Drosophila* during embryogenesis. Comparatively little is known about embryogenesis and morphogenetic movements in *Helicoverpa*. Considering that male and female reproductive cells of mesodermal origin occupy positions trans-lateral to clonally-related epidermal cells in our *H. armigera* gynandromorph specimen, we conclude that similar extensive cell movements occur in *H. armigera* during mesodermal differentiation also.

The influence of pesticidal molecules, including plumbagin, on epistatic sex determination has not been well-studied. Intersexes arise due to disturbances of the epistatic relationship between male and female determining genes during development. Such forms are common in *Aedes* sp. exposed to higher temperatures and in *Lymantria dispar* when genetically distinct strains are crossed (Richards and Davies, 1977).

Therefore, the insect under study can at the best be regarded as a natural gynandromorph occurring at an extremely low frequency (0.000125%, i.e., one out of 8000 insects reared so far), as also observed in *N. quernaria* by Kutis and Heppner (1990) and in *H. melpomene* by Emmel and Boender (1990).

ACKNOWLEDGMENTS

The authors are extremely grateful to N. Ramakrishnan, Division of Entomology and Shanti Chandrasekharan, Division of Genetics, I.A.R.I., New Delhi for reviewing the manuscript.

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SOCIETY MEETING OF APRIL 22, 1998

Andrew Short
Glasgow High School/Univesity of Delaware

ENGINEERED STREAM SYSTEMS AS TOOLS FOR MACROINVERTEBRATE RESEARCH

Mr. Short has done research on the effects of elevated nutrient levels on benthic macroinvertebrates. He has designed and used artificial stream systems that are capable of maintaining extended pristine conditions. He received the Society's Calvert Award in 1996 for his work.

In the first part of his talk, Short discusssed the uses of artificial streams in dealing with riparian ecosystems as well as their applications in macroinvertebrate studies. Designs of his own stream systems were shown along with designs from Stroud Water Research Center and other engineered environments. Construction materials and methods for engineered environment construction were presented. Procedures for the collection of sediments and organisms, such as community block injection, and system operation were also given. Short described the function and uses of algal turf scrubber technology as an advisable alternative to other water filters and purifiers.

During the second part of this talk, Short presented his current research on the effects of elevated nutrient levels on benthic macroinvertebrates in artificial streams. Short outlined the procedures for data collection in the engineered systems. He discussed his results, in which certain populations of macroinvertebrates, primarily Trichoptera: Hypopsychidae, experienced significant declines over control populations, immediately after nutrient elevation. The nutrient factors used in the initial trials were nitrate nitrogen and soluble phosphorus, in concentrations consistent with poultry manure runoff that might be experienced regionally as a consequence of current agricultural practices. These population declines took place without the effects of eutrophication taking place. In subsequent trials, nitrate nitrogen elevation alone showed no negative effect on similar macroinvertebrate populations.

– W. J. Cromartie,
Correspnding Secretary

A NEW SPECIES OF *SWELTSA* (PLECOPTERA: CHLOROPERLIDAE) FROM EASTERN NORTH AMERICA[1]

Boris C. Kondratieff[2], Ralph F. Kirchner[3,4]

ABSTRACT: *Sweltsa holstonensis*, new species, is described from southwestern Virginia. The new species is most similar to *Sweltsa urticae*. The male epiproct of both species are illustrated for comparison.

The genus *Sweltsa* in the Eastern Nearctic is represented by eight species (Kondratieff and Kirchner 1991). These species, with the exception of *S. naica* (Provancher), form a monophyletic lineage based on male epiproct shape. Two species of this group, *S. urticae* (Ricker) and *S. voshelli* Kondratieff and Kirchner, are related and constitute a distinctive clade within the group. Both species have the epiproct broadly dorsolaterally flanged and occur in small streams of the Southern Appalachian Mountains. A third member belonging to this clade was recently discovered in southwest Virginia by Bill P. Stark and Ralph F. Kirchner.

Sweltsa holstonensis NEW SPECIES

(Figs. 1-2)

Male.- Body length 7.5-8.0 mm. Macropterous, length of forewing 8.5-9.0 mm. General color bright yellow in life, yellow-white in alcohol. Head with three dark ocellar rings. Pronotum with black margins, no median stripe. Middorsal region of abdominal terga 1-9 with black dashes or stripes. Terga 9 with transverse ridge (Figs. 1-2). Epiproct erectile, inflated in dorsal view (Fig. 1), forming a flange laterally for most of its length, covered with appressed golden hairs; in lateral view deeply incurved on distal fourth forming a dorsally directed hook, apex projecting above dorsal plane and not transversely compressed; ventral aspect convex in lateral view (Fig. 2).

Female.- Body length 9.5-10.5 mm. Macropterous, length of forewing 10-10.5 mm. General color and pattern as male. Subgenital plate about as long as wide, lateral margins slightly incurved; apex acutely rounded, about one-fifth width of plate.

Types.- Holotype male, Washington County, Virginia, Little Moccasin Creek, County Rt. 690, 15 May 1997, B. P. Stark and R. F. Kirchner. Paratypes, same data as holotype, 2 males; same data as holotype but 19 May 1998, R. F. Kirchner, 3 males, 3 females. The holotype will be deposited in the United States Museum of Natural History, Smithsonian Institution, Washington D.C., and paratypes in the collection of R. F. Kirchner and the C.P. Gillette Museum of Arthropod Diversity, Colorado State University.

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[4] The views of this author do not purport to reflect the position of the Department of the Army or the Department of Defense.

Etymology.- The specific epithet refers to the Holston Valley of the Great Appalachian Valley of Virginia. In Virginia, the Great Valley is divided into the Shenandoah, Roanoke, New, and Holston Valleys based on drainage systems. Little Moccasin Creek flows into the North Fork of the Holston River at Holston.

Diagnosis.- Males of *S. holstonensis* can be distinguished from *S. urticae* by the hook of the epiproct lacking the transversely compressed apex (Fig. 3), epiproct ventrally convex, hook of epiproct usually exceeding the level of the dorsal plane, and flange of epiproct covered with appressed golden hairs. Additionally, the male of *S. holstonensis* can be separated from the only other similar species, *S. voshelli*, by an epiproct only 2 to 3 times as long as the greatest width and not gradually tapering to the apex (Figs. 2 and 3, Kondratieff and Kirchner 1991). The female is similar to both *S. urticae* and *S. voshelli*, but can be distinguished from *S. voshelli* by the acutely rounded apex of the subgenital plate (*S. voshelli*, the apex is broadly rounded), and from *S. urticae* by the longer and narrower apex, about one-fifth width of subgenital plate.

Remarks.- Little Moccasin Creek is a high gradient mountain stream originating at Low Gap (1150.3 m) between the Clinch and Brumley Mountains. It flows

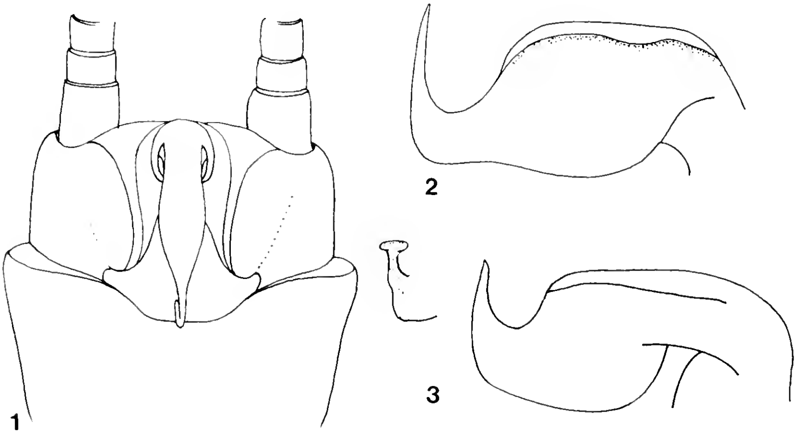

Fig. 1.-3. *Sweltsa holstonensis*. 1. male terminalia, dorsal. 2. epiproct, lateral view. *Sweltsa urticae*. 3. epiproct, lateral view; inset, tip.

south 8.04 km to its confluence with the North Fork of the Holston River (438.9 m) at Holston, just northwest of Abingdon. Most of the original forest was cleared for upland pasture. Virginia's threatened peltoperlid, *Tallaperla lobata* Stark, was also collected from Little Moccasin Creek near Low Gap (Kondratieff and Kirchner 1991). Other species collected with *S. holstonensis* included *Alloperla usa* Ricker, *S. lateralis* (Banks), *S. onkos* (Ricker), and *Yugus* n. sp.

ACKNOWLEDGMENTS

We thank Bill P. Stark, Mississippi College for making the material available. Lynn C. Bjork produced the illustrations.

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BOOKS RECEIVED AND BRIEFLY NOTED

RECENT ADVANCES IN ARTHROPOD ENDOCRINOLOGY. G.M. Coast & S.G. Webster, eds. 1998. Cambridge Univ. Press. 406 pp. $110.00 (hardcover).

Nearly fifty contributors describe current work in selected areas of arthropod endocrinology and highlight directions future studies may take. Endocrine mechanisms are dealt with in the first sixteen chapters, while the final two chapters are concerned with peptide processing and the development of stable lipophilic peptidomimetics.

THE BUTTERFLIES OF WEST VIRGINIA AND THEIR CATERPILLARS. Thomas J. Allen. 1997. Univ. of Pittsburgh Press. 388 pp. 50 plates in color. $37.50 (cloth); $22.95 (trade paper).

Descriptions of 128 species of butterflies, along with their caterpillars and pupae, found in West Virginia. Each species account provides a description and information on distribution, habitat, life history, nectar sources, and larval host plants. Twenty of the fifty colored plates depict larvae and pupae, many not published elsewhere. Included are chapters on studying butterflies and butterfly gardening.

INSECT HORMONES. H. E. Frederick Nijhout. A 1998 paperback edition of a 1994 edition. Princeton Univ. Press. 267 pp. ($19.95 (paper).

The emphasis in this book on insect endocrinology is on the biology of the organism and the ways in which physiological and developmental regulatory mechanisms are integrated into the insect's life cycle.

SOCIETY MEETING OF MARCH 25, 1998

Dr. Joseph K. Sheldon and Mr. Jeff Erikson
Department of Natural Science, Messiah College

SERPENTINE BARRENS OF PENNSYLVANIA AND MARYLAND

Dr. Sheldon began by explaining the nature of serpentine barrens, where they are located, and why they are important ecologically. It was pointed out that the unique soil conditions have resulted in an unusual plant community. The goal of the research currently being conducted by Dr. Sheldon and Mr. Erikson is to determine whether an equally unusual community of insects is associated with the unique plant community in the Nottingham and Goat Hill Serpentine Barrens.

Dr. Sheldon briefly described the survey work already completed on the Lepidoptera by The Nature Conservancy: five species of butterflies and 11 species of moths from Nottingham are listed as rare, threatened, or endangered. Seven endangered Lepidoptera have been recorded from Goat Hill. Dr. Sheldon's work on the Acrididae has found 18 species within the two barrens. Grasshoppers are seasonally active within the barrens from April until the first killing frosts of October or November. No species of special concern (as monitored by The Nature Conservancy) have been encountered to date in the study. It was pointed out that this is not surprising since our current knowledge of Acrididae is not sufficient for most species to be evaluated in terms of their rarity. Additional natural history work on most species across their ranges will be required.

The purpose of Mr. Erikson's study was to gather baseline macroinvertebrate community data and to determine if a proposed trout hatchery could utilize Black Run's water. Black Run is a three mile long tributary which flows over serpentine geology in Nottingham Barrens on its way to Ocotaro Creek (a tributary to the Susquehanna River).

Jeff reported on two unique chemical characteristics at Black Run: a low calcium hardness and a high pH. These parameters did not negatively affect the macroinvertebrate community richness. Over the past nine months he collected more than 100 genera of macroinvertebrates among four sites along this stream. He outlined the different macroinvertebrate orders found and showed their spatial and temporal distributions.

Jeff reported a phoretic relationship between Chironomidae: *Plecopteracoluthus* and Corydalidae: *Anchytarsus* at Black Run.

He concluded that Black Run has a diverse macroinvertebrate community, which could be utilized by trout as food, but he has yet to determine water temperatures and pH levels during the summer season to see if these parameters are too high for trout survival.

In notes of entomological interest, Dale Schweitzer reported that the past winter moth season was the worst ever in southern New Jersey, but that butterflies were present unusually early: two or three species in January, as many as five species in an hour of searching in February. Included were numerous male *Celastrina* "Azures." Butterfly numbers went down in March, following a cold spell.

– W. J. Cromartie,
Correspnding Secretary

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U S ISSN 0013-872X
VOL. 109 NOVEMBER & DECEMBER, 1998 NO. 5

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CEROCOCCUS MICHAELI (HEMIPTERA: CEROCOCCIDAE): A NEW SPECIES OF FALSE PIT SCALE FROM NEW ZEALAND[1]

Paris Lambdin[2]

ABSTRACT: A new species of pit scale insect, *Cerococcus michaeli*, from New Zealand is described and illustrated. *Cerococcus michaeli* represents the second indigenous species to New Zealand and the eighth species from the Australian Region in the genus. This species is distinguished from other species in the genus by the presence of an anal shield with a dorsal opening, spine-like apical setae on anal lobes, the occurrence of asteroform tubular ducts, and the absence of multilocular pores in transverse abdominal rows on the ventrum. A modified key is provided to separate *C. michaeli* from other known species in this taxon.

Species of false pit scales (Cerococcidae) are represented in all major zoogeographical regions, however, most are found in the tropical and subtropical areas. Several species are considered important pests of agricultural crops and ornamentals (Lambdin and Kosztarab 1977). Of the 56 species assigned to the genus *Cerococcus*, only one species, *C. corokiae* (Maskell), has been described from New Zealand. Recently, a new species was found while examining a series of unidentified scale insect material from the coccoidea collection of the National Museum of Natural History, Washington, D.C., USA. This species represents the eighth species known from the Australian Region in this genus.

This new species is placed in the genus *Cerococcus* based on measurements and observations on 37 morphological characteristics of the adult female. The structures evaluated are considered common to species in this genus (Borchsenius 1959, Danzig 1980, Lambdin & Kosztarab 1977). Specifically, the presence of dorsal 8-shaped pores, prominent anal lobes, a triangular anal shield, and cribriform plates are consistent structures for this taxon. In addition, this species has a three-segmented labium, one segmented antennae, bilocular pores, submarginal spiracles and associated spiracular furrows lined with quinquelocular pores on the ventrum. All measurements are rounded to the nearest micrometer. Where possible, 10 measurements of each structure were taken and are presented as an average followed by the range in parentheses. Terminology follows Lambdin and Kosztarab (1977).

Cerococcus michaeli, NEW SPECIES

(Fig. 1a-k)

Type Locality. Coromandel, New Zealand.

Type-Material. Holotype adult (encircled, lower center) and 4 paratype on 1 slide (No. 1651), on *Dysoxylum spectabile*, Coromandel, New Zealand.

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[1] Received:July 2, 1998. Accepted July 27, 1998.

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Description of Slide-mounted Adult Females

Body (Fig. 1a) pear shaped, membranous, 732 (650-820) long, 464 (410-540) wide; with distinct anal cleft; anal lobes (Fig. 1b) elongate, with scale-like overlapping cells, 88 (78-90), long, 49 (48-50) wide, each lobe with an outer (conical) and inner (needle-like) subapical seta, each 7 (6-12), and an stout apical seta (needle-like) 11 (10-12) long.

Dorsal Surface (Left half)

Anal shield (Fig. 1a,b) triangular, with enclosed anterior anal opening, plate 69 (65-75) long, 54 (52-55) wide. Anal ring (Fig. 1a,b) minute, 12 (12-13) in diam., with 6 fleshy setae, each 18 (14-21) long. Cribriform plates (Fig. 1c) unevenly aerolated, 2 pairs, 1 pair each located on segments 7-8 anterior to anal lobes and triangular plate; each 5 (4-7) in diam. 8-shaped pores (Fig. 1d) sparse, appearing to form a swirled pattern on derm with subcircular areas devoid of pores, each 4 (3-5) long, 2 (2-3) wide. Setae (Fig. 1e) sparse, few submedial tack-like setae in longitudinal rows, especially on 6th - 9th abdominal segments, each 2 (2-3) long, other setae rare. Simple disc pores absent. Tubular ducts (Fig. 1f) asteroform, inner ductule reduced, invaginated inner end with 1-3 minute teeth, outer ductule long and slender; scattered throughout derm, more numerous in marginal areas, especially in posterior abdominal region; each 21 (18-25) long, 1 (1-2) wide.

Ventral Surface (Right Half)

Antennae (Fig. 1g) one segmented, 10 (8-12) long, 9 (6-15) wide; with 6 (4-7) setae. No associated quinquelocular pores (Fig. 1h) at base. Bilocular pores (Fig. 1i) subcircular, irregularly spaced, most numerous in submarginal area of cephalothorax, especially around mouthparts, antennae, and spiracles; few occasionally on margin of abdominal segments, each 4 (3-5) in diameter. Clypeolabral shield rectangular, 138 (134-140) long, 115 (112-118) wide. Marginal band of 8-shaped pores (Fig. 1d) extending around body to apex of anal lobes and in transverse rows, one pore wide, on abdominal segments; each 4 (3-5) long, 2 (2) wide. Labium three-segmented, triangular, 54 (51-58) long, 55 (51-58) wide; with 5 (5-6) pairs setae, each 5 (3-6) long. Legs absent. Spiracles (Fig. 1j) located in submarginal area, 29 (28-31) long, 11 (11-12) wide, atrial diameter 4 (3-5); spiracles and spiracular furrows with associated quinquelocular pores, few 4-7 locular pores; anterior spiracle with lateral cluster of 9 (7-11) pores, spiracular furrow with 21 (15-30) pores extending from spiracle to margin; posterior furrows bifid, cluster of 8 (6-10) pores associated with spiracle, 7 (3-11) pores in anterior branch of spiracular furrow and 3 (2-5) pores in posterior branch, each pore 4 (4-5) in diam. Multilocular pores absent. Setae (Fig. 1k) sparse, tack-like, in segmental transverse rows, 3 pairs associated with vulva, 3 medial pairs between antennae, and a seta associated with each spiracle, each 2 (2-3) long. Tubular ducts (Fig. 1f) similar in shape and size to those on dorsum, but fewer on ventrum. Vulva large, ca. 50 in diam., largest among known cerococcids.

Etymology. This species is named for my son, Michael, in tribute to his interests in insects.

DISCUSSION

Morphological similarities of *C. michaeli* to other species in the genus *Cerococcus* include: a similar body shape (pyriform), a long anal cleft and triangular anal shield, cribriform plates, and 8-shaped pores on the dorsum. Ventrally, this species has a three segmented labium, one segmented antennae, and a pair of thoracic spiracles with a bifid posterior furrow lined with quinquelocular pores. Also, the type of pores (bilocular, quinquelocular, and 8-shaped) and their arrangement on the ventrum are also similar to those of other species in the genus. This species is easily distinguished from other species by the presence of an asterolecaniid type of tubular duct. This is the first cerococcid known to have such tubular ducts. The long outer ductile has

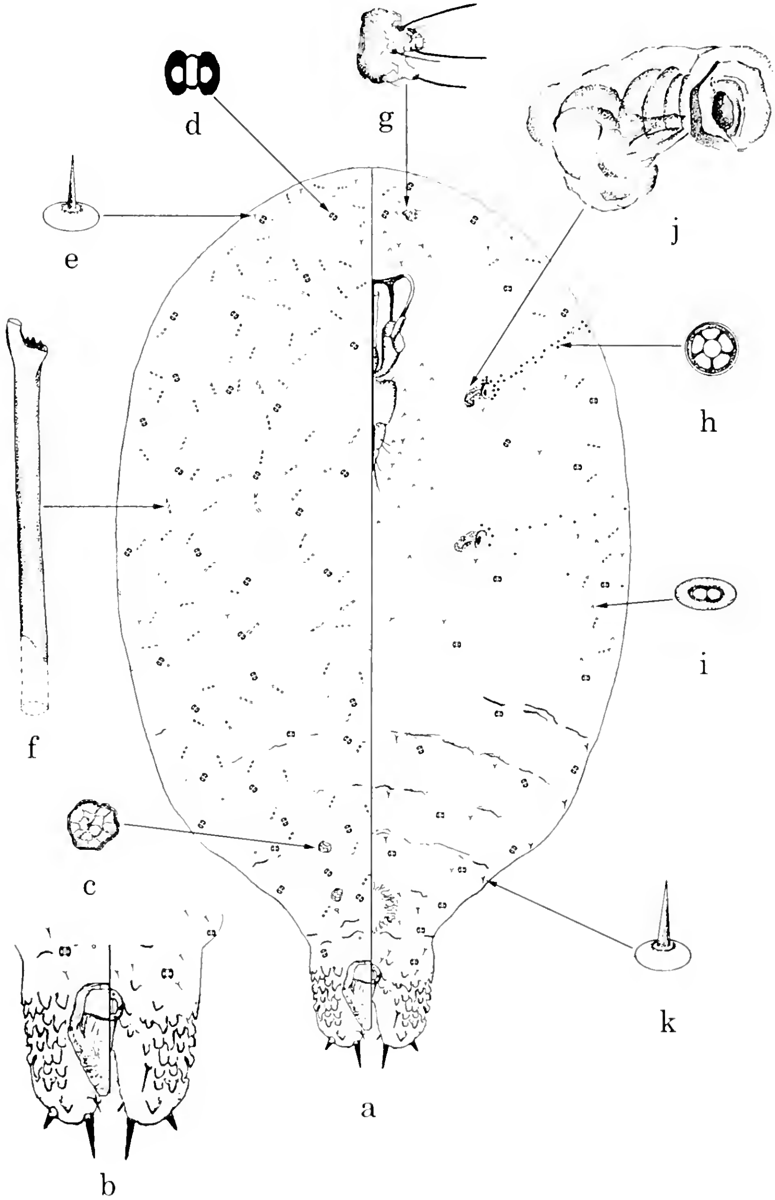

Fig. 1. *Cerococcus michaeli* Lambdin, n. sp.: (a) dorsoventral view; (b) anal lobes and anal shield; (c) cribriform plate; (d) 8-shaped pore; (e) dorsal seta; (f) tubular duct; (g) antenna; (h) quinquelocular pore; (i) bilocular pore; (j) spiracle; (k) ventral seta.

been reduced, but there are one to three teeth within the cup. Also, the anal shield differs somewhat from those typically exhibited by other species of false pit scales. There exists an opening near the anterior margin of the anal shield for waste elimination and the shield curves ventrad, but does not join medially. The minute anal ring is enclosed by the anal shield and has six slender anal ring setae. Of the 56 known species in the taxa, only one other species, *C. gallicolus* Mamet, from Madagascar is known to have six setae. Also, there is a lack of quinquelocular pores at the base of the antennae and multilocular pores on the ventral abdominal segments. In addition, these segments are distinguished by a transverse row of 8-shaped pores.

The other endemic species to New Zealand, *C. corokiae* (Maskell), is distinguished from this species by the presence of more numerous cribriform plates, an anal ring with eight setae, an anal shield without an opening, two sizes of 8-shaped pores, presence of a submarginal row of quinquelocular pores extending from the antennae to the posterior spiracles, and multilocular pores in transverse abdominal rows. *C. michaeli* possess some of the more primitive traits observed in species assigned to this genus (scale-like anal lobes, the unevenly aerolated cribriform plates, and perhaps the tubular ducts).

This new species may be identified using a modified key (Lambdin and Kosztarab 1977) to the adult females of *Cerococcus* as follows:

32. Without quinquelocular pores at base of each antenna 32a
With quinquelocular pores at base of each antenna 33
32a. Posterior spiracular furrows absent; anal shield without dorsal opening; 1-segmented leg stubs present; with multilocular pores in transverse abdominal rows .... *indonesiensis*
Posterior spiracular furrows present; anal shield with dorsal opening; 1-segmented leg stubs absent; without multilocular pores in transverse abdominal rows ...... *michaeli*

ACKNOWLEDGMENTS

Grateful appreciation is extended to D. R. Miller, SEL\ARS USDA, Bldg. 046, BARC-W, Beltsville, MD 20705, for the loan of the material studied. I also thank R. Pereira, D. Paulsen, and Adrian Mayor, University of Tennessee, Knoxville, TN, for their reviews and comments on the manuscript.

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THE LARVA OF *MACROTHEMIS INACUTA* (ODONATA: LIBELLULIDAE)[1]

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ABSTRACT: A detailed description and illustrations of the larva of *Macrothemis inacuta* are provided. Larva is similar to *M. celeno* but can be distinguished by stouter movable hook, and larger lateral spines and dorsal portuberances on abdominal segments 8-9. Larvae were found living in lentic environments, in muddy areas close to the shore, where emerging and floating vegetation was present.

The Neotropical genus *Macrothemis* comprises 37 species described to date (Garrison, in litt.) of which only nine occur in Mexico and Central America (Paulson, 1982; González-Soriano & Novelo-Gutiérrez, 1996). Despite the fact that it is a very speciose genus, its immature stages are poorly known; larvae of only three species have been described: *M. celeno* (Selys) (Klots, 1932), *M. musiva* Calvert (Santos, 1970), and *M. pseudimitans* Calvert (Limongi, 1989). Here, we describe and illustrate the larva of *M. inacuta* Calvert. Terminology of the labium follows Corbet (1953).

Macrothemis inacuta Calvert
(Figs. 1-9)

Description: Exuviae yellowish-brown, larvae brown; body short and robust; integument covered with small spiniform setae.

Head: Two times wider than long, narrowed posteriorly, occipital margin slightly concave, cephalic lobes poorly developed, not bulging (Fig. 1), covered with minute spiniform setae and long delicate setae; compound eyes rather small, slightly more dorsal than lateral. Antennae 7-segmented (Fig. 2), the third the longest, relative length of antennomeres: 0.5, 0.7, 1.0, 0.6, 0.7, 0.8, 0.8; scape mostly pale with a dark dorsobasal spot, pedicel pale with a dark ring on distal end; third antennomere reddish-brown, antennomeres 4-6 dark in basal half, pale in apical half; last antennomere mostly pale with apex dark. Labrum bare, setose on distal border; clypeus bare. Frons and vertex with abundant spiniform setae and long and delicate setae. Mandibles biramous (Fig. 3), external branch with four cusps in both mandibles and a small cusp at base of ventral cusp on right mandible, internal branch vestigial, represented only by three, low, blunt protuberances slightly more developed on right mandible. Maxillae: Galeolaciniae with seven acute teeth (Fig. 4), four large and three smaller; palp with numerous, long, stiff setae, ending in a robust spine. Labium: Prementum-postmentum articulation reaching posterior margin of mesocoxae; prementum subrhomboid with 7+3 and 7+2 setae (Fig. 5a), lateral margins with small spiniform setae, ligula prominent with distal margin very slightly serrate and with a row of stout setae on dorsal surface, but very close to distal margin, its tip .

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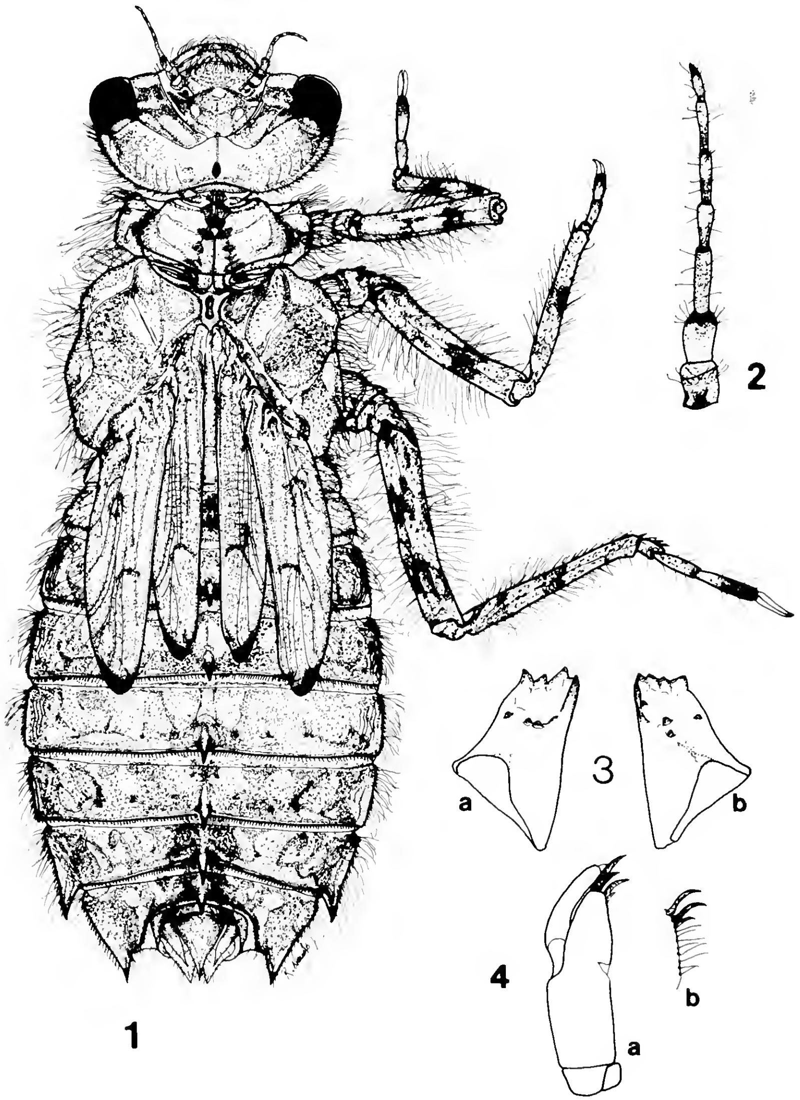


PLATE I. Figs. 1-4, *Macrothemis inacuta* larva. 1) Dorsal habitus of last instar larva (left legs omitted); 2) Left antenna, dorsal view; 3) Mandibles, ventrointernal view: a, left mandible, b, right mandible; 4) Ventral view of right maxilla (a), ventrointernal aspect of the dorsal teeth (b).

Labial palp with six long setae and a row of short, robust, spiniform setae on basal 0.70 of outer margin (Fig. 5c); movable hook robust, incurved, suddenly sharply-pointed, as long as palpal setae (Fig. 5a); distal margin of palp with seven crenations, notches between crenations deep, diminishing in depth from outer margin to internal one, each crenation finely serrate and bearing three stout setae, one large and two small, except the two dorsal crenations which bear only two (Fig. 5c); inner margin of palp with a single row of stout and stiff setae; a group of 7-9 setellae at base of palp close to articulation with prementum; surface of palp sprinkled with dark spots of different sizes in an irregular pattern.

Thorax light brown; lateral and posterior margins of pronotum rounded; pronotal disk yellow with an inverted, dark V-shaped spot on middle part (Fig. 1); anterior margin of proepisternum with a tuft of long stiff setae; proepimeron with a longitudinal reddish-brown stripe on its upper margin. Synthorax mostly dark, pale on sutures. Anterior and posterior wing pads dark, their tips darker brown, reaching and surpassing posterior margin of abdominal segment five respectively. Legs long (*e.g.* hind legs when fully extended reaching beyond the level of anal pyramid); meso- and metacoxae with a distal, ventrolateral, digitiform process (Fig. 6a); femora slightly compressed laterally, dorsal and external surfaces covered with long, stiff setae intermingled with spiniform ones; femora and tibiae pale, with a clear pattern of three transverse bands at basal, middle and distal portions; tarsi yellow, dark on apical 0.50 of third tarsomere; claws simple with a pulvilliform empodium.

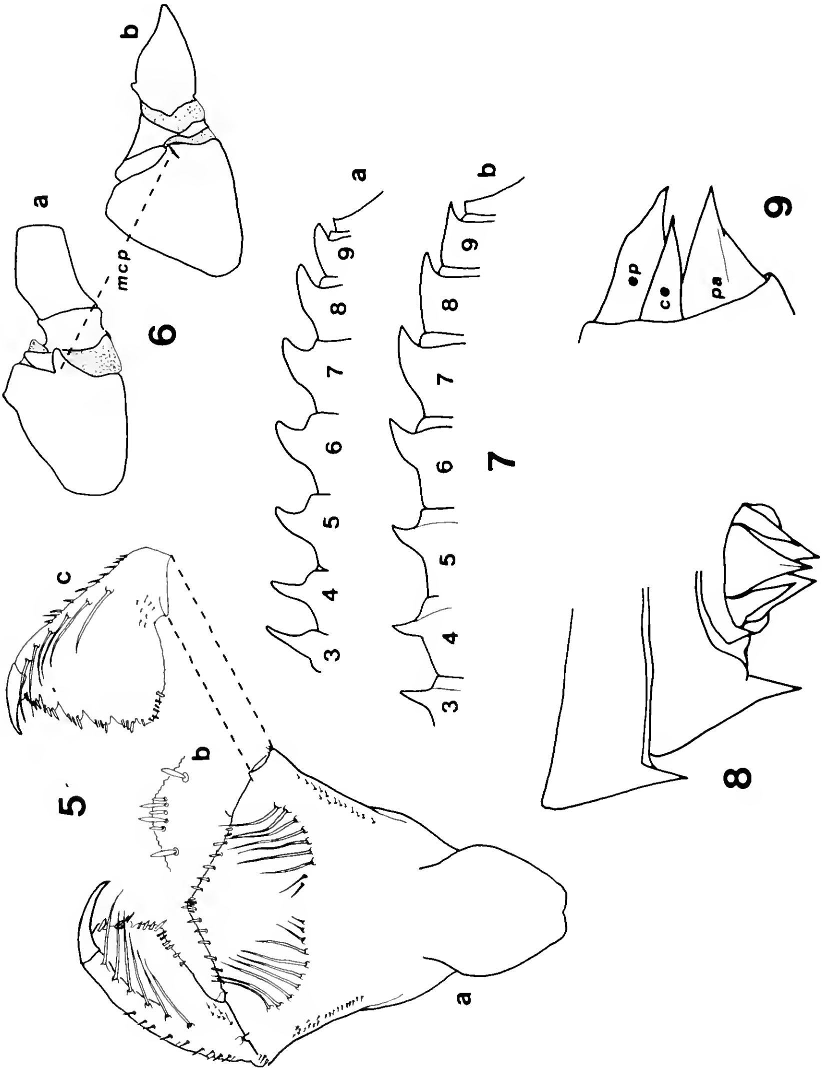
Abdomen reddish-brown, with a complex color pattern shown on Fig. 1; tergites 3-9 with spine-like protuberances well developed, that on 3 almost vertical, remainder gradually directed rearward (Fig. 7a); lateral margins of 2-3 slightly convex, straight on 4-7 and slightly concave on 8-9; those of 2-7 covered with minute spiniform setae which increase in length and robustness on 8-9; lateral spine on 8 0.65 as long as dorsal length of 8; that on 9 as long as or longer than dorsal length of 9, reaching level of tips of cerci (Fig. 8). Gonapophyses indistinguishable, just a minute gonopore visible in male. Epiproct and paraprocts pyramidal, acutely pointed, with small spiniform setae on margins; epiproct little longer than its basal width (ratio 1:0.8), in lateral view (Fig. 9), the basal 0.50 of its dorsal margin slightly concave then becoming straight but slightly slanting. Cerci sharply pointed, shorter than remaining appendages. Epiproct and basal 0.35 of cerci dark, distal 0.65 of cerci and all of paraprocts pale. Size proportions: Epiproct 1.0, paraprocts 1.0, cerci 0.80.

Dimensions (mm): Total length including appendages 17-17.6; abdomen 10.2-10.6; hind femur 4.2-4.4; maximum width of head 4.5-4.6; lateral spines on abdominal segment 8, 0.5; on 9, 0.6-0.7.

Material examined: 2 exuviae (♂♂), reared, 5 last instar larvae (4♂♂, 1♀). MEXICO: Veracruz; Emiliano Zapata, Miradores (Lagoon), 1000 meters above sea level (masl), 8-IX-1996, R. Arce leg., (5♂♂, 1♀) as last instar larvae. Deposited at Instituto de Ecología, A.C. Xalapa, México. COSTA RICA: Provincia de San José; Zona Protectora El Rodeo, 16-XI-1990, A. Ramírez leg., (1♂) as last instar larva. Deposited at Museo de Zoología, Universidad de Costa Rica.

DISCUSSION

The larva of *M. inacuta* closely resembles that of *M. celeno* in the number of palpal setae (6), size proportions on caudal appendages, and general stature. It differs by the larger and stouter movable hook on the labial palp, coxal processes more developed, larger lateral spines on abdominal segments 8-9, and larger dorsal protuberances on 3-9 (mainly those on 8-9). The larva of *M. inacuta* differs from that of *M. pseudimitans* by the stouter movable hook on the labial palp, the larger metacoxal digitiform process (*cf.* Fig. 6), and the shape of the dorsal protuberances on 7-9 (*cf.* Fig. 7). The larva of *M. musiva*



LATE II. Figs. 5-9. Morphology of *Macrothemis* larvae. 5) Dorsal view of prementum (a), detail of ligula (b), and dorsointernal view of right palp (c) of *M. inacuta*; 6) Left metacoxae of *M. inacuta* (a) and *M. pseudimitans* (b), showing metacoxal process (*mcp*), lateroventral view; 7) Profile view of abdominal dorsal line of *M. inacuta* (a) and *M. pseudimitans* (b); 8) Partial figure of abdominal segments 8-10 showing lateral spines on 8-9, dorsal view; 9) Left lateral aspect of differs in having only 8 premental setae on each side of middle (5+3) and only 4 palpal setae. The genus *Macrothemis* has not been clearly defined based upon larvae; this is important in order to differentiate *Macrothemis* from the closely related genus, *Brechmorhoga*. Needham and Westfall (1955) tabulated some features based exclusively on *M. celeno*, but this does not constitute a generic characterization. At present, these genera can be differentiated by the following combination of features (those of *Brechmorhoga* [*cf.* Novelo-Gutiérrez, 1995] in parentheses): Integument mainly setose (granulose), cephalic lobes widely rounded, not bulging (bulging); pronotum with an inverted V-shaped dark mark (without such a mark); inferior margin of proepimeron with long and delicate setae (with short and robust setae); sides of abdomen convex throughout (parallel on segments 5-7); abdominal segment 10 and anal pyramid hidden laterally by the lateral spines of segment 9 (segment 10 and anal pyramid not hidden [partially hidden in *B. rapax*] by spines of 9); posterior margin of sternite 10 usually visible in dorsal view (not visible from above); dorsal protuberances well developed on abdominal segments 3-9, often acutely-pointed (well developed on 2-5 or 2-6, vestigial or lacking on posterior segments, often bluntly-tipped); cerci 0.75-0.80 as long as epiproct (cerci 0.50-0.66 as long as epiproct).

Ecological notes.- Larvae of *M. inacuta* were found in a lagoon in open pasture land, on the muddy bottom near shore where scattered aquatic vegetation grew. Mature larvae were caught on September 8, 1996. The lagoon was visited one year later (September 21, 1997) but no *M. inacuta* larvae were found, although teneral adults were captured in surrounding areas. These preliminary observations suggest potential synchrony (or seasonality?) in emergence of the larvae, probably starting at the end of August or beginning of September. Available published information indicates that all *Macrothemis* species dwell in lotic habitats (García-Díaz, 1938; Limongi, 1989; González-Soriano, 1992). However, Santos (1970) mentioned that *Macrothemis musiva* larvae probably inhabit intermediate lotic and lentic waters. *M. inacuta* is another exception since larvae were collected in lagoons, and adults are seen at streams and rivers. It is likely that when living in a lotic system the larvae favor still waters in pools and areas near the margins.

ACKNOWLEDGMENTS

We thank Roberto Arce-Pérez, M. Sc. for his invaluable help collecting and maintaining alive larvae of *M. inacuta*. We also thank Sidney Dunkle (Plano, TX) and Michael May (New Brunswick, NJ) for their invaluable criticism to improve the final manuscript. A. Ramírez was supported by the National Science Foundation grant DEB95-28434 during preparation of the manuscript.

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A NEW SPECIES OF THE NEOTROPICAL GENUS *BYTHONIA* (HOMOPTERA: CICADELLIDAE) AND THE FEMALE OF *B. CONSENSA*[1]

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ABSTRACT: *Bythonia ferruginea*, new species, is described from the states of Bahia and Minas Gerais, Brazil. The female of *B. consensa* is described for the first time based on specimens from the states of Rio de Janeiro (new record) and Espírito Santo, Brazil. The presence of two sclerotized plates from the sternum VIII is reported in females of *Bythonia* for the first time. Notes on specimens of *B. kalypso* from the Brazilian states of Santa Catarina (new record) and Minas Gerais are added. A map showing the known distribution of the species of *Bythonia* is also presented.

Three species of the Neotropical genus *Bythonia* Oman were recorded by Blocker and Webb (1990). Only a few specimens of this genus were cited in the literature. *B. rugosa* (Osborn, 1923), the type-species, is known only from the female holotype from Bolivia and a male from Peru (Linnavuori 1959). This species was originally described in the genus *Nionia* Ball. *B. kalypso* Linnavuori, 1959 and *B. consensa* Blocker and Webb, 1990 were, until the present paper, known only from their male holotypes from Brazil. The affinities of *Bythonia* to other leafhopper genera were briefly discussed by Blocker and Webb (1990), who assigned this genus to the subfamily Iassinae. The original description by Oman (1936) and subsequent descriptions by Linnavuori (1959) and Blocker and Webb (1990) should be consulted for characteristics of the genus.

A new species of *Bythonia* from the states of Bahia and Minas Gerais, Brazil, is herein described. The previously unknown female of *B.consensa* is described for the first time. This species is newly recorded from the state of Rio de Janeiro, Brazil. Notes on six additional male specimens of *B. kalypso* Linnavuori are added and the species is newly recorded from the state of Santa Catarina, Brazil.

Acronyms for collections in which the specimens herein studied are deposited are as follows: DZRJ (Departamento de Zoologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil), MNRJ (Museu Nacional, Rio de Janeiro), and NHM (The Natural History Museum, London). In quotations of label data, a virgule (/) separates lines on a label and a semicolon separates information on different labels. Morphological terminology follows mainly

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Young (1977). The software package FishMap (Buckup 1995) was used for producing a distribution map of the species of *Bythonia.*

Bythonia ferruginea, NEW SPECIES

(Figs. 1-7)

Diagnosis. – Males of *B. ferruginea* can be distinguished from the other known species of the genus by the following features: pronotum with arrow-shaped group of irregular black spots; sternum VIII with anterior and posterior acute processes on lateral margins; pygofer without processes, ventrolateral portion with longitudinal fold; basal half of styles with blunt dorsal process; aedeagus with pair of lateral processes on apical third and without median spine on apodeme.

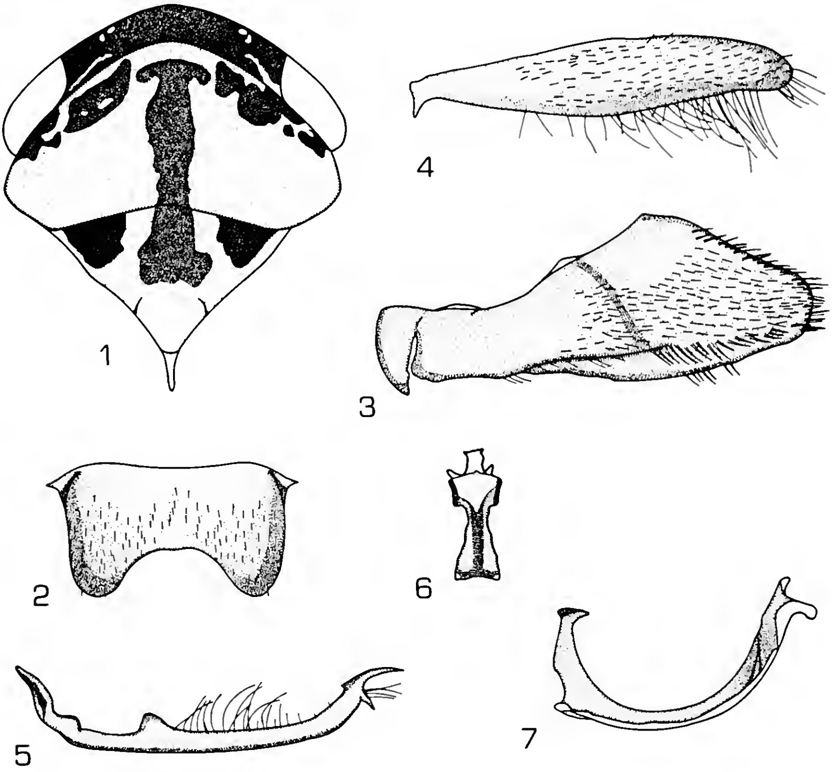
Description of male. – Length including forewings, 6.3-6.8 mm. Head (Fig. 1) short, median length of crown approximately one-eighth interocular width, anterior margin rounded; surface of crown with small punctures; face with pubescence; clypeus with inconspicuous muscle impressions; clypellus in lateral view forming angle at transition with clypeus; antennal ledges slightly protuberant; lora broad, slightly striate; genae with deep excavation below eyes. Thorax (Fig. 1) with pronotal width approximately equal to transocular width of head; disc of pronotum with pubescence, transversely striate; dorsopleural carinae complete; mesonotum transversely striate. Forewings with clavus and adjacent regions of corium punctate. Legs pubescent. Abdominal sternum VIII (Fig. 2) broad in ventral view, lateral margins with anterior and posterior small acute processes, posterior margin broadly concave, ventral surface with microsetae uniformly dispersed. Remaining morphological characteristics of head and thorax as in the original generic description of Oman (1936: 358) and the subsequent description of Linnavuori (1959: 13).

Color. – Reddish-brown marked with black. Crown (Fig. 1) almost entirely black; ocelli yellowish. Pronotum (Fig. 1) with arrow-shaped group of irregular black spots; mesonotum (Fig. 1) with pair of subtriangular black maculae on anterior portion and median black stripe continuous with pronotal arrow-shaped mark. Forewings hyaline, with irregular amber areas. Hindwings hyaline. Clypeus and clypellus with median black stripe narrowing toward inferior portion; lora with blackish spot. Legs with blackish markings.

Male genitalia. – Pygofer (Fig. 3) elongate in lateral view, with apex rounded, ventrolateral portion with longitudinal fold, apical half of disc with numerous microsetae, apical margin with macrosetae extending anteriorly along one-third of ventral and dorsal margins. Subgenital plates (Fig. 4) in lateral view elongate, extending posteriorly beyond apex of pygofer, median portion slightly enlarged, apex rounded, plates with dispersed microsetae. Styles (Fig. 5) in lateral view with apical portion curved dorsally, bifurcate, C-shaped, with short triangular process and small group of long microsetae, dorsal margin with long microsetae, basal half with dorsal blunt process. Connective (Fig. 6) in dorsal view with very short, dorsally curved arms, dorsal area of stalk with median keel. Aedeagus (Fig. 7) curved dorsally in lateral view, with apical digitiform process, distal third with pair of thin lateral processes; aedeagal apodeme well developed, apex bifurcate.

Female unknown.

Known distribution. – Brazilian states of Bahia and Minas Gerais (Fig. 14). The two known records of *B. ferruginea* are included in areas originally covered by the Brazilian Atlantic Forest (see map in Warren 1996).



Figs. 1-7. *Bythonia ferruginea*, new species, male. 1, Head and thorax, dorsal view. 2, Abdominal sternum VIII, ventral view. 3, Pygofer, lateral view. 4, Subgenital plate, lateral view. 5, Style, lateral view. 6, Connective, dorsal view. 7, Aedeagus, lateral view.

Etymology. – The species epithet *ferruginea*, is of Latin derivation and refers to the reddish-brown color of its anterior dorsum.

Type material. – Holotype: Male, Brazil, "Encruzilhada-BA [state of Bahia, 15° 31' S, 40° 54' W]/ XI-1972/ Alvarenga/ 960 m", MNRJ. Paratypes: Two males, same data as holotype, MNRJ and DZRJ; three males, Brazil, "Pedra Azul/ Minas [state of Minas Gerais, 16° 00' S, 41° 17' W], Brasil; Seabra &/ Oliveira/ XI-72", MNRJ.

Notes. – The color pattern in *B. ferruginea* is very similar to that of *B. consensa* (see description below). The anterior dorsum (Fig. 1) in both species is reddish-brown with black markings and the face has a median black stripe. In terms of morphology, the sternum VIII and male genitalia of *B. ferruginea* are also similar to those of *B. consensa.* The sternum VIII (Fig. 2) in the new species presents an anterior and a posterior pair of lateral processes, while in *B. consensa* only a single median pair of processes is present. The pygofer (Fig. 3) in *B. ferruginea* has a ventrolateral longitudinal fold, a feature that is not observed in *B. consensa.* On the other hand, the ventral margin of the pygofer in the latter species has a bifurcate process which is not present in the former. The apical portion of the styles (Fig. 5) in both species is curved dorsally and bifurcate, but the basal half of this structure in *B. ferruginea* has a blunt projection which does not occur in *B. consensa.* The aedeagus (Fig. 7) in these species is curved dorsally and bears a pair of lateral processes. These processes are longer in *B. ferruginea.* The aedeagal apodeme in *B. consensa* has a spine that is not present in *B. ferruginea.*

Bythonia consensa Blocker and Webb

(Figs. 8-13)

Description of female.– Length including forewings, 7.6 mm. Morphological characteristics of head and thorax as in *B. ferruginea,* new species, and also as in the generic descriptions of Oman (1936: 358) and Linnavuori (1959: 13) and the original specific description of Blocker and Webb (1990: 294).

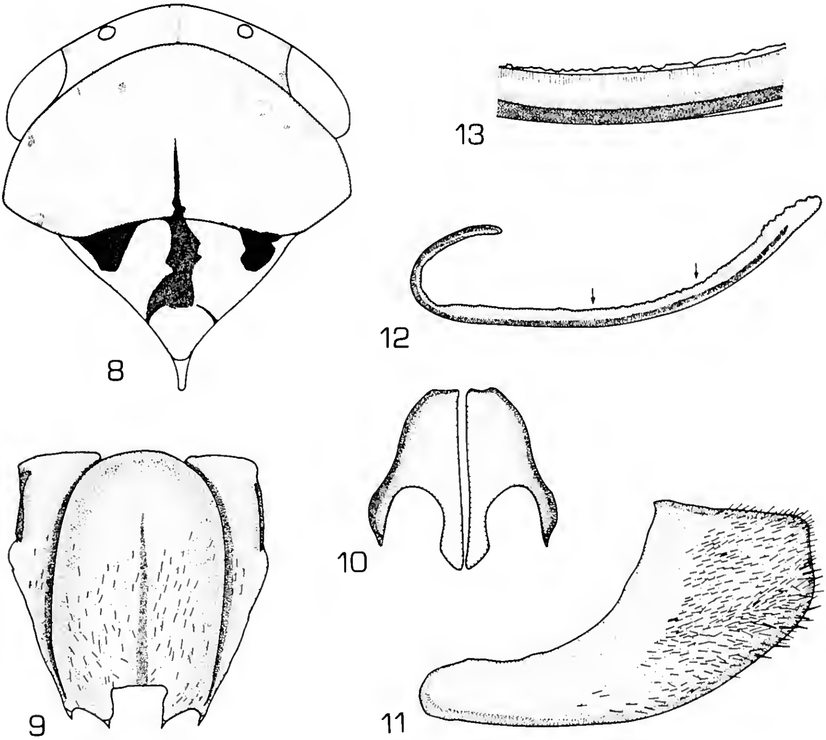
Color. – Reddish-brown marked with black, ocelli yellowish. Pronotum (Fig. 8) with small blackish areas and faint, longitudinal blackish-brown stripe on median portion; mesonotum (Fig. 8) with pair of black maculae on anterior portion and faint, longitudinal blackish-brown stripe on median portion continuous with pronotum stripe, extending to transverse sulcus. Forewings reddish-brown with apex amber. Hindwings hyaline. Clypellus with small black maculae on central portion. Legs with blackish areas.

Female genitalia.– Abdominal sternum VII (Fig. 9) narrowed posteriorly, ventral surface strongly convex, with microsetae uniformly distributed, lateral margins without processes, posterior margin shallowly emarginate on each side of median quadrangular concavity, lateral margins of emarginations with spiniform processes. Sternum VIII (Fig. 10) well developed, sclerotized, formed in dorsal view by pair of plates, each with deep posterior concavity. Pygofer (Fig. 11) elongate in lateral view, with apex truncate, apical half with microsetae uniformly distributed, ventroapical portion with small group of macrosetae. Ovipositor with first valvulae long and narrow, apex blunt, dorsal and ventral sculptured areas with sinuate and almost vertically aligned striae; second valvulae (Fig. 12) slightly expanded apically, without preapical prominence, apex blunt, apical portion with broad, rectangular, sloping teeth, median portion (Fig. 13) with small irregular denticles.

Known distribution. – *B. consensa* was originally described by Blocker and Webb (1990) from the state of Espírito Santo. This species is herein newly recorded from the state of Rio de Janeiro (Fig. 14). The known records of *B. consensa* are included in areas originally covered by the Atlantic Forest.

Material examined. – One female, two males, Brazil, "Angra dos Reis [state of Rio de Janeiro, 23° 00' S, 44° 19' W]/ Japuhyba/ 2-1944/ Wygodzinsky L.; MNRJ", MNRJ. Two females, Brazil, "Corrego Ità [Córrego Itá]/ E. Santo. [state of Espírito Santo] Br./ X-1954/ W. Zikan", MNRJ. Male holotype, "Tijuco Preto/ Esp. Santo [state of Espírito Santo, 20° 17' S, 40° 53' W]; Holotype/ *Bythonia consensa*/ Blocker + Webb/ 1990", NHM.

Notes. – The two above-mentioned males of *B. consensa* from the state of



Figs. 8-13. *Bythonia consensa,* female. 8, Head and thorax, dorsal view. 9, Sternum VII, ventral view. 10, Sternum VIII, dorsal view. 11, Pygofer, lateral view. 12, Second valvula of ovipositor, lateral view. 13, Area between arrows in figure 12 at a higher magnification, lateral view.

Rio de Janeiro were identified using the original description of Blocker and Webb (1990) and through the examination of the species' male holotype in the NHM. The reddish-brown color of the anterior dorsum of the females of *B. consensa* is similar to that of the males. However, the latter have a longitudinal black stripe on clypeus and blackish areas on crown and anterior portion of pronotum that are not observed in the females. *B. rugosa* is the only other species in the genus *Bythonia* for which the female has been described. *B. consensa* can be distinguished from *B. rugosa* by the form of the sternum VII. In the former species this sternum (Fig. 9) does not have processes on lateral margins and a quadrangular concavity is present on posterior margin, while in the latter species it has a pair of lateral spiniform processes and a posterior trapezoidal process (see Blocker and Webb 1990).

Females of *B. consensa* present two sclerotized plates at the base of the ovipositor dorsad of the sternum VII (Fig. 10). These plates, which are here reported in the genus *Bythonia* for the first time, are homologous to those described by Nielson (1965) in the proconiine genus *Cuerna* Melichar and to the sclerites of the genital chamber described by Young (1977) in several cicadelline genera. They are derived from the sternum VIII, which is greatly reduced in females of cicadellids (Nielson 1965, Mejdalani in press). Nielson (1965) demonstrated that this modified sternum can provide useful characteristics for distinguishing species in *Cuerna*. Comparative studies on females of *Bythonia* are necessary in order to know if the sternum VIII is also of taxonomic value in this genus. The sternum VIII in *B. consensa* is similar to the derived type of modified sternum described by Nielson (1965) in *Cuerna*, which is characterized by the presence of two distinct plates.

The first and second valvulae of the ovipositor of *B. consensa* are very similar to those of *B. rugosa*. The valvulae of the latter species were described by Hill (1970). The dorsal sculptured area of the first valvulae presents in both species sinuate, almost vertically aligned striae. These striae differ greatly from the alveolate sculpturing found in other Iassinae (see Hill 1970, Dietrich 1993). The shaft of the second valvulae in *B. consensa* (Fig. 12) and *B. rugosa*, unlike those of other Iassinae (see Hill 1970), does not present dorsal tooth-like prominences. The apical portion of these valvulae is slightly expanded and bears teeth in both species.

Bythonia kalypso Linnavuori

B. kalypso was described from a single male from the state of Minas Gerais (Linnavuori 1959: 15). We have identified five additional male specimens of this species from Minas Gerais in the MNRJ collection; one male specimen from the Brazilian state of Santa Catarina was identified in the NHM collection (Fig. 14). This is the first record of *B. kalypso* from Santa Catarina. This species also occurs in areas of Atlantic Forest. In terms of color and morphology, these specimens agree fairly well with the original description of the species. However, they are slightly smaller (7.5-8 mm) than the holotype (9 mm). Males of this species can be recognized by the following characteristics: pygofer with a triangular projection on median portion of ventral margin; apex of styles acute; apex of aedeagus with an acute process directed anteriorly and a blunt, weekly sclerotized process directed dorsally. The holotype of *B. kalypso* is reportedly deposited in the Hungarian Natural History Museum but could not be located in that collection (Blocker and Webb 1990).

Material examined. – Five males, Brazil, "Pedra Azul/ Minas [state of Minas Gerais, 16° 00' S, 41° 17' W], Brasil; Seabra &/ Oliveira/ XI-72; MNRJ", MNRJ. One male, Brazil, "Coleção/ Campos Seabra; Corupá/ S. Catarina [state of Santa Catarina, 26° 25' S, 49° 14' W] Brasil/ I-1954/ A. Maller", NHM.

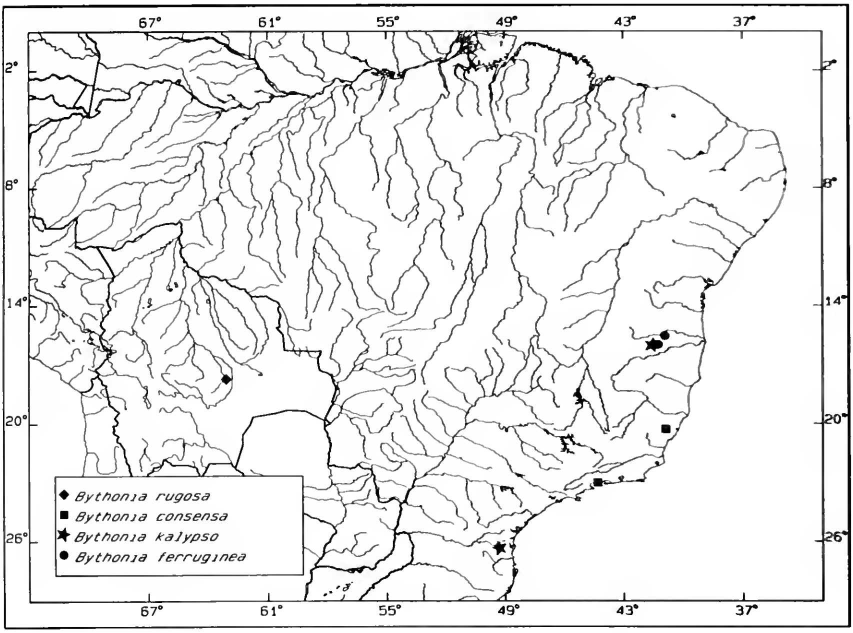


Fig. 14. Known geographic distribution of the species of the South American genus *Bythonia*. *B. rugosa* was also recorded from an unknown locality in Peru by Linnavuori (1959).

ACKNOWLEDGMENTS

The manuscript benefited from the useful comments of A. L. Carvalho, L. B. N. Coelho, L. F. M. Dorvillé, M. W. Nielson, S. A. Vanin, M. D. Webb, and two anonymous reviewers. This work was finished during a visit of GM to the NHM. Working facilities in that museum arranged by M. D. Webb, J. Margerison-Knight, and J. Martin are greatly acknowledged. Fellowships from Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES, Brazil) to MF and from Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP, Brazil) to GM are acknowledged.

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BOOKS RECEIVED AND BRIEFLY NOTED

BUTTERFLY CONSERVATION. (Second ed.) T.R. New. 1998. Oxford Univ. Press. 248 pp. $27.95 paperback).

This book provides a broad survey of the science of insect and butterfly conservation and the rationale for conserving both. Most of the book explores butterfly conservation and international efforts to safeguard species, including steps individuals can take to encourage and document butterfly conservation.

TERMITES. BIOLOGY AND PEST MANAGEMENT. M.J. Pearce. 1998. Oxford Univ. Press. 172 pp. 32 plates. $65.00 (cloth).

This book provides a general scientific introduction to termites, including their biology, behavior, pest status, and control. It is directed to advanced students in entomology and pest management, as well as to professionals.

A FIELD GUIDE TO COMMON TEXAS INSECTS. B.M. Drees & J.A. Jackman. 1998. Gulf Publishing Co., Houston, TX. 359 pp. 381 color photos on 64 plates. $18.95 (paper).

A regional field guide describing insects, mainly by order and family, and, in the larger orders, by genus, with specific examples.

PERLESTA GOLCONDA (PLECOPTERA: PERLIDAE), A NEW STONEFLY SPECIES FROM ILLINOIS[1]

R. E. DeWalt[2], Bill P. Stark[3], M. A. Harris[4]

ABSTRACT: The male, female, and egg of a new species of perlid stonefly, *Perlesta golconda* are described. Most specimens were captured from the banks of the Ohio River at Golconda, Illinois. This species is most similar to *P. lagoi* Stark, but may be differentiated by wing and body coloration, the male internal genitalia, and egg morphology. The addition of *P. golconda* brings to 16 the total number of known *Perlesta* species.

Stark (1989) recognized *Perlesta placida* (Hagen) as a species complex nearly a decade ago. He described seven new species and revised and keyed another five species from eastern North America. Shortly thereafter, Poulton and Stewart (1991) added *P. fusca* from Arkansas. Recently, Kirchner and Kondratieff (1997) described *P. teaysia* from Virginia, and Stark and Rhodes (1997) added *P. xube* from Nebraska. During statewide monitoring of sensitive aquatic insects in Illinois, this new species was collected from the banks of the Ohio River near Golconda, Illinois.

Perlesta golconda DeWalt and Stark, NEW SPECIES

Male. Forewing length from 10.5 to 11 mm. General color pale yellow-brown. Ocellar patch diffuse mesally, but with dark bars almost connecting lateral ocelli to anterior ocellus (Fig. 1). Wing membrane pale amber with intercostal margin paler, veins light brown. Femora pale yellow on anterior face, but dark brown on dorsum (Fig. 3). Paraprocts short, subapical spine prominent (Figs. 2, 5). Tergum 10 sensilla basiconica patch sparse (Fig. 2). Penis tube and sac moderately long and sinuate (Fig. 6); dorsal patch broad and with narrow lateral bands of larger seta-like spines giving a distinctly darker aspect (Fig. 7). Caecum poorly developed; ventral base of sac with a small nipple (Fig. 6). Ventral extension of aedeagus was only partially everted (Fig. 6), but appeared to be long and narrow.

Female. Forewing length from 13 to 14 mm. Body and wing coloration similar to the male. Subgenital plate lobes rounded, separated by a V-shaped notch; lobes with about 10 scattered large bristles each (Fig. 4).

Egg. The two females produced only poorly sclerotized eggs, but they were sufficiently developed to demonstrate a smooth, to slightly granular chorion (Fig. 8). The egg collar was sessile and the anchor fibrous.

Nymph. Unknown.

Types. The holotype male and paratypes consisting of one male and two females were deposited at the Illinois Natural History Survey (INHS), Champaign, Illinois.

Type locality. The holotype male and a male and female paratype were collected from the Ohio River at Golconda, Pope County, Illinois, on 25 June 1997. Universal transverse mercator coordinates are zone 16, 368,710 m easting, and 3,600,000 m northing (1927 North American

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ENT. NEWS 109(5): 315-317, November & December, 1998

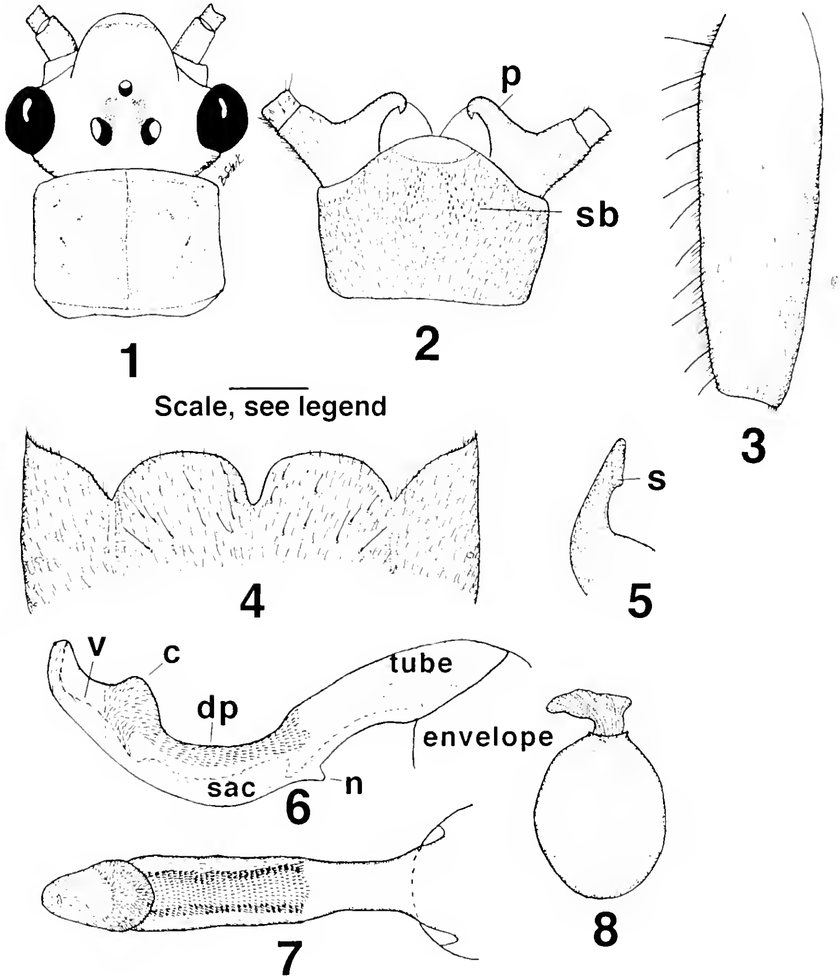

Fig. 1-8. *Perlesta golconda* : 1. Male head and pronotum. 2. Male tergum 10, sb = sensilla basiconica, p=paraproct. 3. Male right fore femur. 4. Female sternum 8. 5. Male paraproct, lateral, s=spine. 6. Aedeagus, lateral, c=caecum, dp=dorsal patch, n=nipple, v=ventral extension. 7. Aedeagus, dorsal. 8. Egg. Scales: 0.6 mm (1), 0.3 mm (2-4), 0.15 mm (5-8).

Datum). They were collected from a black light trap (2030-2115 CST, 26.1°C air temperature) by R. E. DeWalt and L. J. Peraino. Another paratype female was taken from along the Ohio River in Elizabethtown, Hardin County, Illinois, 30 June 1993, by M. A. Harris and H. E. Kitchel.

Etymology. *Perlesta golconda* is named for the town along the Ohio River where the majority of specimens were collected.

DISCUSSION

Perlesta golconda most closely resembles *P. lagoi* Stark. It may be differentiated from the latter by its lighter wing and body coloration, by the dorsal setal patch of the aedeagus forming two prominent, lateral bands (Fig. 6, 7), by the absence of egg follicular cell impressions, and by a sessile egg collar (Fig. 8). *Perlesta lagoi* has the typical dark brown wings of the genus, a dorsal patch composed of a single, wide row of spines, and the egg has a button-like collar and wide, circular, follicular cell impressions (Stark 1989). Additional specimens of *P. golconda* may demonstrate the usefulness of the pigment patterns of the ocellar patch and fore femora for identification. No nymphs of *P. golconda* were available for comparison to its congeners.

Associated species in the light trap collection were the stonefly *Isoperla bilineata* (Say), the mayflies *Hexagenia bilineata* (Say), *Stenacron interpunctatum* (Say), *Leucrocuta* sp., *Stenonema* sp., the caddisflies *Hydroptila waubesiana* Betten, *Potamyia flava* (Hagen), *Neureclipsis crepuscularis* (Walker), *Hydropsyche orris* Ross, *Nectopsyche candida* (Hagen), *Ceraclea* sp., and the megalopteran *Neohermes* sp. Two species of *Perlesta* are now known from Illinois. The other species, *P. decipiens* (Walsh), occurs statewide and was reported by Harris and Webb (1995).

ACKNOWLEDGMENTS

We thank D. W. Webb, S. J. Taylor, G. A. Levin, all of the INHS, for reviewing earlier drafts. Appreciation is extended to C. E. Warwick for scanning the original drawing and adding labels. Travel expenses and publication costs were provided by the Illinois Department of Natural Resources, Critical Trends and Assessment Project, a statewide monitoring program.

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TWO NEW SPECIES OF *CHOREBUS* (HYMENOPTERA: BRACONIDAE) FROM SPAIN[1]

I. Docavo[2], J. Tormos[3]

ABSTRACT: *Chorebus pseudometallicus* and *C. pseudoasini*, two new species from Spain, are described and compared with allied species of the genus.

The subfamily Alysiinae is one of the most distinctive subfamilies of the Braconidae because all members possess the exodont condition and are endoparasitoids of cyclorrhaphous Diptera.

This subfamily is subdivided traditionally into two tribes: Alysiini and Dacnusini. *Chorebus* Haliday, whose species are endoparasitoids of Agromyzidae and Ephydridae Diptera (there exists only one exception, a species that attacks *Psila rosae* [F.]), is the largest genus of Dacnusini with approximately 215 Holarctic species. Many of its species are characterized morphologically by having a densely setose metapleuron (metapleural rosette) and usually a sculptured sternaulus. We have discovered two new species, described below, which were obtained netting on Papilionaceae, in Alcira (province of Valencia), Spain. The Dacnusini have been dealt with, both at the morphological and biological levels, by Griffiths (1964, 1966, 1968, 1984) and Tobias (1986, summary of the Palearctic taxa with keys to genera and species, translated into English 1995).

Terms for body morphology and wing venation follow Griffiths (1964) and Wharton (1977, 1986).

Chorebus pseudometallicus NEW SPECIES

Female: Head (Figs. 1, 2, 3) – Transverse, 1.87 times wider than long, 1.25 times higher than long; occiput bare; vertex with scattered pubescence; base of the mandibles with tenuous pubescence; eyes in lateral view 0.87 times as long as the temples; temples bulging beyond eyes in dorsal view; eyes strongly converging below; face 1.4 times as wide as high; antennae with 23 antennomeres, apical flagellomeres ca 2.5-3.2 times as long as wide; mandibles 3-tooth, 1st relatively small, weakly expanded, blunt, 2nd tooth very long and pointed, 3rd tooth short, expanded, slightly pointed; maxillary palpi long.

Mesosoma (Figs. 1, 2, 4) - 1.28 times as long as high, 1.71 times as long as width between tegulae; pronotum bare and shining, only setose along anterior oblique suture; mesonotal disc extensively bare, with only scattered setae on its anterior half and along each notaular line; midpit shallow, narrow, extending from about posterior 1/3 of disc nearly to posterior margin; notauli scarcely visible, represented by smooth fine line that seems reach midpit; sternaulus extending to posterior border of mesopleuron, narrow, shiny, practically smooth; posterior

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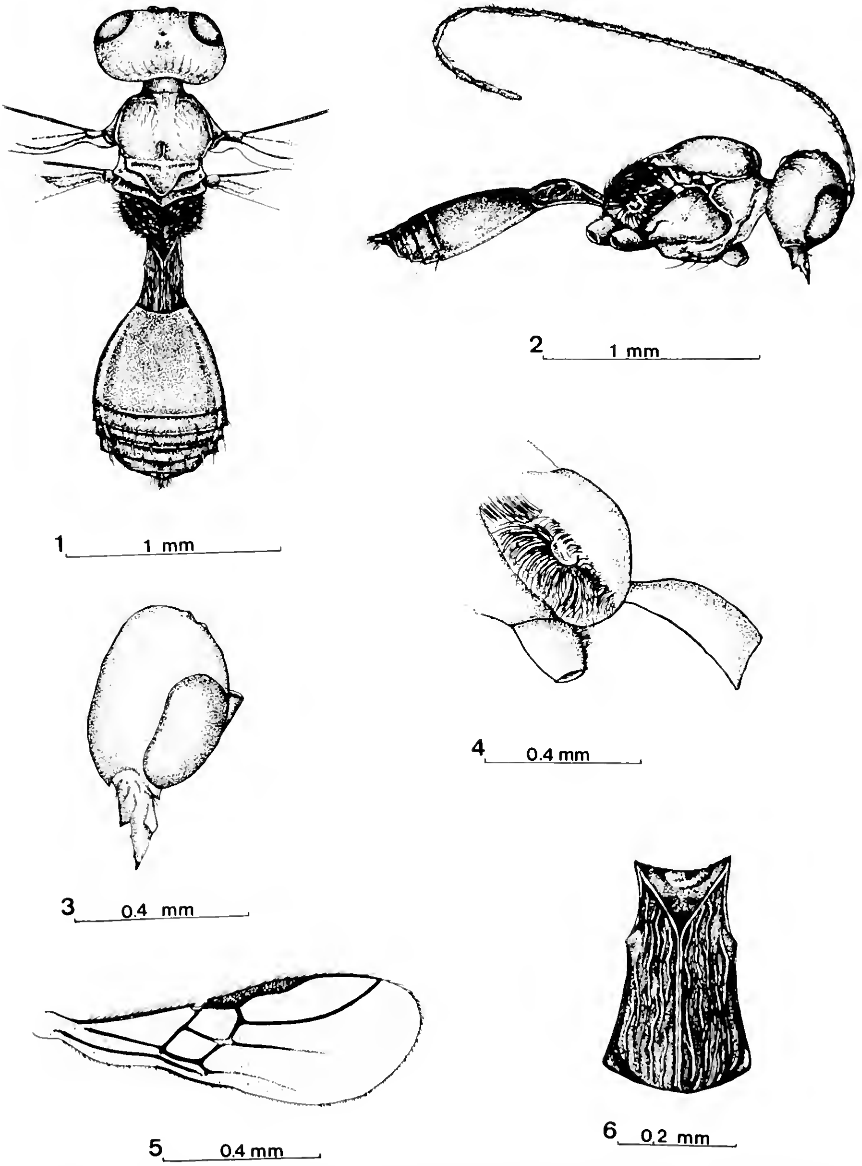
ENT. NEWS 109(5): 318-324, November & December, 1998



FIGURES 1-6. *Chorebus pseudometallicus* sp. nov. (female).- 1, Body (except legs and wings) in dorsal view; 2, in side view; 3, Head in lateral view; 4, Propodeum in lateral view; 5, Anterior right wing; 6, Petiole in dorsal view.

mesopleural furrow smooth; mesopleuron smooth, shiny, bare, only with a few long setae near the ventral border; metapleuron and propodeum with pubescence only moderately densely setose, which allows its rugose sculpture to be clearly seen; posterior coxae with a setae tuft little differentiated on its posterior margin.

Wings (Fig. 5) - Pterostigma quite narrow and little darkened, 1.2 times longer than the metacarpus; 1st radial segment shorter than the length between its insertion and the parastigma, and about as long as the pterostigma wide; remainder of radius evenly curved; n. rec. antefurcal; 3rd discoidal segment represented only by a shadow, so that cell B is open at its lower distal corner.

Metasoma (Figs. 1, 2, 6) - Petiole 1.4 times longer than wide apically, glabrous, grooved, with a pronounced central ridge; ovipositor sheath setose, robust, extending slightly beyond last tergite in resting position.

Color and size - Head, mesosoma and metasoma black; face black, clypeus and labrum darkish; maxillary and labial palpi dark brown - the labial palpi a little lighter-; antennae black, with yellowish brown pedicel and base of the scape; centre of mandibles reddish-yellow; mesopleuron black shiny; legs reddish-brown, with middle and posterior coxae, tibiae and tarsi more infuscated (darker); wings hyaline, with dark pterostigma. Body length: 2.1 mm.

Male: unknown. **Host:** unknown.

Material examined: [deposited in the Fundación Entomológica "Torres-Sala" (Docavo Collection) (Valencia, Spain)]: Holotype: female, SPAIN: Valencia: Alcira, 30-II-1963 (leg. I. Docavo). Paratype: female, SPAIN: Valencia: Alcira, 30-II-1963 (leg. I. Docavo).

Etymology: The specific name of this species makes reference to *C. metallicus* Griffiths [Griffiths, 1968], to which the new species is very similar.

Chorebus pseudoasini NEW SPECIES

This new species appears very close to *C. pseudometallicus,* but can be distinguished by the following characters:

Female: Head - Weakly transverse, 1.6 times wider than long, 1.4 times higher than long; base of the mandibles with well differentiated pubescence (Fig. 7).

Mesosoma - Sternaulus pointed in its anterior part; posterior coxae with a tuft of setae well differentiated on its posterior margin (Fig. 8).

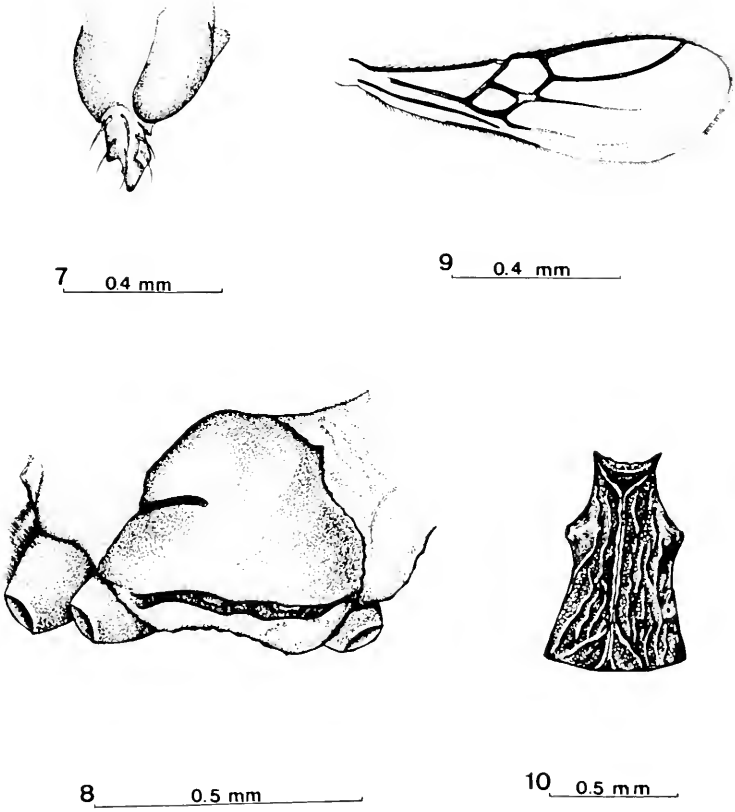
Wings (Fig. 9) - Pterostigma narrow, imperceptibly joining the metacarpus; cell R narrower and shorter, finishing before the tip of the wing; 3rd discoidal segment decolored; cell B incompletely closed.

Metasoma - Petiole 2.1 times longer than wide apically, with the tubercules of the spiracles very pronounced (Fig. 10); last tergite narrow and prolonged covering the ovipositor of which only its apex can be appreciated.

Color and size - anterior and middle coxae a very yellowish reddish brown; posterior very dark. Body length: 1.9 mm.

Male: unknown. **Host:** unknown.

Material examined: [deposited in the Fundación Entomológica "Torres-Sala" (Docavo Collection) (Valencia, Spain)]: Holotype: female, SPAIN: Valencia: Alcira, 28-II-1960 (leg. I. Docavo). Paratypes: 2 females, Valencia: Alcira, 28-II-1960 (leg. I. Docavo).



FIGURES 7-10. *Chorebus pseudoasini* sp. nov. (female). - 7, Mandible in lateral view; 8, Sternaulus and lateral view of the right posterior coxae; 9, Anterior right wing; 10, Petiole in dorsal view.

Etymology: The specific name makes reference to the closely related *C. asini* Docavo [Docavo, 1965].

Notes: These new species belong to a group which Griffiths (1964) has described as the "affinis complex". They are similar to *C. metallicus* and *C. asini*, from which they differ in the following respects: a) number of antennomeres; b) pubescence from the base of the mandibles, sides of pronotum, mesonotal disc, metapleuron (rosette), posterior coxae (setae tuft) and propodeum; c) coloring of the legs (particularly of the coxae); d) morphology of the pterostigma, cell B (brachial cell), sternaulus and metasoma (specially petiole morphology); e) body length.

C. pseudometallicus can be differentiated from:

C. metallicus: a) By the clearly differentiated metapleuron pubescence (rosette) (Figs. 2, 4) [less differentiated in *C. metallicus*]; b) coxae reddish-brown [in *C. metallicus* gold yellow]; c) anterior oblique suture of the pronotum pubescent (Fig. 2) [in *C. metallicus* the sides of the pronotum are bare and shiny]; d) mesonotal disc slightly pubescent (Fig. 1) [*C. metallicus* has only a few setae along the notauli]; e) pubescence on propodeum more dense than in *C. metallicus* (Figs. 1, 2, 4).

C. asini: a) Antennae with 23 antennomeres [*C. asini* has 25 antennomeres]; b) mesonotal disc more shiny and less pubescent (Fig. 1) [in *C. asini* dull and much more setose]; c) legs lighter; d) sides of pronotum pubescent (Fig. 2) [in *C. asini* they are practically glabrous]; e) sternaulus narrow, pointed anteriorly (Fig. 2) [in *C. asini* completely smooth]; f) pterostigma narrower (Fig. 5).

C. pseudoasini: Due to the morphological characters previously explained in the description of this species. The differences between this species and *C. asini* are the same as those of *C. pseudometallicus* except the number of antennomeres which is 23.

The most important characteristic for recognizing these species lie in well differentiated metapleural rosette for *C. pseudometallicus* (Figs. 2, 4), and in well differentiated setae tuft in the posterior coxae for *C. pseudoasini* (Fig. 8).

The four species: *C. pseudometallicus, C. metallicus, C. pseudoasini* and *C. asini*, can be distinguished in table I.

Table I - Morphological characterization of *C. pseudometallicus, C. metallicus, C. pseudoasini* and *C. asin*i [differentiated character (*); scarcely differentiated or missing (-)]. Number of antennomeres (1). Pubescence well differentiated in: base of mandibles (2), sides of pronotum (3), mesonotal disc (4), metapleuron (rosette) (5), propodeum (6); coxae dark (7), pterostigma narrow (8); cell B completely open (9); sternaulus completely smooth (10); posterior coxae (setae tuft) (11), Tubercles of the spiracles greatly differentiated (12).

Species	1	2	3	4	5	6	7	8	9	10	11	12
C. pseudometallicus	23	-	*	*	*	*	-	*	-	-	-	-
C. metallicus	21/22	-	-	-	-	-	-	*	-	*	-	-
C. asini	25	-	-	*	*	*	*	-	-	*	-	-
C. pseudoasini	23	*	*	*	*	*	-	*	*	-	*	*

These species can be inserted in the keys of Tobias (1995: 340) as follows:

Females

(475) (476)

(475a) (475b)

Antennae with 23 antennomeres. Mesonotal disc more or less shiny, with a few setae along the notauli and central anterior part. Pronotum shiny, with a few setae, fine and scattered, along the anterior oblique suture. Petiole 1.6 to 2.1 times longer than wide, shiny, practically bare, with a well differentiated central ridge and longitudinal grooving. Propodeum scarcely pubescent, more differentiated at its sides, although allowing the sculpture situated underneath to be perceived. Pubescence of the metapleuron (rosette) and propodeum well differentiated and characteristic of the genus *Chorebus*.

(475b) (475c)

Anterior coxae reddish brown, middle and posterior a darker brown with reddish overtones. Petiole almost bare, grooved, with a well differentiated central ridge. Metasoma oval, elongated, less rounded on the apex than in *C. pseudoasini*, without the last tergite being elongated and narrow; ovipositor, therefore, more protruding than in mentioned species. Pterostigma wider than in *C. pseudoasini*, not so imperceptibly joining the metacarpus. Cell B somewhat open in its lower distal corner, with just a trace of the 3rd discoidal segment. Length of body: 2 mm. Host: unknown.

C. pseudometallicus sp. nov.

(475c) (475)

Anterior and middle coxae, a more yellowish reddish brown, but the posterior, partly, darker. Petiole shorter, but with extremely protruding stigmatipherous tubercules. Metasoma rounder, with the last tergite narrow and prolonged, covering the ovopositor, of which only the apex can be seen from above, while in lateral view the ovopositor appears curved upwards. Pterostigma narrow, imperceptibly joining the metacarpus. Cell R narrower and shorter, finishing beyond the extremity of the wing. Cell B completely open, as 3rd discoidal segment is completely missing. Length of body: 1.9 mm. Host: unknown.

C. pseudoasini sp. nov.

(475) (476)

ACKNOWLEDGMENTS

We are much indebted to Cees van Achterberg (Nationaal Natuurhistorisch Museum, The Netherlands) and Max Fischer (Naturhistorisches Museum Wien, Österreich), for their comments on the manuscript. Financial support for this paper was provided from the Junta de Castilla y León, project SA 18/96.

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BOOKS RECEIVED AND BRIEFLY NOTED

INVERTEBRATE SURVEYS FOR CONSERVATION. T.R. New. 1998. Oxford Univ. Press. 240 pp. $35.00 (paperback).

A comprehensive guide to the ecological methods used to survey invertebrate animals in terrestrial, freshwater, and marine environments. It describes how to select taxonomic groups for study, how to collect and analyse samples, and how to set priorities for protection.

MELANISM. EVOLUTION IN ACTION. M.E.N. Majerus. 1998. Oxford Univ. Press. 338 pp. $105.00 (cloth); $45.00 (paperback).

Placing melanism into its historical and scientific context, the author considers the diversity of melanism in the animal and plant worlds, and its physical and genetic properties. Examining melanism in moths and ladybeetles in detail, he explores the diversity of evolutionary reasons for melanism and the complexities underlying this phenomenon.

THE BIRDER'S BUG BOOK. G. Waldbauer. 1998. Harvard Univ. Press. 290 pp. $27.95 (hardcover).

This book is an interesting introduction into the many fascinating relationships between birds and insects. As past eons have come and gone, birds and insects have become increasingly enmeshed in a complex web of interrelationships: birds eating insects, bloodsucking insects feeding on birds, parasitic insects infesting birds, and birds struggling to rid themselves of the parasites. In this book, the author describes these and many other interactions between birds and insects.

DIPTEROUS PARASITOIDS FROM ADULTS OF MOTHS (LEPIDOPTERA)[1]

Timothy L. McCabe[2]

ABSTRACT: An adult moth, *Cucullia lucifuga* (Lepidoptera: Noctuidae), was parasitized by the maggot of *Sarcophaga aldrichi* (Diptera: Sarcophagidae). Circumstances suggest that the fly, which is a scavenger and a larval and pupal parasitoid of Lepidoptera, also attacks the adults of moths. This is the first report of a sarcophagid fly from the adult of a moth. The maggot of a phorid fly, *Megaselia rufipes*, is reported from the adult of another noctuid moth, *Amphipyra glabella*.

It is unusual to have the adult stage of a moth or butterfly parasitized. Adult lepidopterans with dipterous parasitoids of the families Tachinidae and Phoridae are known. Tachinid observations were presumed to be examples of larval or pupal parasitoids that carried over into the adult (Cockayne, 1911; DeVries, 1979; Smith, 1981). Flemyng (1918) reported an adult sphingid parasitized by a phorid fly, *Megaselia rufipes* (Meigen). Flemyng's original observation was too casual to ascertain whether the living moth or the carcass had been attacked. Borgmeier (1965) considers *M. rufipes* maggots to be polyphagous; Robinson (1971) documents a wide range of hosts from lepidopteran pupae to bat guano. Flemying's report, however, may have some credence.

In July of 1997, I held a captive female *Amphipyra glabella* (Morrison) (Lepidoptera: Noctuidae), collected near Albany, New York, in a tightly sealed container for a week. Soon after the moth's death maggots could be observed. Two female flies emerged after ten days. These proved to be *M. rufipes*. Despite frequently having held moths for eggs, this was my first observation of phorid parasitoids killing a moth. Whole abdomens of moths are treated chemically when lepidopterists prepare specimens for dissection, and I have only twice encountered unidentified phorid maggot exoskeletons in the course of three thousand dissections.

The following represents the first report of a sarcophagid parasitoid of an adult lepidopteran.

Sarcophaga aldrichi Parker is an important internal parasitoid of the pupa of tent caterpillars. Hodson (1939) proved unequivocally that tent caterpillar larvae were not attacked, but that the pupae were. The fly has been reported as a parasitoid of the larva of the satin moth (Lejeune and Silver, 1961) and the gypsy moth (Hodson, 1939). Gypsy moth, satin moth, and tent caterpillars all make an exposed cocoon. *Sarcophaga aldrichi* is viviparous. A female lays its first instar maggot on the silk of the host's cocoon. The maggot finds its way through the silk to the pupa and feeds internally for 3 to 5 days. After this

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[1] Received January 22, 1998. Accepted March 13, 1998.

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period the maggot may stay within the pupal cadaver for more than a month, eventually dropping to the ground to pupate (Hodson, 1939). *Sarcophaga aldrichi* also will breed in decaying organic material and carrion (Hodson, 1939) as do most *Sarcophaga* species (Sanjean, 1957).

On July 22, 1987, an adult female of *Cucullia lucifuga* [Denis and Schiffermüller] was captured nectaring at milkweed blossoms on the pine barrens near Albany, New York. The moth was held for oviposition in a plastic cup with a tight fitting lid. The moth died without ovipositing on July 24th. The following day the moth carcass had the legs, wings, and head detached. No internal organs remained. A third (ultimate) instar *Sarcophaga* (Diptera: Sarcophagidae) maggot was present. It had been an internal parasitoid of the moth. The maggot was offered additional fresh, decapitated, live moths and fresh cadavers of moths, but refused to feed. The maggot was kept in a moist container. It lived 51 days, until September, but died. Its carcass was preserved and identified as *Sarcophaga aldrichi.*

The caterpillar of *C. lucifuga* is a flower feeder. When fully grown, the caterpillar moves to the ground and enters the soil. It pupates in an underground cocoon. My pupation boxes have 15 centimeters of peat and *C. lucifuga* typically pupates at the bottom. The species is triple brooded in the north and the summer brood has a pupal stage that lasts for 10 days or more. Therefore, the sarcophagid loses its opportunity to parasitize *C. lucifuga* once the caterpillar enters the soil.

The fly is probably not a pupal parasitoid here, although it would have had the opportunity to parasitize the larva. Hodson (1939) did not observe larval parasitism by *S. aldrichi* in 100 field collected last-instar larvae of tent caterpillars. Sixty percent of the tent caterpillar pupae from Hodson's experimental site had been parasitized by *S. aldrichi.*

The sarcophagid maggot completes its development in 3 to 5 days (Hodson, 1939). *Sarcophaga aldrichi* is a large fly, larger than a house fly, and there is no chance of a parasitized host the size of *C. lucifuga* surviving. A large satyrine caterpillar has been reported as surviving despite having been parasitized by a tachinid maggot (DeVries, 1984); the caterpillar survived the exiting of the maggot and ultimately produced an adult. The maggot was not carried over to the butterfly's adult molt.

In the present case the adult may have been the stage initially parasitized. The reasoning for this is as follows: 1) I estimate the moth was 4 -7 days of age at death (age determination based on my observations of many captive and bred lepidopterans); 2) maggot development time is 3-5 days; 3) the maggot was large enough to kill an organism the size of *C. lucifuga* at any stage; 4) the pupa was probably not parasitized because pupation takes place deep underground; 5) the larva was probably not parasitized because *S. aldrichi* seldom attacks larvae and the maggot development time of 3-5 days is too quick; 6) the moth is active at early dusk, while there is still light, and both fly and moth can be found visiting milkweed blossoms simultaneously.

Given the relatively constant development time for the maggot, one would expect a small to mid-size imago to be killed within 3 to 5 days of attack. When I collected the moth, which I determined to be mated based on clasper marks, I estimated it to be 2-5 days of age. When the parasitoid emerged the moth would have been 4-7 days of age, sufficient time for a first stadium maggot to have entered the imago and completely matured.

The preserved maggot agrees well with the description and illustration of *S. aldrichi* given in Greene (1925). The maggot has anterior spiracles with multiple rows of lobes. This is a rare condition in *Sarcophaga*. The lack of spines around the posterior pocket and the prominent anal tubercles are all concordant with *S. aldrichi* morphology. The mouthparts of the preserved *S. aldrichi* maggot are illustrated (Fig. 1). Mouthparts were not illustrated in Greene's (1925) paper and prove to be valuable for species recognition. Subsequent captures of adult *Cucullia* in the last ten years have not rediscovered the parasitoid and it may prove to be a rare event.

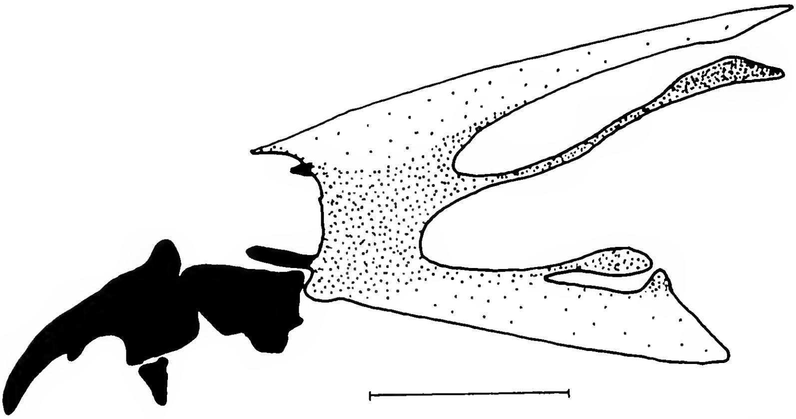

Fig. 1. *Sarcophaga aldrichi*. Cephalo-pharyngeal skeleton, showing mouthhooks and associated structures, third instar. Scale line = 0.25 mm.

ACKNOWLEDGMENTS

I thank Christine Weber and Charles Sheviak for reviewing the paper and for helpful comments. Specimens are vouchered in the New York State Museum. This is published as Contribution number 738 of the New York State Science Service.

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BIOLOGY OF *TANYCHELA PILOSA* (HYMEMOPTERA: ICHNEUMONIDAE), A PARASITOID OF THE AQUATIC MOTH *PETROPHILA CONFUSALIS* (LEPIDOPTERA: PYRALIDAE)[1]

Wanda Jamieson[2], Vincent H. Resh[3]

ABSTRACT: *Tanychela pilosa*, a solitary endoparasite of the aquatic moth *Petrophila confusalis*, has hymenopteriform eggs that are oviposited in late summer or early fall, in the Clearwater River drainage of western Montana, USA. The first instar is a caudate-mandibulate type. Superparasitism may result from polyembryony but only a single wasp larva survives. Larvae undergo heteromorphosis as a third and final instar. Pupation occurs in the dry cocoon of the moth. Adult sex ratios approach 1:1. 72.2% of sites examined in the Clearwater River drainage had *P. confusalis* and 61.5% of these contained *T. pilosa*. Emergent rocks may enable ovipositing females to enter streams and search for caterpillars. Parasitization of *P. confusalis* reported from Idaho, Washington, and California may be by *T. pilosa*.

Hymenoptera parasitizing aquatic insects are rarely encountered in collections of stream insects. In an earlier study, we discovered that a population of the aquatic lepidopteran *Petrophila confusalis* (Walker) was parasitized by an aquatic wasp (Resh and Jamieson 1988) in Owl Creek, Missoula County, Montana (Fig. 1). The rate of parasitism in the moth population ranged from 55% at the outlet of Placid Lake into Owl Creek to 0% less than 5 km downstream from the lake outlet. Wasp pupae were identified as *Tanychela pilosa* Dasch, the type specimen of which is from Mexico (Dasch 1979).

In our original study, we indicated that parasitism occurred during the pupal stage of the aquatic moth, as has been reported for the agriotypid (now generally considered a subfamily of the Ichneumonidae) wasp *Agriotypus armatus* Curtis that parasitizes the caddisfly *Silo pallipes* (Fabricius) in Europe (Elliott 1982). In retrospect, if this supposition were correct we would have expected to see some type of activity indicating that moth pupae were being parasitized, such as adult wasps near the pupal patches that occurred on rocks in the streambed, or wasp eggs or larvae inside the moth pupae or moth cocoons.

Because of the lack of detailed information on hymenopteran parasites of aquatic insects (Hagen 1996), the present study was initiated to (1) describe the biology of the parasitoid *T. pilosa* and (2) document the distribution of *T. pilosa* beyond Owl Creek through surveys conducted in the Clearwater River drainage system of western Montana.

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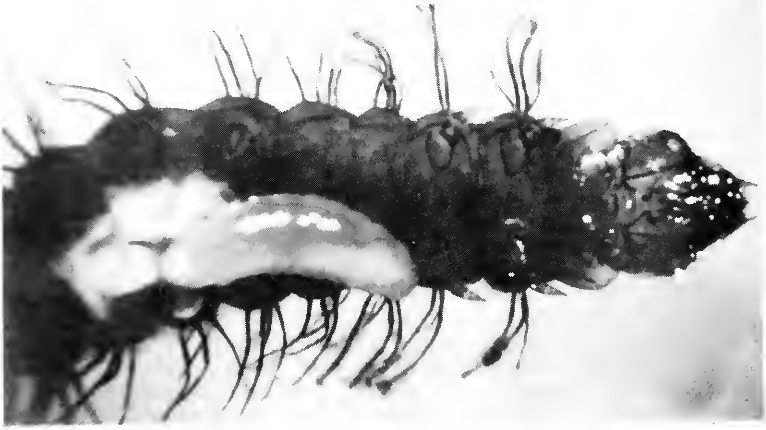

Fig. 1. *Petrophila confusalis* and its endoparasite *Tanychela pilosa*.

METHODS AND MATERIALS

In May 1989, lepidopteran larvae were collected from Owl Creek near the outlet of Placid Lake (Fig. 2). During the summers of 1993, 1994 and 1995, samples of approximately 100 *P. confusalis* larvae and pupae were collected randomly from various sites along the Clearwater River and its tributaries (Fig. 2).

Head widths of the moth larvae and prepupae were measured to determine instar classification; the caterpillars were then dissected to determine rates of parasitism. Wasp cocoons were dissected to determine stage of development and sex of the wasps. Life cycle observations were based on examinations of more than 1400 aquatic wasp larvae and pupae, the dissections of more than 1900 aquatic moth larvae and prepupae, and the examination of more than 2000 empty wasp and moth cocoons.

BIOLOGY OF *TANYCHELA PILOSA*

Egg stage: *T. pilosa* wasps are solitary endoparasites of *P. confusalis* caterpillars. The biology of the host (sometimes referred to as *Paragyractis confusalis*) is described by Tuskes (1977, 1981), McAuliffe & Williams (1983), Bergey (1995), and summarized by Lange (1996). In late summer or early fall, the female wasp deposits an egg within the abdominal cavity of the moth larva. The pale yellow, jellybean-shaped eggs, about 0.5 mm long and 0.2 mm wide, are the hymenopteriform type (Hagen 1964, Fig. 14a).

Larval stage: Parasitism could occur during the moth's free-living first instar or during its other larval stages that are spent beneath silken retreats that

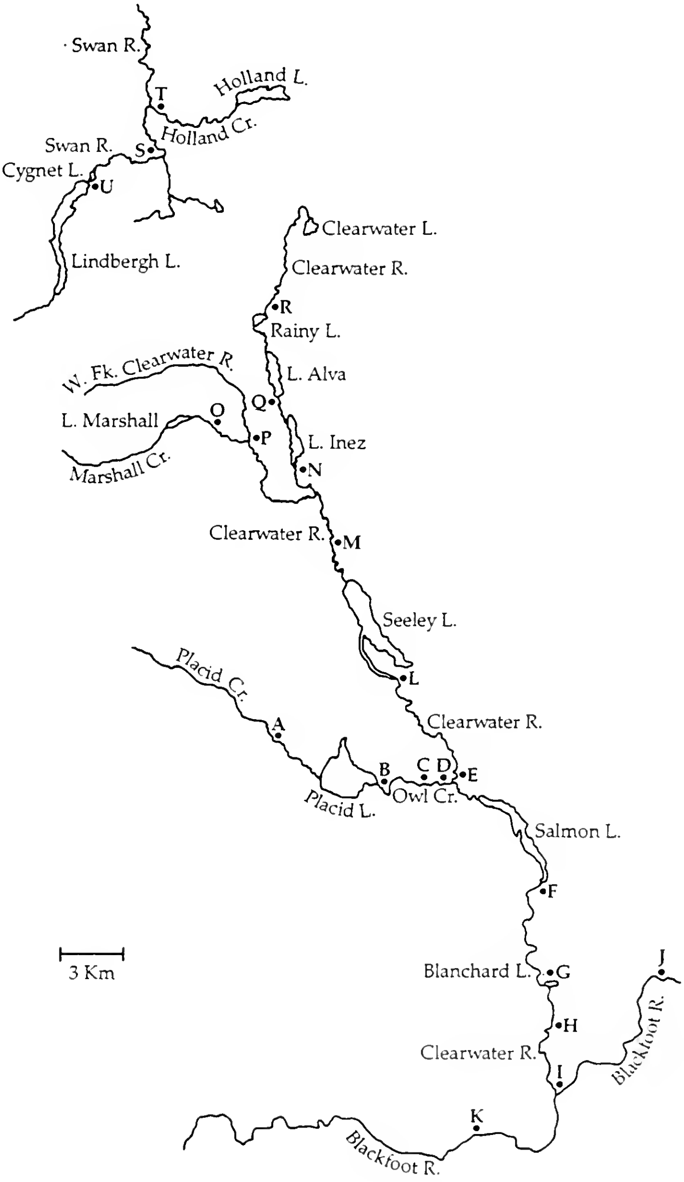

Fig. 2. Sampling locations in the Clearwater Drainage, western Montana, USA.

provide shelter (Lange 1996, Fig. 19.1). The free living, first-instar caterpillar is more vulnerable to predation and to dislocation (i.e., drift), and the duration of this stage is brief, e.g. first instars of *P. confusalis* occur in Owl Creek (Fig. 2) during a brief two-week period (McAuliffe & Williams 1983). In contrast, second, third, and fourth instars occur from mid-August to mid-October (McAuliffe & Williams 1983), and the female wasp could penetrate the silken covering of these instars with her ovipositor, laying her eggs within the host caterpillar.

The newly hatched wasp larva is less than 2 mm long. This primary or first instar is of the caudate-mandibulate larval type described by Hagen (1964, Fig. 18a, b, c). It has a brownish sclerotized head capsule with a black mandible. Its long, slender, segmented body is enclosed in a colorless, transparent integument; the internal body mass is bright yellow. A long "tail" that is almost equal in length to the rest of its body extends posteriorly from the dorsal portion of the wasp larva. Ullyett (1944) suggests the long tail may serve as one and/or all of the three following functions: an egg burster, a balancing organ to compensate for its large head, or for food absorption. Although the first instar wasp has mandibles, we found no evidence in any of the host larvae that internal tissues or organs had been damaged, nor did we ever observe any tissue attached to the mandibles of the wasp larva that would indicate it had been feeding. Apparently, the wasp larva absorbs food through its very thin cuticle from its host's hemolymph. Strands of fat bodies were noticeably reduced or absent in the hemocoels of parasitized caterpillars. Because there are no spiracles on the first instar larva, respiration is probably cutaneous.

T. pilosa overwinters in the first instar within its host. The wasp larva grows very slowly from October to June and growth appears to be relatively constant from year to year. For example, wasp larvae in samples collected from Owl Creek and the Lake Inez outlet (Fig. 2) on 23 Oct 1993 were very similar in size to the wasp larvae in samples collected during June 1994 and June 1995 from the same streams.

In areas where the rate of parasitism is high, two or more parasitoids may occur in one host (i.e., superparasitism). For example, of 44 moth larvae that were collected 23 Oct 1993 from Lake Inez (Fig. 2), 32 were parasitized. Of these, six (19%) caterpillars had been parasitized more than once; three of them had two larval parasites and each of the other three had three, four, and five parasitic larvae, respectively.

Several genera of Ichneumonidae that parasitize the eggs and larvae of Lepidoptera exhibit polyembryony (Hagen 1964, Chapman 1982) and this could account for the multiple *T. pilosa* parasitoids within the host *P. confusalis* caterpillar. We have not determined how long the different larvae within a single host live, but we have observed that eventually all but one die. For example, in a sample taken 15 Aug 1995 from the Lake Inez outlet (Fig. 2), one late-instar moth larva had 10 wasp larvae within its hemocoel. All wasp larvae were the same size, and had sclerotized heads and transparent body coverings, but only one was wiggling; apparently nine of the wasp larvae had just died. Thus, this moth larva had been host to 10 wasp larvae for 9 -10 months.

The dead wasp larvae can be found in the last abdominal segment; perhaps, the wiggling motion of the caterpillar forces these dead larvae to the posterior end of the moth's abdominal cavity where they remain (and subsequently can be counted). We noted that when host caterpillars contained only one wasp larva, that larva was usually alive. The bodies of the dead wasp larvae become white and opaque; their sclerotized head capsules enabled us to distinguish them from the fatty tissues of the caterpillar.

Hagen (1964) reported that the number of larval instars among hymenopterous parasites is variable. However, there appears to be a tendency for ectoparasitic larvae to have five instars and endoparasitic forms to have fewer than five (and often three).

During the fifth instar of the caterpillar, the wasp larva grows rapidly and undergoes heteromorphosis (sensu Chapman 1982; Hagen 1964 refers to this as hypermetamorphosis). The sclerotized head capsule splits along the dorsal line and the wasp larva emerges from its exuvium with a new body form. The new segmented body is covered with a loose transparent membrane. The body internally is bright yellow. During this metamorphosis, the wasp larva abruptly changes from a slender 2-mm long caudate-mandibulate type larva to a fat, globular, grub-like larva that eventually grows to fill the thorax and abdomen of the 10-mm long caterpillar within four weeks. This grub-like larva may represent the third instar.

We examined the head-capsule width of approximately 100 caterpillars from sites D in 1993, and N in 1993 and 1995 (Fig. 2). No size-class differences were observed in parasitized and unparasitized caterpillars.

Pupal stage: Prior to its pupation, the *P. confusalis* caterpillar modifies its silken retreat on a rock surface to form a thicker, oval patch. This patch is referred to as the external pupal case in Resh and Jamieson (1988, Fig. 1). The patch has semicircular openings at the edge [as described by Lloyd 1914, 1919 for *Petrophila fulicalis* (Schaus)] and the caterpillar scores a C-shaped slit at the upstream end of the patch. Beneath the patch, the caterpillar spins a waterproof cocoon that provides a dry environment for the pupal stage. When it has completely enclosed itself within a cocoon, the caterpillar becomes an immobile prepupa. When examined externally, there is no indication whether or not the caterpillar prepupa is host to a parasite.

If parasitization has been successful (i.e. sometimes the wasp larva dies before heteromorphosis occurs), the wasp larva emerges from its host during the caterpillar's prepupal stage. During emergence, the thoracic and abdominal skin of the caterpillar appears to disintegrate within the cocoon. The head sclerites and other tissues of the moth fall to the posterior end of the cocoon as the wasp larva emerges from its host within the dry environment of the host's cocoon. At this time, spiracles are very prominent on the wasp larva.

The wasp larva immediately begins to spin its own cocoon within the caterpillar's cocoon and the wasp's cocoon is completed within a few hours. Of the 5,000+ specimens examined for this study, <0.1% had wasp larvae that were outside the host but not yet enclosed in their own pupal cocoons.

The structure of the wasp cocoon indicates that it is spun in a circular (or sideways) manner back and forth from one end of the cocoon to the other, until it is about three layers thick. During this process the wasp larva is visible between the strands of the cocoon. When the cocoon is completed, the wasp larva is no longer visible. The cocoon is dark brown, leathery, oval-shaped, and about 8 mm long. When the cocoon is turned inside out and placed underwater, it takes on the metallic sheen characteristic of an unwettable surface. During the construction of the cocoon, the wasp larva alternately faces anteriorly and posteriorly within the cocoon. But in the final phase of its prepupal stage, the wasp larva always faces anteriorly within the cocoon, i.e., it points its head in the same upstream direction that the caterpillar would have pointed its head.

Because the stage of development cannot be determined until the cocoon is dissected, all specimens within wasp cocoons have been described as pupae. However, within this category, we have identified four phases of development from what we found when the anterior end of the cocoon was opened. First, in the "early" phase, which is actually still part of the larval stage, the larva is still mobile within the cocoon and responds to touch when the cocoon is opened. Morris (1937) referred to this as the eonymphal phase. As development proceeds, the wasp larva begins to transform into the pupal form. The colorless, transparent membranous skin becomes white and opaque. Another change in the larva is the formation of red spots where the compound eyes will form. Differentiation of body regions begins. Morris (1937) referred to this final, immobile, phase as the pronymphal stage.

During the second (or white) phase, three distinct body regions have formed; the head is white and the compound eyes are red. Long legs and long antennae have formed and in females the ovipositor is very well developed. In the later part of this phase, although the head is still white, the thorax becomes black, the eyes dark brown, and wing pads start to form.

The third (or black) phase is characterized by the pupa having a black head, black antennae, black thorax, black legs, a brown and white striped abdomen, and very prominent wing pads. Both the white phase and the black phase are enclosed within a transparent membrane. A meconium is attached posteriorly to the developing pupa (Resh and Jamieson 1988, Fig. 10). These three phases each require about one week. During the fourth (or pre-adult) phase, the wasp pupa has shed the transparent membrane within the cocoon, the meconium has become detached, and the wings are fully expanded.

Adult stage: To emerge from its cocoon, the adult wasp chews a hole dorsally through its cocoon and through the lepidopteran's external pupal case; it does not use the C-slit made by the caterpillar for its own emergence. When the newly emerged wasp comes in contact with the water, an air bubble from the cocoon surrounds its hairy body. We observed that when an adult female wasp emerged underwater (e.g. in a dish that contained moss and pebbles; we have not observed this in nature), she grasped a sprig of moss with her hind leg and groped in the dish with her other five legs. In another cocoon that was opened underwater, we observed that after a female emerged from the water she gripped the wooden handle of the teasing needle; then, with her hind legs, she wiped down her abdomen and ovipositor and, with her front legs, wiped her head and antennae. A few minutes after drying off, she flew away.

Based on the observations of 575 wasp pupae, the sex ratio of the wasps approaches 1:1 (290 females: 285 males). Some streams, however, had collections favoring females (e.g. Fig. 2, site B, 43:11) or males (e.g. Fig. 2, site F, 8:22; site L, 7:22).

Emergence of wasps begins about two weeks after the unparasitized moths have emerged. Once the moths have emerged from their cocoons, decomposition of their pupal patches begins and lasts for approximately one additional month. The extended duration of the lepidopteran silken patch until the wasps emerge is crucial to the wasps' existence and survival.

Parasitization of the moth larvae varies even on a single rock. For example, 18 lepidopteran patches were collected 23 Jul 1995 from one rock at the mouth of the Clearwater River (Fig. 2, site I). Among these patches: five contained cocoons from which moths had emerged; three held moth larvae, one of which was decomposing and another was parasitized; three were moth pupae, one in an early stage of pupal development and the other two in a later stage with scaled wings; seven specimens were wasp pupae, with three in the early phase, three pre-adults (one male and two females), and one in a damaged condition.

DISTRIBUTION AND PARASITISM

Of 18 sites sampled in the Clearwater River Drainage, *P. confusalis* was found at 13 sites: B, C, D, F, G, H, I, J, K, L, M, N and Q (Fig. 2). *T. pilosa* parasitized *P. confusalis* at eight of those sites: B (55% parasitism 29 Jul 1987, 44% 26 Jun 1988, 5% 3 Jul 1988, 41% 10 Jul 1988, 36% 22 Jul 1993, 45% 14 Jul 1993, 44% 28 Jul 1993, 50% 3 Aug 1993, 35% 11 Aug 1993, 13% 23 Oct 1993, 13% 25 Jul 1994, 29% 5 Jul 1995); C (24% 9 Aug 1987, 5% 26 Jun 1988, 4% 16 Jul 1993); F (58% 22 Jul 1993, 43% 27 Jul 1994); G (41% 28 Jul 1993, 41% 3 Aug 1993, 48% 27 Jul 1994, 47% 23 Jul 1995, 74% 15 Aug 1995, 80% 22 Oct 1995); H (29% 3 Aug 1993, 20% 27 Jul 1994, 50% 5 Jul 1995); I (73% 3 Aug 1993, 64% 27 Jul 1994, 54% 23 Jul 1995); L (35% 22 Jul 1993, 46% 25 Jul 1994); N (75% 22 Jul 1993, 71% 11 Aug 1993, 67% 23 Oct 1993, 48% 12 Jul 1994, 47% 19 Jun 1995, 57% 15 Aug 1995). Variations in rates of parasitism at individual sites may have been caused by sampling of different microhabitats at a site.

What were the characteristics of the sites where either *P. confusalis* or *T. pilosa* were absent? No lepidopterans were found in the cold water (10°C) of the West Fork of the Clearwater River on 28 Jul 1993. Algal patches on the rocks of the warm Marshall Lake outflow (Fig. 2, site O) suggested a lepidopteran population may have been present earlier in the season but had emerged. The Clearwater River at Highway 83 (R) was sampled on 2 Aug 1993; the water was very cold (11°C) and no moths were found. On 3 Aug 1993 the Blackfoot River at the Russell Gates Fishing Access (J) was sampled. The river was wide, shallow, and swift, and the rocks in the streambed were large, round, smooth and very slippery. The lepidopteran population was very sparse and only 11 specimens could be collected; none were parasitized. The Blackfoot River at the Roundup Fishing Access (K) also had no parasitism in the 49 moths examined. The river here was very deep, wide, and swift. Sampling was limited to a rocky area near the shore.

Samples outside the Clearwater Drainage were also collected during summer 1993. No parasitism was found in a sample taken on 26 Jul 1993 from the outflow of Loon Lake on the Fisher River in Lincoln County, Montana, nor in a sample of 145 specimens taken on 27 Jul 1993 from the Lower Crow Creek above the Lower Crow Reservoir near Pablo in Lake County. Although moth pupae and larvae were abundant in Lower Crow Creek, the water was deep and swift.

Ashley Creek in Flathead County was sampled 30 Jul 1993 at its outflow from Ashley Lake and near the bridge between Lake Monroe and Lone Lake; no parasitism of the moth larvae or pupae present at either site was evident. The patches were extremely calcified and this may have prevented wasps from chewing their way out of their cocoons even if parasitism had occurred. Three sites (S, T, U) in the Swan River drainage system adjacent to the headwaters of the Clearwater River (Fig. 2) sampled on 2 Aug 1993 did not have lepidopteran populations. Algae mats were thick on rocks in the streambed and the water was very slow moving in Holland Lake Creek (T). Although the water was warm at the Lake Lindbergh outlet (U), it was very deep and swift. At site S, the Swan River was deep and wide. There was no parasitism in a sample of 65 specimens collected from Swan River below the dam near Bigfork on 10 Aug 1993. The water there was also deep and very swift.

FACTORS AFFECTING *T. PILOSA* DISTRIBUTION

From the above information, it is apparent that parasitization by *T. pilosa* does not occur in all streams that had *P. confusalis* populations. Reasons underlying this distribution are not readily evident. For example, Lake Inez and Lake Alva (Fig. 2, sites N and Q) are two very similar lakes in the Clearwater River system, with Lake Alva just to the north of Lake Inez in the upper portion of the drainage. Both are warm-water lakes and are surrounded by summer homes. Wooden plank structures dam the outlets of each lake, and the outflow streams have rocky bottoms and banks lined with vegetation. Each stream supports a population of *P. confusalis*. However, parasitization at the Lake Alva outflow is 0% while parasitization at the Lake Inez outflow is 75%.

Why is there such a difference in parasitism when these lake outlets are less than 5 km apart? Water in the Lake Alva outlet flows smoothly (i.e. no emergent rocks or riffles) over a streambed of uniformly sized rocks that are densely covered with lepidopteran pupal patches. When the water level goes down in late summer, the stream still flows smoothly. However, at Lake Inez, the outflow stream does not have a streambed of uniform composition and the water does not flow smoothly; instead, riffles form from emergent rocks and boulders interspersed among sand and gravel bars. Lepidopteran patches can be found on the large rocks and boulders as well as on small rocks and pebbles. In late summer, the larger rocks project above the water; if the female wasp requires a landing place before she enters the water for oviposition, then the Lake Inez outflow would be a possible habitat whereas Lake Alva would not. Given that the above-described habitats differ in terms of emergent rocks or riffles, and that this was often a feature lacking in sites where moths occurred but parasitism was absent, we suggest that this may be a key feature in determining the local distribution of *T. pilosa*. Perhaps the wasp adult requires emerging rocks to enter the water and remain attached while it searches for a potential host. Our laboratory observations of adults holding on to objects suggest that this is the case.

Owl Creek has characteristics of both Lake Inez and Lake Alva outflows. Riffle regions alternate with pool regions. No parasitism was found in 51 specimens collected 23 Jul 1995 at Owl Creek (Fig. 2, site B) from a pool area located behind a line of rocks across the stream. However, in a riffle area at this site, 22 of the 57 specimens collected were parasitized. The rocks in this riffle area project above water in late summer.

Gustin (personal communication) found a species of *Tanychela* parasitizing populations of *P. confusalis* in the Potlatch River and several of its tributaries in Latah Co, Idaho and in the Palouse River system in Latah County, Idaho, and Whitman County, Washington. The immature ichneumonids found in his study and the unnamed immatures previously reported by Tuskes (1977) in California may also be *T. pilosa*. If the distribution of *T. pilosa* follows that of *P. confusalis*, it would include central California, north to British Columbia and east to Nevada, Idaho, and Montana (Monroe 1972). However, because the type specimen of *T. pilosa* is from Mexico, other species of moths may also be parasitized.

Local factors may also affect distribution. Cool summers may favor the growth and development of the wasp larvae whereas warm summer temperatures may favor the rapid growth of fifth instar caterpillars and, consequently, earlier pupation and emergence. If *T. pilosa* cannot follow the rapid transformation of its host, then it will not be ready for its own pupation.

Because the larval wasp occurs within the caterpillar's body and the moth occurs within an air-filled cocoon (Lloyd 1919), the only aquatic portions of *T. pilosa's* life cycle are when the wasp adult emerges underwater and then returns to water to lay its eggs. This life history fits even the most narrow definition of an aquatic insect (Hagen 1996). However, like many other parasitic insects that occur in aquatic environments, once inside its host the biology of *T. pilosa* more resembles that of a terrestrial insect than an aquatic one.

ACKNOWLEDGMENTS

We thank: Stuart Neff, Temple University, and Brett Merritt, Michigan State University, for assistance in collecting specimens; Jack Stanford and the staff of the Flathead Lake Biological Station of The University of Montana for their assistance and use of facilities; Powder River High School (Broadus, Montana) for use of facilities; the students at Powder River High School for their encouragement to continue this project; Kenneth Hagen and Leo Caltagirone, University of California, Berkeley, for their comments on the manuscript; and Jim Gustin for permission to use his observations. We dedicate our efforts on this study to the late Professor Kenneth Hagen.

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NEW OHIO RECORDS OF CORIXIDAE (HEMIPTERA)[1]

Stephen W. Chordas, III[2], Brian J. Armitage[2]

ABSTRACT: One new genus and five new species of corixids have recently been recorded from Ohio as part of a comprehensive survey of adult aquatic insects. The total number of corixid taxa now known from Ohio is 25. All five taxa were collected using black light traps. The newly reported genus, *Corisella*, is known mainly from western North America. *Corisella inscripta* has heretofore only been found west of the Mississippi River. The other four new species records for Ohio represent three genera and include *Palmacorixa buenoi*, *Sigara defecta*, *S. hubbelli*, and *Trichocorixa kanza*. All five new taxa were collected on one or more of the following State Wildlife Areas: Big Island, Killdeer Plains, and Resthaven.

There are almost 80 State Wildlife Areas in Ohio. These are managed by the Ohio Division of Wildlife (the Division) for a variety of hunting, fishing, recreational, and watchable wildlife functions. However, few of these wildlife areas have been surveyed for their aquatic insect fauna. Recently the Division funded the Ohio Biological Survey (the Survey) to conduct a three year study of the state-listed, special category species for Killdeer Plains Wildlife Area. The Survey is also conducting a multi-year comprehensive survey of the adult aquatic insects in Ohio co-funded by the Division, the Partnerships for Wildlife Foundation of the U.S. Fish and Wildlife Service, and the Procter and Gamble Co., Inc. Finally, the Wisconsin Department of Natural Resources, with funding from Partnerships for Wildlife, has contracted with the Survey to conduct a six-state prairie Lepidoptera study. All of these projects generated aquatic insect collections from state wildlife areas, especially Big Island (Marion County), Killdeer Plains (Wyandot County), and Resthaven (Erie County).

The aquatic hemipteran fauna within Ohio, including the family Corixidae, is poorly known. There have been no previous studies pertaining specifically to the aquatic members of this order in Ohio. This void is evident when comprehensive aquatic Hemiptera works, such as Truxal's (1953) revision of the genus *Buenoa* (Hemiptera; Notonectidae), contained no Ohio material. However, efforts such as that of Williams et al. (1996), Chordas (in review), this paper, and the current survey of adult aquatic insects in Ohio, are addressing this deficiency. Until recently, only 20 species of the family Corixidae (Insecta: Hemiptera) were known from Ohio. These included the genera (# species): *Hesperocorixa* (9); *Palmacorixa* (3); *Rhamphocorixa* (1); *Sigara* (5); and, *Trichocorixa* (2). In contrast, there have been 49 species, representing 9 genera, of water boatmen reported from Wisconsin (Hilsenhoff, 1984).

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[1] Received February 6, 1998. Accepted May 10, 1998.

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In this paper we report five new Ohio records of water boatmen, representing one new genus and five new species. This is one of a series of papers about this family and order which will culminate in a comprehensive diagnostic atlas for aquatic Hemiptera in Ohio.

METHODS

Adult corixids were collected from May through October using black light traps. Specimens from Killdeer Plains and Resthaven Wildlife Areas were collected during a survey of prairie moths. Specimens from Big Island Wildlife Area were collected during a study of aquatic insect dispersal to proposed reconstructed wetland areas. Identifications were made using keys and descriptions in Hungerford (1948) and Sailer (1948). Polhemus et al. (1988) was used as the reference for known distributional records. Specimens are preserved in 75% ethanol and deposited in the Ohio Biological Survey's Aquatic Insect Collection.

RESULTS

All species collected on Big Island, Killdeer Plains, and Resthaven Wildlife Areas are presented in Table 1. The new genus and species records for Ohio are indicated by symbols. Additional county records from sites outside of the three wildlife areas are provided in table footnotes.

Table 1. Corixids found on three state wildlife areas.

	Wildlife Areas		
Species	**Big Island**	**Killdeer Plains**	**Resthaven**
†* *Corisella inscripta* (Uhler), 1894[a]	X	X	X
Hesperocorixa atopodonta (Hungerford), 1927		X	
H. obliqua (Hungerford), 1925	X	X	X
* *Palmacorixa buenoi* Abbott, 1913[b]	X		
Ramphocorixa acuminata (Uhler), 1897	X	X	
Sigara alternata (Say), 1825	X	X	X
* *S. defecta* Hungerford, 1948[c]		X	X
S. grossolineata Hungerford, 1948		X	
* *S. hubbelli* (Hungerford), 1928[d]		X	
S. modesta (Abbott), 1916			X
Trichocorixa calva (Say), 1832	X	X	X
* *T. kanza* Sailer, 1948[e]	X	X	X
T. sexcincta (Champion), 1901		X	X

† = Denotes a previously unreported genus for Ohio * = Denotes a new state record for Ohio

[a] Also identified from Madison County

[b] Also identified from Clermont County

[c] Also identified from Athens, Clermont, and Greene counties

[d] Also identifed from Franklin and Jackson counties (kicknet samples)

[e] Also identified from Ashtabula, Clermont, Morgan, Pickaway, Richland, Tuscarawas, Washington, and Williams counties.

DISCUSSION

The five new state records increase the total state list of corixids by 25% to 25 species. This relatively large increase in the faunal list, from a small number of sites, supports the notion that Ohio is undercollected. Given the distributions published by Polhemus et al. (1988), approximately 10 additional taxa, primarily in the genus *Sigara*, could possibly be found in Ohio. Furthermore, Chordas (in review) specifically discusses potentially resident species belonging to the genus *Hesperocorixa* that may ultimately be found in Ohio. The Till Plains physiographic province in western Ohio contains remnants of midwestern prairies which once were common. Killdeer Plains and Big Island Wildlife Areas contain some of these relict areas. Additional collecting in these and other similar areas could reveal other taxa whose distribution is normally considered more typical of the prairie states west of the Mississippi River. Ohio has portions of four other physiographic provinces (Lake Plains, Bluegrass, Glaciated Allegheny Plateau, and Unglaciated Allegheny Plateau) which also could contain taxa typical to these regions in other states but heretofore not collected or identified from Ohio.

Sigara defecta: Ohio lies along the very southern edge of this species' midwestern range (Hungerford, 1948; Polhemus et al., 1988). This species has been previously reported only from two states bordering Ohio (Michigan and Pennsylvania). However, its occurrence in two widely spaced wildlife areas suggests that it is likely to be found in additional Ohio locations.

Sigara hubbelli: This species has previously been reported for all of the states bordering Ohio (Indiana, Kentucky, Pennsylvania, and West Virginia) except Michigan to the north. Based on the distributional data presented by both Hungerford (1948) and Polhemus et al. (1988), Ohio lies well within its known range and it is no surprise that it has been found within the State. A single male specimen was taken from Killdeer Plains Wildlife Area in Wyandot County. Although the single male specimen was taken by black light sampling, several specimens taken by dipnet sampling, from two additional localities within Ohio (Table 1), are in the first author's private collection. This further serves to establish the presence of this species within Ohio.

Trichocorixa kanza: The report of this species in Ohio extends the northern distribution of this primarily southern species. Of the five new species reported from Ohio, this species was taken in the largest numbers and was one of the least anticipated. It has been taken from only one state, Pennsylvania, bordering Ohio. In addition to its historical distribution in the southeastern United States (Polhemus et al., 1988), the northern records of this species include the District of Columbia, Delaware, Maryland, Pennsylvania, and Wisconsin (Hilsenhoff, 1984; Polhemus *et al.*, 1988).

Palmacorixa buenoi: This species has previously been reported for all states bordering Ohio (Indiana, Michigan, Pennsylvania, and West Virginia), except

Kentucky to the south. Its reported distribution extends from Ontario south to Florida and west to Iowa (Polhemus et al., 1988). This vast distribution, and records for bordering states, clearly place Ohio within its range.

Corisella inscripta: Historical records for the genus *Corisella* are primarily from western North America (Hungerford, 1948). Two species of this genus have been recorded from states east of the Mississippi River: *Corisella edulis* (Champion), 1901 and *Corisella tarsalis* (Fieber), 1851 (Hilsenhoff, 1984; Hungerford, 1948; Polhemus et al., 1988). Prior to this paper, the easternmost records of *Corisella inscripta* were from Missouri (Polhemus et al., 1988) and a single male specimen from Arkansas (Cochran and Harp, 1990). *Corisella inscripta* represents not only a new genus for Ohio, but also a considerable eastern geographical range extension.

ACKNOWLEDGMENTS

Funding for projects from which this work is derived came from the Ohio Division of Wildife's "Do Something Wild!" Income Tax Check-off Program, U.S. Fish & Wildlife Service's Partnerships for Wildlife Program, and the Procter & Gamble Co., Inc. Special thanks to George L. Harp, Arkansas State University and Benjamin A. Foote, Kent State University for preliminary review of this manuscript. Suggestions by two anonymous reviewers further improved the paper.

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TWO CORRECTIONS: ARADIDAE, TINGIDAE (HETEROPTERA)[1]

Richard C. Froeschner[2]

ABSTRACT: (1) Makes modification of captions and text to correct transposed captions for *Chelonoderus stylatus* and *Isodermus gayi* in world list of flat bugs. (2) Rewrites couplets 19-22 of key to world genera of lace bug tribe Phatnomatini to properly place genus *Minitingis*.

(1) Kormilev and Froeschner's (1987) "Flat Bugs of the World" [Entomogr., 5:1-246] contains a transposition of names of the figures on pages 220 and 221. The illustration on page 220 should be labeled "Fig. 2. *Chelonoderus stylatus* Usinger. SEE p. 122."; and the illustration on page 221 should be labeled "Fig. 3. *Isodermus gayi* (Spinola). SEE p. 94." This necessitates the following changes in the text: on p. 94 the reference to the figure for *Isodermus gayi* should read "Fig. 3 (p. 221)"; and on p. 122 the reference for the figure of *Chelonoderus stylatus* should read "Fig. 2 (p. 220)."

(2) In Froeschner,s (1996) "Lace Bug Genera of the World" [Smithson. Contr. Zool, 574:i-iv, 1-44] the genus *Minitingis* is misplaced within the key to the world genera of the tribe Phatnomatini (pages 17-19). Couplets 19-22 must be modified to read as follows:

19. Abdomen ventrally on basal half or more with a distinctly impressed groove along midline 20
-----Abdomen ventrally not distinctly impressed along midline 21
20. Paranotum narrowest opposite humerus, thence widened cephalad to 4 or more row of cells .... *Phatnoma* Fieber
----- Paranotum anteriorly not or only slightly (1-2 cells) widened .... *Minitingis* Barber
21. Head with a clypeal spine 22
----- Head without a clypeal spine 25
22. Occipital spines nearly or quite as long as horizontal diameter of an eye .... *Gonycentrum* Bergroth
----- Occipital spines absent or much shorter than horizontal diameter of an eye 23

Couplets 23-25 as published.

ACKNOWLEDGMENTS

Thanks are extended to T. J. Henry (U.S.D.A.-Systematic Entomology Laboratory) and P. J. Spangler, Smithsonian Institution for reviews of this paper.

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[1] Received May 29, 1998. Accepted June 13, 1998.

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ENT. NEWS 109(5): 343, November & December, 1998

NEW NAME FOR A GENERIC HOMONYM IN TELOGANODIDAE (EPHEMEROPTERA)[1,2]

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

McCafferty and Wang (1997) proposed the name *Nadinella* McCafferty and Wang for two species of South African mayflies (family Teloganodidae) that represented a new distinctive genus with numerous diagnostic features, including, in the larvae, possession of two rows of denticles on the claws and lamellate gills on abdominal segments 2-5. These mayflies had previously been considered in the genus *Ephemerellina* Lestage. John Page of Great Britain has kindly informed us by letter, however, that the name *Nadinella* is preoccupied by a fossil protozoan described in 1899 by Eugene Penard (Penard 1899). That name was more recently listed in Moore (1964), but we had missed the citation in the Zoological Record and are not schooled in general invertebrate paleontology.

We therefore propose *Nadinetella* McCafferty and Wang, nomen novum for *Nadinella* McCafferty and Wang, 1997:399, nec *Nadinella* Penard, 1899:82. The name *Nadinetella* incorporates the given name of Nadine McCafferty, for whom it is named and who was of considerable aid in collecting specimens of the new genus in South Africa.

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[1] Received and accepted August 10, 1998.

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ENT. NEWS 109(5): 344, November & December, 1998

A NEW NORTH AMERICAN GENUS OF BAETIDAE (EPHEMEROPTERA) AND KEY TO *BAETIS* COMPLEX GENERA[1, 2]

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

ABSTRACT: *Plauditus*, n. gen. (Ephemeroptera: Baetidae) is established for certain North American *Baetis* complex species that lack hindwingpads and a developed median caudal filament in the larval stage and that were recently transferred from *Pseudocloeon* to *Baetis* or *Barbaetis*. Thus, *P. alachua*, n. comb., *P. armillatus*, n. comb., *P. bimaculatus*, n. comb., *P. cestus*, n. comb., *P. cinctutus*, n. comb., *P. dubius*, n. comb., *P. elliotti*, n. comb., *P. futilis*, n. comb., *P. punctiventris*, n. comb., *P. rubrolateralis*, n. comb. *P. veteris*, n. comb., and *P. virilis*, n. comb. are contained in the new genus. *Plauditus cestus* is the type species. The larval stage of *Plauditus* is differentiated from other genera of the *Baetis* complex by numerous characteristics, and the adult stage is differentiated from other North American baetids also having double marginal intercalaries in the forewings and lacking hindwings (certain *Acentrella*, *Apobaetis*, and *Paracloeodes*). A new, simplified, and illustrated generic key to the North American *Baetis* complex larvae is provided.

Small minnow mayflies (Ephemeroptera: Baetidae) are relatively well known in North America north of Mexico, with 143 species among 20 genera currently reported (McCafferty 1996, 1997a; see also McCafferty and Silldorff 1998, Wiersema 1998, Wiersema and McCafferty 1998). Larvae are distinguished by having the initial lateral branches of the epicranial suture located anterior to (below) the lateral ocelli (Wang and McCafferty 1996: Figs. 1-6) and the femoral apices with a ventrally oriented dorsal lobe (Wang and McCafferty 1996: Figs. 13-16). Adults are distinguished by having forewing veins IMA, MA_2, IMP, and MP_2 basally detached, and three-segmented mid- and hindtarsi. Male adults are further distinguished by the presence of membranous penes and turbinate compound eyes (the South American genus *Aturbina* Lugo-Ortiz and McCafferty [1996] lacks turbinate compound eyes). Despite being easily recognized at the family level, several North American baetid species have been difficult to assign to genera. This situation is primarily due to the fact that reductive trends and relative high frequency of homoplasy within the family have limited the number of reliable diagnostic characteristics of use at the genus level.

North American species previously assigned to *Pseudocloeon* Klapálek are examples that have required revised generic placement as our knowledge

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[1] Received January 22, 1998. Accepted March 13, 1998.

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of genus level systematics has improved. North American species once assigned to *Pseudocloeon* have the following combination of characteristics: absence of hindwings (and hindwingpads), presence of double marginal intercalaries in the forewings, and presence of a highly reduced medial caudal filament in the larval stage. As a result of the restriction of the concept of *Pseudocloeon* to its Oriental type (Waltz and McCafferty 1985, 1987), all North American species once considered to belong to *Pseudocloeon* were transferred to *Apobaetis* Day (Waltz and McCafferty 1986), *Acentrella* Bengtsson (Waltz and McCafferty 1987), *Baetis* Leach (McCafferty and Waltz 1990), and *Barbaetis* Waltz and McCafferty (McCafferty and Waltz 1990).

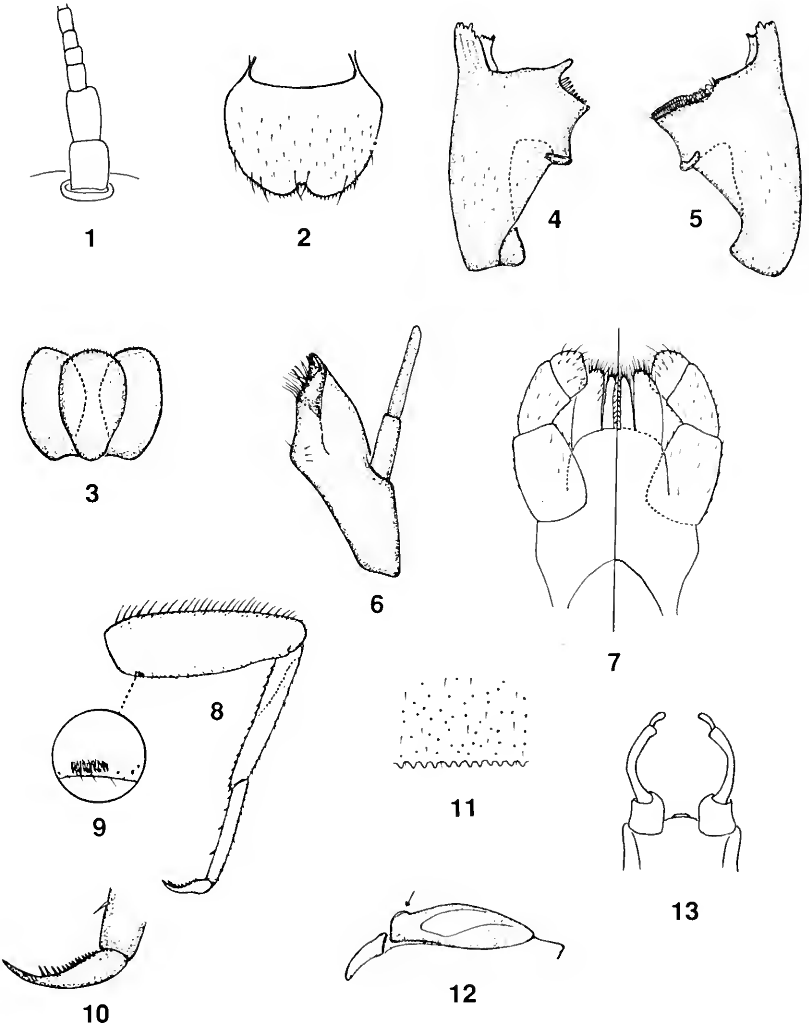
Our research indicates that all 11 species of *Pseudocloeon* that were provisionally assigned to *Baetis* by McCafferty and Waltz (1990) and also *Barbaetis cestus* (Provonsha and McCafferty) (originally described in *Pseudocloeon*) represent a new *Baetis*-complex genus distinguishable by numerous characteristics. We herein describe the new genus and provide a revised generic key to the North American larvae of the *Baetis* complex.

Plauditus Lugo-Ortiz and McCafferty, NEW GENUS

Larva. Head: Antennae as long as head capsule or longer; scapes without distal notch, subequal in length in length to pedicels (Fig. 1). Labrum (Fig. 2) broadly rounded anteriorly, with anteromedial notch. Hypopharynx (Fig. 3) with lingua and superlinguae broadly rounded apically. Left mandible (Fig. 4) with incisors fused; prostheca apically broad and denticulate. Right mandible with incisors apically fused (Fig. 5) or slightly cleft; prostheca slender, apically denticulate. Maxillae (Fig. 6) with palps two segmented. Labium (Fig. 7) compact; glossae slightly shorter than paraglossae, apically narrower than base; paraglossae broad, broadly rounded apically; palps three segmented; palp segment 1 slightly longer than segments 2 and 3 combined; palps segment 2 as long as or slightly longer than segment 3; segment 3 relatively broad apically, approaching truncate, sometimes appearing slightly concave, medial margin straight to slightly convex distally (never convergent apically from base). Thorax: Hindwingpads absent. Legs (Fig. 8) with femora with villopore present (Fig. 9) and dorsal row of long, robust setae. Tarsal claws (Fig. 10) somewhat elongate and with only weak curvature, with one row of long, sharp denticles. Abdomen: Gills on abdominal segments 1-7, broadly rounded, untracheated or poorly tracheated, marginally smooth. Terga (Fig. 11) creased, with minute, sharp, triangular spines, or with minute, fine, simple setae scattered over surface. Cerci with abundant fine, simple setae medially. Medial caudal filament subequal in length to abdominal segment 10.

Adult. Head: Male compound eyes circular, somewhat enlarged. Male foretibiae 1.3-1.5x length of femora. Mesoscutum with small, rounded anterior process in lateral view (Fig. 12). Forewings with paired marginal intercalaries. Hindwings absent. Genital forceps (Fig. 13) three segmented; segment 1 distomedially produced; segment 2 slender, strongly arched; segment 3 slender, ellipsoidal.

Type species. *Pseudocloeon cestum* Provonsha and McCafferty.



Figs. 1-11. *Plauditus punctiventris*. 1. Antennal scape and pedicel. 2. Labrum (dorsal). 3. Hypopharynx. 4. Left mandible. 5. Right mandible. 6. Left maxilla. 7. Labium (left-ventral; right-dorsal). 8. Right foreleg (posterior face). 9. Villopore. 10. Tarsal claw. 11. Detail of tergum 4. 12. Adult mesoscutum (lateral). 13. Male genitalia.

Included species. (In addition to the recombined species listed below, a new species is presently being described by McCafferty and Waltz [1998], and one other is in manuscript [R. D. Waltz, pers. comm.]).

Plauditus alachua (Berner), n. comb.
  Pseudocloeon alachua Berner 1940:58 (larva; male, female adults).
  Baetis alachua (Berner): McCafferty and Waltz 1990:775.
Plauditus armillatus (McCafferty and Waltz), n. comb.
  Pseudocloeon parvulum McDunnough 1932:210 (larva; male, female adults). [secondary homonym].
  Baetis armillatus McCafferty and Waltz 1990:775. [renamed].
Plauditus bimaculatus (Berner), n. comb.
  Pseudocloeon bimaculatum Berner 1946:79 (larva; male, female adults).
  Baetis bimaculatus (Berner): McCafferty and Waltz 1990:775.
Plauditus cestus (Provonsha and McCafferty), n. comb.
  Pseudocloeon cestum Provonsha and McCafferty 1982:28 (larva; male, female adults).
  Barbaetis cestus (Provonsha and McCafferty): McCafferty and Waltz 1990:777.
Plauditus cinctutus (McCafferty and Waltz), n. comb.
  Pseudocloeon cingulatum McDunnough 1931:85 (male, female adults); Ide 1937:236 (larva). [secondary homonym].
  Baetis cinctutus McCafferty and Waltz 1990:776. [renamed].
Plauditus dubius (Walsh), n. comb.
  Cloeon dubium Walsh 1862:380 (male, female adults).
  Pseudocloeon dubium (Walsh): McDunnough 1924b:115; Ide 1937:237 (larva).
  Pseudocloeon chlorops McDunnough 1923:45.
  Baetis dubius (Walsh): McCafferty and Waltz 1990:775.
Plauditus elliotti (Daggy), n. comb.
  Pseudocloeon elliotti Daggy 1945:392 (male, female adults).
  Baetis elliotti (Daggy): McCafferty and Waltz 1990:775.
Plauditus futilis (McDunnough), n. comb.
  Pseudocloeon futile McDunnough 1931:86 (male, female adults).
  Baetis futile (McDunnough): McCafferty and Waltz 1990:775.
  Baetis futilis (McDunnough): McCafferty 1997b:318.
Plauditus punctiventris (McDunnough), n. comb.
  Pseudocloeon punctiventris McDunnough 1923:45 (male, female adults); Ide 1937:237 (larva).
  Pseudocloeon anoka Daggy 1945:391.
  Pseudocloeon edmundsi Jensen 1969:14.
  Pseudocloeon myrsum Burks 1953:139.
  Baetis punctiventris (McDunnough): McCafferty and Waltz 1990:776.
Plauditus rubrolateralis (McDunnough), n. comb.
  Pseudocloeon rubrolaterale McDunnough 1931:86 (male, female adults).
  Baetis rubrolaterale (McDunnough): McCafferty and Waltz 1990:776.
  Baetis rubrolateralis (McDunnough): McCafferty 1997a:318.
Plauditus veteris (McDunnough), n. comb.
  Pseudocloeon veteris McDunnough 1924a:8 (male, female adults).
  Baetis veteris (McDunnough): McCafferty and Waltz 1990: 776.
Plauditus virilis (McDunnough), n. comb.
  Cloeon virile McDunnough 1923:46 (male, female adults).
  Pseudocloeon virile (McDunnough): McDunnough 1924b:116; Ide 1937:239 (larva).
  Baetis virile (McDunnough): McCafferty and Waltz 1990:776.
  Baetis virilis (McDunnough): McCafferty 1997b:312.

Distribution. Species of *Plauditus* are presently known from the conterminous USA and the lower tier of provinces of Canada. There remains the possibility that the genus may eventually be found in Mexico because it is presently well represented in Texas (Lugo-Ortiz and McCafferty 1995, Wiersema and McCafferty 1998). It is also possible that *Plauditus* is represented in the eastern Palearctic by certain species that otherwise may have been variously regarded as *Acentrella*, *Baetis*, or *Pseudocloeon*. We have no evidence of this at the present.

Etymology. The generic name is an arbitrary combination of Latin letters having a transliteral meaning of "little applause."

Diagnosis. The presence of the larval femoral villopore indicates that *Plauditus* is a member of the *Baetis* complex of genera, represented in North America north of Mexico by *Acentrella*, *Baetis*, *Barbaetis*, *Heterocloeon* McDunnough, and *Labiobaetis* Novikova and Kluge. Within that complex, larvae of *Plauditus* are distinguished by the following combination of characteristics: lacking a medial field of setae dorsally on the labrum (Fig. 2); having the right mandible with an apically denticulate prostheca (Fig. 5); lacking a protuberance on the apex of maxillary palp segment 3 (Fig. 6); having glossae shorter than paraglossae, relatively broad paraglossae, and a subquadrate palp segment 3 (Fig. 7); lacking dorsal setae on the apical half of the glossae (viz. well-developed medial aspect) (Fig. 7); lacking hindwingpads; lacking procoxal osmobranchia; lacking clavate setae on the dorsal margin of the tibiae and tarsi (Fig. 8); and having a highly reduced medial caudal filament (Provonsha and McCafferty 1982: Fig. 8). A more detailed diagnosis of *Plauditus* larvae in relation to those of other *Baetis*-complex genera can be performed using the identification key provided below.

Adults of *Plauditus* are similar to hindwingless *Acentrella*, *Apobaetis* Day, and *Paracloeodes* Day. Adults of *Plauditus* differ from those of *Acentrella* in having a small, rounded anterior process on the mesoscutum (Fig. 12), and from those of *Apobaetis* by lacking a subconical process between the male genital forceps (Fig. 13). Adults of *Plauditus* differ from those of *Paracloeodes* in that segment 2 of the male genital forceps is slightly produced distomedially and tends to be more slender and strongly arched (Fig. 13).

KEY TO LARVAE OF NORTH AMERICAN *BAETIS*-COMPLEX GENERA

1. Both mandibles lacking tuft of setae between incisors and prostheca (Figs. 4, 5); villopore usually apparent on femora (Fig. 9); claws never approaching or exceeding length of tarsi (Figs. 8, 10) .... *Baetis* complex, 2
- One or both mandibles with tuft of setae between incisors and prostheca (Fig. 14); villopore absent from femora; claw length variable .... other Baetidae

2. Antennal scapes with distal notch (Fig. 15); maxillary palp segment 2 with subapical excavation (Fig. 16); hindwingpads present; median caudal filament developed .... *Labiobaetis*
- Antennal scapes without distal notch (Fig. 1); maxillary palp segment 2 without subapical excavation (Fig. 6); hindwingpads present or absent; median caudal filament developed or highly reduced 3

3. Median caudal filament developed; hindwingpads present 4
- Median caudal filament reduced; hindwingpads present or absent 5

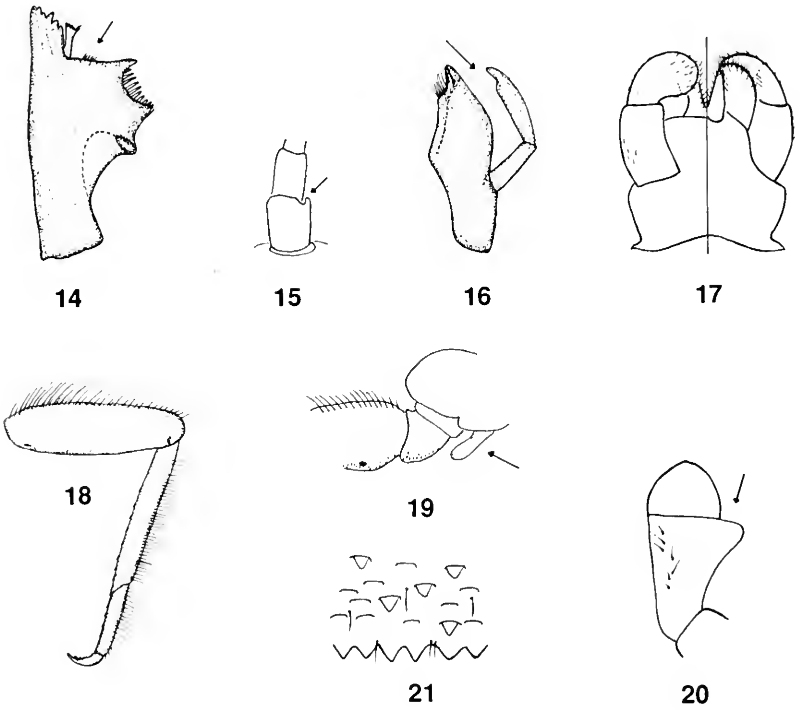
4. Antennae approximately twice length of head capsule .... *Baetis*
- Antennae subequal in length to head capsule .... *Barbaetis*

5. Procoxae with (Fig. 19) or without gills; claws with two rows of denticles (second row minute and sometimes conspicous only under high magnification) .... *Heterocloeon*
- Procoxae without gills; claws with one row of denticles 6

6. Hindwingpads absent 7
- Hindwingpads present, sometimes minute 8

7. Femora, tibiae, and tarsi without row of long setae (Fig. 8); labial palp segment 3 subquadrate, with medial margin almost straight (not receding from base) and sometimes appearing slightly convex apically (Fig. 7) .... *Plauditus*
- Femora, tibiae, and tarsi with row of long setae (Fig. 18); labial palp segment 3 apically rounded, with medial margin receding from base (Fig. 17) .... *Acentrella*

8. Labial palp segment 2 with well-developed distomedial thumb (Fig. 20); abdominal tergal scales present (Fig. 21) .... *Baetis*
- Labial palp without well-developed distomedial thumb (Fig. 17); abdominal tergal scales absent .... *Acentrella*



Figs. 14-21. 14. *Fallceon quilleri*, left mandible (pointer towards setal tuft) (modified from Lugo-Ortiz et al. [1994]). 15-16. *Labiobaetis propinquus* 15. Antennal scape and pedicel (pointer towards notch) (modified from McCafferty and Waltz [1995]). 16. Left maxilla (pointer towards excavation) (modified from McCafferty and Waltz [1995]). 17-18. *Acentrella turbida*. 17. Labium (modified from McCafferty et al. [1994]). 18. Right foreleg (modified from McCafferty et al. [1994]). 19. *Heterocloeon berneri*, forecoxal gill (pointer towards gill) [modified from Müller-Liebenau [1974]). 20-21. *Baetis bicaudatus*, labial palp (pointer towards thumb) (modified from Morihara and McCafferty [1979]). 21. Detail of tergum 4.

ACKNOWLEDGMENTS

We thank R. D. Waltz (Department of Natural Resources, Indianapolis, Indiana) for discussing this paper, and A. V. Provonsha and R. P. Randolph (Purdue University, West Lafayette, Indiana) for preliminary review of the manuscript.

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A NEW SPECIES OF THE SMALL MINNOW MAYFLY GENUS *PLAUDITUS* (EPHEMEROPTERA: BAETIDAE) FROM SOUTH CAROLINA[1]

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

ABSTRACT: A newly discovered species of Baetidae (Ephemeroptera), *Plauditus gloveri*, n. sp., is described from larvae taken in South Carolina. Characterization or combinations thereof involving color pattern, antennal length, labral setation, maxillary palp shape and size, distal shape of the labial palps, claw curvature, and tergal spines distinguish the new species. Antennal and claw characterization suggests a possible close relationship with *P. cestus*.

Our examination of larval material of small minnow mayflies recently taken from streams in South Carolina revealed a distinctive new species. Generic characterization of the new species place it within the recently erected genus *Plauditus* Lugo-Ortiz and McCafferty (1998). We are honored to name the new species after James B. Glover (Columbia, South Carolina), who collected the original material.

Plauditus gloveri NEW SPECIES

(Figs. 1-10)

Larva. Body length, 4.5-5.0 mm; antennae length, ca. 1.0 mm; cerci length 1.8-2.0 mm. Base color pale yellow; markings light to medium brown. Head: Head capsule with submedian rows of short, irregular, transverse dashes on either side of medial trunk of epicranial suture, with pair of short transverse dashes below each compound eye, and with oblique pair of spots above each antennal base. Antennae not marked. Dorsal chetotaxy of labrum as in Fig. 1, with pair of long, simple, hairlike, submarginal setae located approximately half way between lateral margin and median line of labrum, and extending beyond distal labral margin for about half length of seta (in some, extending setae slightly more proximate to each other than shown in Fig. 1). Maxillae as in Fig. 2, with maxillary palp narrow and extending beyond apex of galealacinia. Mandibles as in Figs. 3 and 4. Terminal segment of labial palp (Fig. 5) slightly broadening apically, with very slight distolateral point; apical margin slightly concave in lateral half, and rounded and somewhat bulbous in medial half. Thorax: Pronotum with three prominent spots (one medial, two submedial) near anterior margin. Mesonotum with mostly scattered, lateral light brown spots. Metanotum with pair of prominent submedial spots. Hindwingpads absent. Legs not generally marked; anterior face of femora with pair of dorsal and ventral dashes as in Fig. 6, dorsal dash sometimes appearing as two partially connected elongate spots. Claws (Fig. 7) relatively straight. Abdomen: Abdominal segment 7 slightly darker than other segments (possibly indicating darker segment band in other individuals), more noticeable ventrally, and perceptible on specimens only when using black background and low magnification; abdominal terga 1-9 (Fig. 8) each with pair of dark submedian spots (lateral spots also usually present); tergum 2 with conspicuous medial V-shaped mark at anterior margin; tergal surfaces with weak creases and minute, simple setae; posterior margin of

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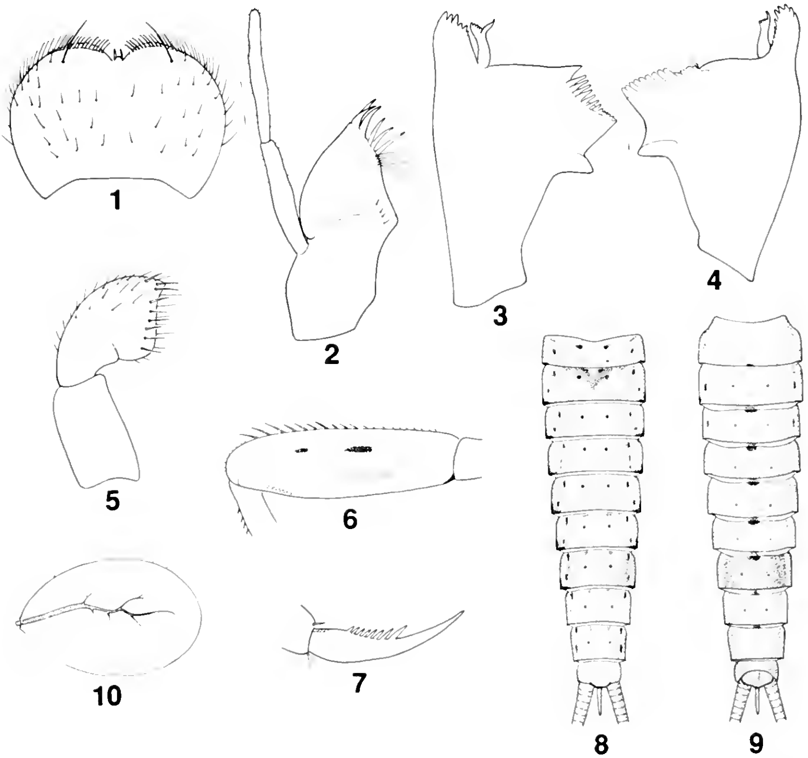
ENT. NEWS 109(5): 354-356, November & December, 1998

terga with slightly separated, triangular shaped spines slightly longer that basal width. Abdominal sterna (Fig. 9) with submedian pair of diffuse brown spots; darker medial maculation present on sterna 2-8 (prominent and larger on sterna 3-5 and overlapping sterna somewhat at anterior and posterior sternal margins); lateral subdermal striations evident on sterna 1-6. Gills (Fig. 10) with margins rounded apically, smooth, and with only very few scattered, short, simple setae; gill tracheal trunk not extending much beyond midlength of gill and with lateral branches only weakly developed (details of tracheation evident only under high magnification). Cerci with three light brown bands (not always perceptible). Median caudal filament highly reduced, subequal in length to mid-dorsal length of tergum 10.

Adult. Unknown.

Material examined. Holotype: Larva, SOUTH CAROLINA, Cherokee County, Kings Creek @ S-11-209, 3 miles west of Smyrna, VI-25-1995, J. Glover (deposited in the Purdue Entomological Research Collection, West Lafayette, Indiana). Paratypes: 1 larva (broken, some parts miss-



Figs. 1-10. *Plauditus gloveri*. 1. Labrum (dorsal). 2. Maxilla. 3. Right mandible. 4. Left mandible. 5. Labial palp. 6. Midfemora (anterior face). 7. Claw. 8. Abdomen (dorsal). 9. Abdomen (ventral). 10. Gill 5.

ing), same data and deposition as holotype; 2 larvae (mounted on slides, medium Euparol), SOUTH CAROLINA, Fairfield County, Little River @ S-20-60, 3.1 miles southwest of Jenkinsville, VI-28-1995, J. Glover (same deposition as holotype).

Remarks. Larvae of *Plauditus gloveri* are easily distinguished from all other known larvae of *Plauditus* on the basis of morphological and color pattern characterization given above. Seven other species of *Plauditus* have been reported from the southeast: *P. alachua* (Berner), *P. armillatus* (McCafferty and Waltz), *P. bimaculatus* (Berner), *P. cinctutus* (McCafferty and Waltz), *P. dubius* (Walsh), *P. punctiventris* ((McDunnough), and *P. rubrolateralis* (McDunnough). On the basis of its relatively straight tarsal claw, *P. gloveri* may be closely related to *P. cestus* (Provonsha and McCafferty). *Plauditus gloveri* and *P. cestus* have antennae that are clearly shorter than other known species of *Plauditus*, although those of *P. gloveri* are not nearly as short as those of *P.* cestus (Provonsha and McCafferty 1982). *Plauditus gloveri*, however, differs from *P. cestus* in numerous other characteristics, including the position of the pair of extending dorsal labral setae, the relatively much longer maxillary palps, femoral markings, the longer and somewhat more pointed tergal spines, and patterning of the abdomen and cerci.

Abdominal segment banding on segment 7 is evident but not well developed on the specimens of *P. gloveri* that we have examined. It is probable that segment 7 banding will be more pronounced in larger series. All of our specimens were female larvae, and it is also possible that the banding as well as other patterning will be more developed in males. This possibility is based on the fact that such sexual dimorphism has been documented for certain other species in the genus *Plauditus* (e.g., *P. dubius* and *P. virilis* [Ide 1937]). Abdominal segment banding occurs on segment 5 in most specimens of *P. cestus*, but has never been seen on segment 7.

Although all material of *P. gloveri* has been taken from the Broad River Basin in South Carolina, no specific ecological data are yet associated with this new species.

ACKNOWLEDGMENTS

We thank Jim Glover (Columbia, South Carolina) for collecting the new species and initially recognizing that it did not match other known species. We especially thank Arwin Provonsha (West Lafayette, Indiana) for the illustrations used herein. This paper has been assigned Purdue Agricultural Research Program Journal No. 15602.

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NEW SPECIES OF *CLOEON* AND *DEMOULINIA* (EPHEMEROPTERA: BAETIDAE) FROM MADAGASCAR[1, 2]

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

ABSTRACT: *Cloeon emmanueli*, new species, and *Demoulinia insularis*, new species, are described from larvae from Madagascar. *Cloeon emmanueli* represents the first *bona fide* report of *Cloeon* from the island. The species is distinguished by the setation of the labrum, abdominal color pattern, tergal armature, and irregular paraproctal spines. *Cloeon cambouei*, *C. durani*, and *C. irretitum* are considered *nomina dubia* because they were described from subimagos only. *Demoulinia insularis* is the first species of *Demoulinia* to be reported from the island. The species is distinguished by the relatively wide anteromedial emargination of the labrum, edentate tarsal claws, and numerous paraproctal spines.

The faunal composition of the small minnow mayflies (Ephemeroptera: Baetidae) of Madagascar has recently received considerable attention (Lugo-Ortiz and McCafferty 1997abef, 1998a), but requires additional study. Baetid genera that were shown in those works to occur in Madagascar include *Afroptilum* Gillies, *Cheleocloeon* Wuillot and Gillies, *Dabulamanzia* Lugo-Ortiz and McCafferty, *Dicentroptilum* Wuillot and Gillies, *Edmulmeatus* Lugo-Ortiz and McCafferty, *Herbrossus* McCafferty and Lugo-Ortiz, *Labiobaetis* Novikova and Kluge, *Mutelocloeon* Gillies and Elouard, and *Xyrodromeus* Lugo-Ortiz and McCafferty. Lugo-Ortiz and McCafferty (1998a) confirmed that *Nesoptiloides*, first described from Madagascar by Demoulin (1973), was a valid genus. Reports of adults of *Centroptilum* Eaton from Madagascar are, however, highly tenuous because species previously assigned to that genus in Africa have been shown to represent diverse evolutionary lineages not including *Centroptilum* (Gillies 1990, Wuillot and Gillies 1994, Lugo-Ortiz and McCafferty 1996abc, 1997cd, 1998ab, McCafferty et al. 1997). We expect such adults in Madagascar to be members of the *Centroptiloides* complex (see Lugo-Ortiz and McCafferty 1998a). Madagascar species described as *Cloeon* Leach are based on subimagos (Navás 1926, 1930, 1936) that cannot be placed to genus with any reliability.

In this paper, we describe one species of *Cloeon* and one species of *Demoulinia* Gillies based on larvae collected from Madagascar. The new species of *Cloeon* represents the first substantiated report of the genus from Madagascar, and the new species of *Demoulinia* is the first of that genus to be described from the island. Examined specimens are housed in the Purdue Entomological Research Collection, West Lafayette, Indiana.

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[1] Received March 11, 1998. Accepted April 4, 1998.

[2] Purdue Agricultural Research Program Journal No. 15659.

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Cloeon emmanueli Lugo-Ortiz and McCafferty, NEW SPECIES

Larva. Body length: 4.3-5.2 mm. Caudal filaments length: 3.0-4.7 mm. Head: Coloration medium brown to medium yellow-brown, with no distinct markings. Antennae approximately 3.0x length of head capsule. Labrum (Fig. 1) with numerous long, fine, simple setae scattered over surface. Hypopharynx as in Figure 2. Left mandible (Fig. 3) with seven denticles; prostheca apically denticulate; tuft of long, fine, simple setae between prostheca and mola. Right mandible (Fig. 4) with outer set of incisors with four denticles and inner set with two denticles; tuft of long, fine, simple setae between prostheca and mola. Maxillae (Fig. 5) with irregular row of long, fine, simple setae submedially in midregion; palps three segmented; palp segment 1 approximately 0.63x length of segment 2 and 3 combined; segment 2 approximately 1.45x length of segment 3; segment 3 poorly defined. Labium (Fig. 6) with glossae slightly longer than paraglossae; glossae basally broad, apically narrow, with minute, fine, simple setae ventrally near base; paraglossae broadly rounded apically, with three rows of long, fine, simple setae ventrally and few minute, fine, simple setae scattered dorsally near base; palp segment 1 approximately 0.82x length of segments 2 and 3 combined; segment 2 subequal in length to segment 3, with row of five to six minute, fine, simple setae dorsally; segment 3 with numerous long, somewhat robust, simple setae scattered over surface. Thorax: Coloration medium yellow-brown, with no distinct markings. Hindwingpads absent. Legs (Fig. 7) pale yellow-brown; femora with two rows of 10-12 robust, apically pointed setae dorsally and numerous short, stout, simple seta ventrally; tibiae with few long, fine, simple setae and one long, robust, simple setae dorsally near apex, and two rows of 15-17 robust, apically pointed, simple setae ventrally; tarsi with few, long, fine, simple setae dorsally and two rows of robust, apically pointed, simple and pectinate setae ventrally; tarsal claws (Fig. 8) with two rows of 15-20 minute to small denticles each. Abdomen: Coloration medium yellow-brown and medium brown; segments 1 and 10 medium yellow-brown; segments 2 and 3 medium yellow-brown, medium brown sublaterally; segments 4-9 medium yellow-brown, with small medium brown markings anterolaterally. Sterna medium yellow-brown; sterna 4-9 with faint medium brown broad band medially. Terga (Fig. 9) with numerous scale bases and few minute, fine, simple setae scattered over surface; posterior triangular spination irregular. Gills 1-6 with two lamellae, gill 7 single. Paraproct (Fig. 10) with 10-12 marginal spines and numerous minute, fine, simple setae scattered over surface. Caudal filaments pale yellow-brown, with medium brown annulations every three to four segments; terminal filament approximately 0.60x length of cerci.

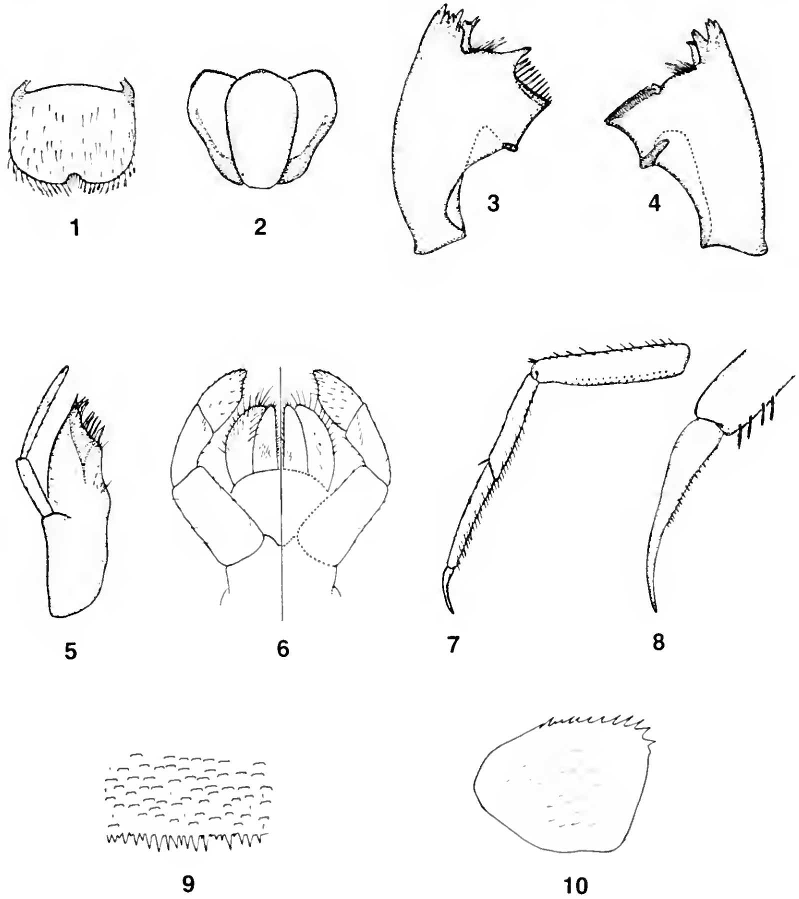
Adult. Unknown.

Material examined. Holotype: Larva, MADAGASCAR, Antsiranana Prov., Djabala R., 11 km NW of Hell-Ville, Nosy Be, 25-X-1971, G. F., C. H. Edmunds, and F. Emmanuel. Paratype: Larva, same data as holotype [mouthparts, left foreleg, tergum 4, gills 4, and paraproct of one larva mounted on slide (medium: Euparal)]. Additional material: Four larvae, same data as holotype.

Etymology. We name this species after F. Emmanuel (Madagascar), who assisted in its collection.

Discussion. Although no other species of *Cloeon* from Madagascar are known from the larval stage, we expect that the setation of the labrum (Fig. 1), abdominal color pattern, tergal armature (Fig. 9), and paraproctal spination (Fig. 10) will be diagnostic features of *C. emmanueli*.

The genus *Cloeon* has been reported from much of the world, although reports of its presence in South America are considered incorrect (McCafferty 1998), and it is only adventive in North America (McCafferty 1996). Its presence in southern Africa and the Orient suggested that it could be present in Madagascar. However, species previously assigned to *Cloeon* in Madagascar include only the highly dubious *C. durani* Navás (1926), *C. cambouei* Navás (1930), and *C. irretitum* Navás (1936). *Cloeon durani* and *C. cambouei* were originally described from female subimagos, and *C. irretitum* was originally



Figs. 1-10. *Cloeon emmanueli*, larva. 1. Labrum (dorsal). 2. Hypopharynx. 3. Left mandible. 4. Right mandible. 5. Right maxilla. 6. Labium (right-ventral; left-dorsal). 7. Right foreleg. 8. Tarsal claw. 9. Tergum 4 (detail). 10. Paraproct.

described from male and female subimagos. Because the three species are so poorly known and because their taxonomic status cannot be corroborated, we place the three names as *nomina dubia*. Thus, *C. emmanueli* is the only *bona fide* species of *Cloeon* known from Madagascar at this time.

Demoulinia insularis Lugo-Ortiz and McCafferty, NEW SPECIES

Larva. Body length: 7.3 mm. Caudal filaments length: 3.5 mm. Head: Coloration medium yellow-brown, with no distinct pattern. Antennal length unknown. Labrum (Fig. 11) with numerous long, fine, simple setae scattered over surface. Hypopharynx as in Figure 12. Left mandible (Fig. 13) with outer set of incisors with three denticles and inner set with two denticles. Right mandible (Fig. 14) with outer set of incisors with three denticles and inner set with two denticles. Maxillae (Fig. 15) with row of 10-12 long, fine, simple setae near crown of galealaciniae and row of six to seven long, fine, simple setae submedially in midregion; palps two segmented; palp segment 1 approximately 0.70x length of segment 2. Labium (Fig. 16) with glossae subequal in length to paraglossae; glossae broadly rounded apically, with minute, stout, simple setae dorsally; paraglossae acute apically, with numerous long, fine, simple setae ventrally and three rows of long, fine, simple setae dorsally; palp segment 1 approximately 0.80x length of segments 2 and 3 combined, with numerous long, fine, simple setae basomedially; segment 2 approximately 2.25x length of segment 3, with numerous long, robust, simple setae on distomedial process; segment 3 slender and elongate, with numerous long, robust, simple setae scattered over surface. Thorax: Coloration medium yellow-brown, with no distinct markings. Hindwingpads absent. Legs (Fig. 17) pale yellow-brown; femora with numerous minute, fine, simple setae and minute, stout, simple setae dorsally and ventrally, setae more abundant ventrally; tibiae and tarsi with numerous minute, fine, simple setae dorsally and numerous minute, stout, simple setae ventrally; tarsal claws approximately 0.63x length of tarsi, edentate. Abdomen: Coloration medium brown to yellow-brown; tergum 1 medium brown, with no markings; tergum 2 medium brown, with anteromedial pair of round, medium brown spots; terga 3-9 medium brown anteriorly, yellow-brown posteriorly, with anteromedial pair of medium brown dashes; terga 7-9 with submedial pair of round, medium brown spots in midregion; tergum 10 yellow-brown. Sterna pale yellow brown, with no distinct pattern. Terga (Fig. 18) with numerous scale bases; posterior triangular spines approximately 1.2x basal width. Gills subtriangular, poorly tracheated, marginally smooth. Paraproct (Fig. 19) with numerous marginal spines, increasing in size apically. Caudal filaments pale yellow-brown; terminal filament subequal in length to cerci.

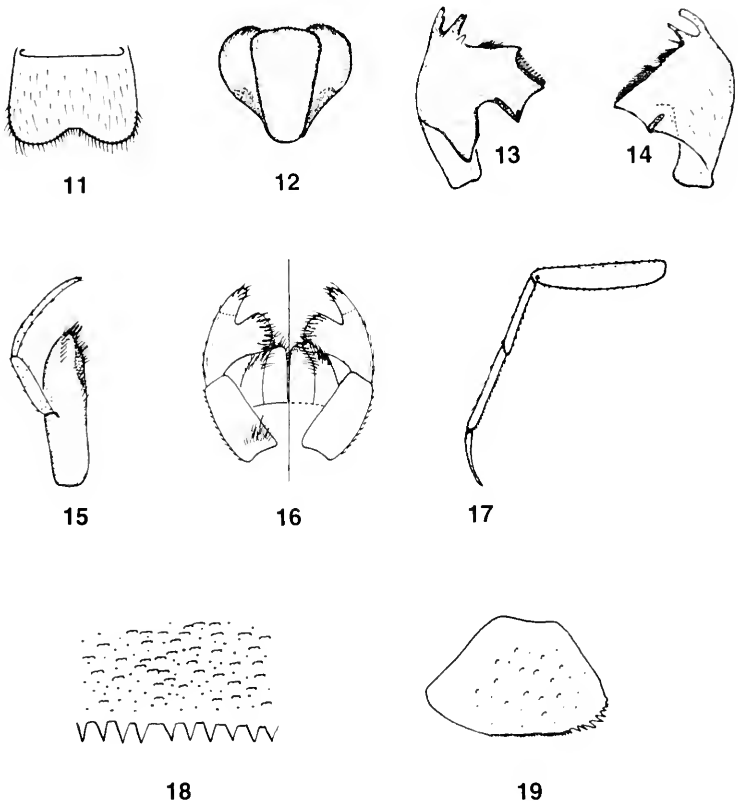
Adult. Unknown.

Material examined. Holotype: Larva, MADAGASCAR, Antananarivo (= Tananarive) Prov., Ankeniheny R., 28°C, 4 km S of Manjakatompo Forest Station, 1-XI-1971, G.F., C. H. Edmunds, and F. Emmanuel [mouthparts, forelegs, tergum 4, and paraproct on slide (medium: Euparal)].

Etymology. The specific epithet is a Latin word meaning "from an island."

Discussion. *Demoulinia* has been known previously only from South Africa (Demoulin 1970, Gillies 1990). *Demoulinia insularis* is distinguished from the southern African species *D. crassi* (Demoulin) by the relatively wide anteromedial emargination of the labrum (Fig. 11), edentate tarsal claws (Fig. 17), and numerous small spines of the paraproct (Fig. 19).

The presence of *D. insularis* in Madagascar is significant because it indicates that *Demoulinia* was well established in at least West Gondwanaland before the island began to separate from the African landmass approximately 100 million years ago.



Figs. 11-19. *Demoulinia insularis*, larva. 11. Labrum (dorsal). 12. Hypopharynx. 13. Left mandible. 14. Right mandible. 15. Right maxilla. 16. Labium (left-ventral; right-dorsal). 17. Right foreleg. 18. Tergum 4 (detail). 19. Paraproct.

ACKNOWLEDGMENTS

We thank G. F. Edmunds, Jr. (Salt Lake City, Utah) for the donation of the material used in this study.

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AEDES ALBOPICTUS (DIPTERA: CULICIDAE) OCCURRENCE THROUGHOUT TENNESSEE, WITH BIOLOGICAL NOTES[1]

James P. Moore[2]

ABSTRACT: *Aedes albopictus*, the Asian tiger mosquito, was recorded for the first time in 87 of Tennessee's 95 counties. Continued occurrence of this species in the remaining 8 Tennessee counties was confirmed. Notes are provided on other mosquito species sharing larval habitats with *Ae. albopictus*, as well as the observed photoperiod-induced egg diapause of *Ae. albopictus* in Montgomery County, Tennessee.

A survey of Tennessee's 95 counties was conducted during 1997 to determine the presence of *Aedes albopictus* (Skuse), the Asian tiger mosquito. This survey, primarily of water-containing tire habitats, established the first record of *Ae. albopictus* in 87 Tennessee counties and confirmed the continued presence of the species in the remaining 8 counties with previously reported infestations (Chet Moore, CDC, personal communication). These 8 counties are Anderson, Coffee, Davidson, Gibson, Henderson, Lawrence, Montgomery, and Shelby.

Mosquito larvae were collected from 108 sites in 86 counties from July to October 1997. These sites consisted of new and waste automotive tires located at roadside dumps (12), county waste collection points (2), and commercial tire businesses (91). Other sites included outdoor plastic and masonry containers at residences (2) and roadside dumps (1). Larvae were collected directly from the tire or other container using a siphon, transported to the laboratory, and identified using standard light microscopy and the taxonomic references of Darsie and Ward (1981), Darsie (1986), and Reinert et al. (1997). At 51% of the larval collection sites, *Ae. albopictus* was the only culicid species collected (Table 1). *Aedes albopictus* shared the habitat with other mosquito species at an additional 31% of the sites, making this species the predominant culicid resident of tire habitats in Tennessee.

Adult *Ae. albopictus* were collected from 50 sites in 50 counties during this survey. An aspirator was used to collect the adults (both sexes) resting at 26 sites and feeding on man at 24 sites. Adult specimens were examined using a dissecting microscope and identified using the taxonomic references of Darsie and Ward (1981) and Darsie (1986). Collection data for each collection site is preserved and available for anyone wishing to visit the collection sites for control purposes.

Aedes triseriatus (Say) was found as the sole inhabitant at 5% of the sites.

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[1] Received February 6, 1998. Accepted April 19. 1998.

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Aedes triseriatus was found with other culicid species at an additional 6% of the sites; *Ae. albopictus* was always one of its cohabitants. This indicates that the Asian tiger mosquito has not totally excluded *Ae. triseriatus* from tire habitats in Tennessee, as had been predicted by Livdahl and Willey (1991).

No specimens of *Aedes aegypti* (Linnaeus) were collected during this survey. However, *Ae. aegypti* larvae were collected previously by the author from tire habitats in Montgomery County, TN, during July 1996 and April 1997. This may indicate that *Ae. albopictus* is competitively displacing *Ae. aegypti* from tire habitats in Tennessee. However, most of Tennessee is in the region identified by Darsie and Ward (1981) as the extreme range for *Ae. aegypti.*

Some populations of *Ae. albopictus* exhibit a photoperiod-induced egg diapause (Hawley et al. 1989, Estrada-Franco and Craig 1995). As the species adapts to new locations, the photoperiod response may be altered, providing researchers with a measure of the length of time the species has inhabited a region (Chet Moore, CDC, personal communication). There are no historical data on the photoperiodism of *Ae. albopictus* in Tennessee. In Montgomery County, TN, during 1997, the hatching of *Ae. albopictus* eggs in outdoor artificial containers was observed as early as 17 April (13.2 hours daylight) and as late as 2 October (11.8 hours daylight).

Table 1. Species composition of larval mosquito collections from Tennessee (July - October 1997), showing percentage of 108 collection sites with a species alone (Solo) and percentage of collection sites with cohabitant culicid species (With others).

	Percentage of 108 larval collection sites		
Mosquito species	Solo	With others	Total %
Aedes albopictus (Skuse)	51	31	82
Aedes atropalpus (Coquillett)	2	2	4
Aedes triseriatus (Say)	5	6	11
Anopheles punctipennis (Say) / *perplexens* Ludlow	0	1	1
Anopheles quadrimaculatus sensu stricto Say	0	1	1
Culex pipiens Linnaeus / *quinquefasciatus* Say	6	11	17
Culex restuans Theobald	5	7	12
Culex territans Walker	0	2	2
Toxorhynchites rutilus septentrionalis (Dyar & Knab)	3	4	7

ACKNOWLEDGMENTS

Grateful appreciation is extended to The Center for Field Biology and the Department of Biology, Austin Peay State University, Clarksville, TN, for their support and laboratory facilities, and to Chet Moore, Division of Vector-Borne Infectious Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Fort Collins, CO, for his advice and encouragement; and to Steve Hamilton, Department of Biology, Austin Peay State University, Clarksville, TN, and C. Steven Murphree, Department of Biology, Belmont University, Nashville, TN, for providing helpful suggestions with the manuscript.

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DISTRIBUTION AND HABITAT OF *CURICTA PRONOTATA* (HEMIPTERA: NEPIDAE) IN SOUTHEASTERN ARIZONA[1]

Jon D. Hoekstra[2], Robert L. Smith[3]

ABSTRACT: *Curicta pronotata* is known from western Mexico and southeastern Arizona. Previous accounts of the species' Arizona distribution draw from only a few collections and localities. Distributional records clarifying the range and habitat of *C. pronotata* in Arizona are reported here.

The genus *Curicta* (Hemiptera: Nepidae) is primarily Neotropical with species entering the United States in Arizona, Texas, and Louisiana (Menke, 1979). *Curicta pronotata's* principal range is in Mexico along the Sierra Madre Occidental; it extends from Nayarit north to eastern Sonora and western Chihuahua (Keffer 1996). *C. pronotata* has previously been reported from two different canyons in the Huachuca Mts. in southern Arizona (Dubois 1978, Keffer 1996), and Sites and Polhemus (1994) reported the species from Sabino Canyon near Tucson on the basis of an individual collected in 1937 (full record given here).

This report extends the range of the species in Arizona. *Curicta pronotata* has now been recorded from the Huachuca, Santa Catalina, and Galiuro mountain ranges in southern Arizona. Based on our own findings and habitat information from previous records, the habitat of *C. pronotata* in Arizona appears to be small shaded streams with woody debris above about 1200m.

NEW RECORDS

Hemiptera: Nepidae: *Curicta pronotata* Kuitert 1949.

Arizona: Pima County: 1 male, Santa Catalina Mts., Sabino Canyon, 29-VII-1937, E.D. Ball, UAIC; Pima County: 1 nymph, Santa Catalina Mts., Sabino Canyon, 3660' (1115 m), 32°22'00" N, 110°47'10" W, 6-VI-1997, J.D. Hoekstra, UAIC; Pima County: Santa Catalina Mts., Bear Canyon, 5530' (1685 m), 32°21'45" N, 110°42'30" W, 19-VII-1997, J.D. Hoekstra and C. Creighton, 1 male, 1 female, 12 nymphs, UAIC, 1 female, 5 nymphs, JTPC; Cochise County: 1 female, Galiuro Mts., Wildcat Canyon, 4120' (1255 m), 32°22'00" N, 110°15'30" W, 20-VIII-1996, J.D. Hoekstra and D.A. Lytle, JTPC; Cochise County, 1 male, same locality data as preceding, 21-IX-1996, J.D. Hoekstra, JTPC.

Abbreviations: JTPC = J. T. Polhemus Collection, Englewood, CO. UAIC = University of Arizona Insect Collection, Tucson, AZ.

DISCUSSION

In Sabino Canyon, a single nymph was collected from mud under a rock

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[1] Received December 29, 1997. Accepted February 8, 1998.

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ENT. NEWS 109(5): 366-368, November & December, 1998

along the margin of a drying pool. The nymph was inactive and presumed dead until it was placed in ethanol, whereupon it revived for a short time. The nymph's behavior may have been an example of "death-feigning" (thanatosis) as reported in *Nepa* and *Ranatra*, or it may have indicated the initiation of estivation, which has been documented in *Nepa* (Sites and Polhemus 1994). This nymph is the first evidence of *C. pronotata* in Sabino Canyon since it was collected in 1937. The authors have sampled the habitat in which it was found extensively over two seasons and have found only this single nymph. We suspect that it was a "stray" which had drifted down from an upstream source population in Sabino Canyon or a tributary.

In Bear Canyon, Santa Catalina Mts., adults and especially nymphs were very abundant among woody detritus in shallow bedrock-lined pools. The stream was narrow (less than 1 m wide) and shallow (average maximum depth 30 - 40 cm). *Curicta pronotata* shared this habitat with *Abedus herberti* (Hemiptera: Belostomatidae), which was also abundant. Of the twenty *C. pronotata* collected on July 19, 3 were adults, 10 were F-1 instar nymphs, and 7 were F-2 instar nymphs. In *Curicta scorpio*, the fourth and fifth stadia lasted an average of 18.56 and 18.87 days for artificially reared individuals from two populations in Texas (Keffer et al. 1994). If *C. pronotata* has a similar developmental rate, most of the individuals in the Bear Canyon population probably eclosed to the adult stage by September.

Arizona collections of *Curicta pronotata* have been very few, despite the species' fairly wide range as indicated by the records reported here. The species probably has been overlooked because of its cryptic appearance and tendency to feign death when captured (Sites and Polhemus 1994). In addition, spatial and temporal components of the species' occurrence in Arizona may have contributed to its rarity in collections.

Arizona populations of *C. pronotata* appear to be highly localized. Such local populations could be relicts of a previously continuous distribution. The Sonoran Desert region has aridified over the past 11,000 yr., with attendant restriction of previously widespread mesic biotic communities to high elevations (Hall et al., 1989). This process may have reduced the number and extent of suitable habitats for *C. pronotata*, such that it currently persists in only a few favorable habitat refuges.

Densities of *C. pronotata* probably fluctuate seasonally with changes in streamflow, as noted by Keffer (1996) for Texas populations of *Curicta scorpio*. Local populations of *C. pronotata* may also be unstable from year to year in Arizona. The species is probably capable of dispersal by flight, which has been reported for *C. scorpio* (Sites and Polhemus 1994). Thus the disjunct Arizona populations could be transient "sink" populations in a metapopulation with a "core" to the south in the Sierra Madre Occidental. Such a metapopulation dynamic has been reported for several southeastern Arizona butterfly species

(Bailowitz and Brock 1991).

Additional surveys and long term monitoring of the Arizona populations will be required to evaluate these alternative hypotheses about the population dynamics and biogeography of *C. pronotata* at the northern limits of its range.

ACKNOWLEDGMENTS

We thank J.T. Polhemus for making the specific determinations on individuals from the populations reported. J.D. Hoekstra also thanks the UA Department of Entomology and the ARCS (Acheivement Rewards for College Scientists) Foundation for support during the time in which this research was conducted.

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HEXAMETHYLDISILAZANE – A CHEMICAL ALTERNATIVE FOR DRYING INSECTS[1]

John Heraty, David Hawks[2]

ABSTRACT: Two methods of chemically drying softbodied Chalcidoidea (Hymenoptera) are compared: critical-point drying (CPD) and hexamethyldisilazane (HMDS). For three groups of Eulophidae, Encyrtidae and miscellaneous Chalcidoidea, the CPD specimens were of consistently higher quality for all groups, although the overall differences between CPD and HMDS specimens were marginal.

Soft-bodied insect specimens have long been the bane of systematics. Freshly killed and air-dried specimens (Fig. 1) undergo partial to complete collapse of body parts, whereas specimens initially preserved in EtOH fare even worse when subsequently removed from the liquid and air dried (Fig. 2). This is not only a problem of obtaining quality museum specimens but in the past has deterred some systematists from bothering with samples preserved in alcohol, such as those taken in malaise or pan traps. Critical-point drying (CPD) of specimens through a liquid CO_2 intermediate (Gordh & Hall 1979) provides a means of retrieving large numbers of soft-bodied specimens from EtOH and is being widely used for some taxa, especially Chalcidoidea. The primary advantage of using CPD is little or no collapse of soft body parts, including internal muscles and nerves. Secondarily, the structure of muscles, nerve tissue and other internal body parts is maintained, allowing for later survey of these structures from museum specimens (Heraty et al. 1997). The disadvantages with the CPD are that it 1) is relatively expensive to buy the initial equipment ($2,000-8,000), 2) is necessary to obtain specialized CO_2 tanks that must be maintained above 900 psi, 3) is labor intensive, 4) can cause abnormal swelling or occasional bursting of some body parts, and 5) may leave surface residues on specimens.

Several alternatives to air drying or CPD have been proposed, some of which are freeze drying, Peldri II (Brown 1990), acetone vapor (van Noort 1995), xylene (R. Carlson pers. comm.), and hexane (D. Hawks, pers. comm.). A new chemical method involving hexamethyldisilazane (HMDS) has been proposed as a simple and cost-effective means of retrieving high-quality specimens from collections preserved in EtOH (Nation 1983, Brown 1993). Only the CPD and HMDS methods are regularly applied for the retrieval of large collections of Chalcidoidea initially preserved in alcohol, and here we compare the two methods.

METHODS

All specimens were initially killed and preserved in 70-75% EtOH at 4°C.

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Evaluations were of separate collections made from 1990 to 1996 in southeast Asia, the Galapagos Islands and California. Lots that had a high proportion of soft-bodied Chalcidoidea were chosen, and all specimens were scored from each lot. Fourteen separate collections (362 specimens) were evaluated for the CPD method and 5 collections (347 specimens) for HMDS. Overlap in collection time and country for each method occurred only for the southeast Asian collections. Additional specimens of a new species of *Cirrospilus* (Eulophidae) from California were examined as representatives of very soft-bodied Chalcidoidea.

Specimens were scored on a scale of 1 to 5, with 5 being a nearly perfect specimen suitable for scanning electron microscopy (SEM). Scores were based only on the softer body parts. *Cirrospilus* are almost entirely soft-bodied and represent an extreme; in other taxa, for example pteromalids, the head and mesosoma are well-sclerotized and do not collapse under any treatment, but the antennae and gaster will partially or completely collapse. A score of 1 would be typical of air-dried eulophids taken from alcohol: completely shrivelled and collapsed (Fig. 2). A score of 2 was assigned to specimens that had extensive collapse of the softer body structures (head, antennae and gaster) (Fig. 1). A score of 3 was given to specimens with partial collapse of all softer body parts (Figs 4, 5). Freshly killed and air-dried specimens would usually be given a score between 1 and 3, with a score of 3 bordering on acceptable for museum collections or SEM (at least partly shrivelled or collapsed). A score of 4 was given for very minimal collapse of not more than one body part or a slight distortion (wrinkling or bloating) of the gaster (Figs 4, 5). The *Cirrospilus* were not scored for comparative analysis. All material is deposited in the Entomology Research Museum, University of California, Riverside.

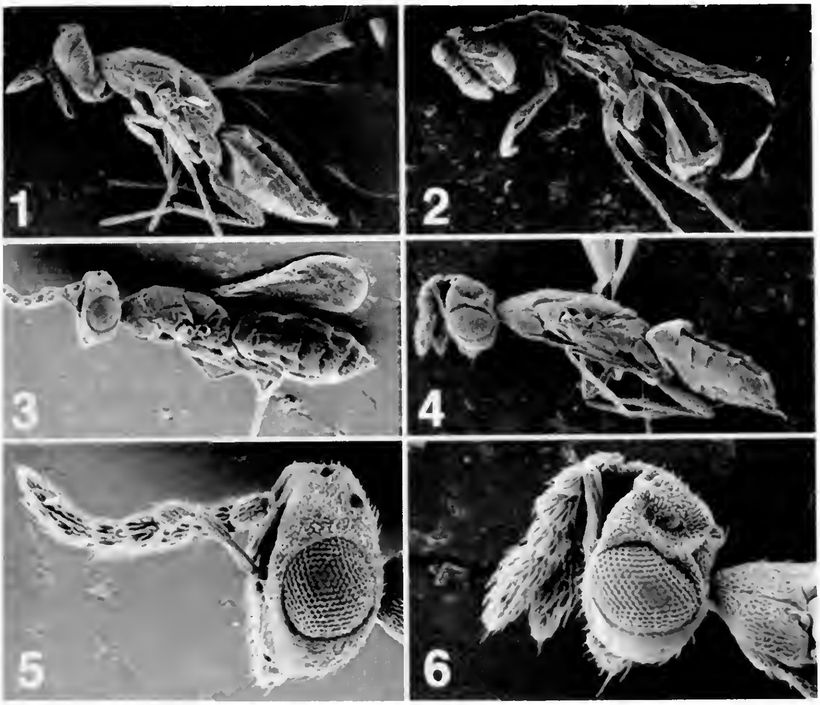
CPD method. The liquid vapor interface is the primary destructive force in air-drying specimens, and if not about equal, results in the breakdown of cell walls and collapse of tissue. For CO_2, the identical vapor pressure as a liquid or gas, the critical point, is reached at 31.0°C and 1093 psi (Burstyn and Bartlett 1975). Specimens were dried as outlined by Gordh & Hall (1979) by 1) dehydrating the specimens to 100% EtOH, 2) exchanging fluids through liquid CO_2 under high pressure (900 psi) and low temperature (11-15°C) through a series of soaks and purges until the exhausted dry CO_2 did not leave a liquid residue (complete sublimation), 3) drying under high pressure (1100-1200 psi) until the chamber temperature reached 41-43°C, and then 4) slowly exhausting the gaseous CO_2 to room atmospheric pressure.

HMDS method. HMDS ($[(CH_3)_3Si]_2NH$) reacts with water to produce hexamethyldisiloxane ($[(CH_3)_3Si]_2O$) and ammonia (NH_3), both of which evaporate from the specimen (Dave Jordon, Polysciences Inc., pers. comm.). Specimens were dried in the manner outlined by Brown (1993) by 1) dehydrating the specimens to 100% EtOH, 2) replacing the alcohol with HMDS for two soaks of 1/2 hour each in a covered glass vial or dish, and 3) after the second soak, pouring off most of the HMDS and allowing the remaining HMDS to evaporate in a fume hood (or outdoors in a well-ventilated area). Samples can be soaked and dried in glass vials or dishes. Gas buildup in the vials may cause the release of liquid HMDS while being uncapped, but this can be avoided by using smaller volumes of HMDS (less than half of vial) or slowly unscrewing the vial top. We prefer to line the bottom of a glass dish with a fine brass screen and cover each sample with a screen lid during evaporation, thus preventing dried specimens from disappearing into the exhaust. HMDS is a skin irritant, and gloves and eye protection are recommended.

All specimens were card-mounted for examination following Noyes (1982).

RESULTS

Cirrospilus (Eulophidae) was used as an example of a very soft-bodied species that does not fare well under any of the drying methods (Figs 1-6). Air-drying (Fig. 1) resulted in collapse of the antennae, femora, and gaster dor-



Figures 1-6. *Cirrospilus* sp. (Eulophidae): **1,** freezer killed and air dried. **2-6,** killed and preserved in 70% EtOH and then: **2,** air-dried; **3&5,** CPD dried; **4&6,** HMDS dried.

sally and laterally; the mesosoma was relatively undistorted. The specimen illustrated would receive a score of 2, which would be marginally acceptable for use in collections. Air-drying from alcohol (Fig. 2) was disastrous, with general collapse of all body parts (score 1). CPD *Cirrospilus* (Figs 3, 5) showed slight collapse of the scape and scrobes, and distortion but not collapse of the gastral tergites. Such a specimen (Fig. 3) would be scored as a 4 (less than perfect). HMDS *Cirrospilus* (Fig. 4, 6) exhibited a greater degree of collapse of the scape, head and metasoma, with the specimen receiving a score of 3. For extremely soft-bodied specimens, the CPD method was consistently better than the HMDS method, and both were better than air-drying.

Seven families of Chalcidoidea were encountered in the 19 collections evaluated (Table 1). Each family presents a different problem with respect to how they were affected by improper drying. Even when CPD- or HMDS-treated, soft-bodied Eulophidae generally had some collapse or distortion of all body parts (cf. Figs. 3-5). Using either CPD or HMDS, 51% of the

Table 1. Quality of soft-bodied Chalcidoidea dried using critical-point drying (CPD) or hexamethyldisilazane (HMDS). Ranking based on a scale of 1-5, with 5 indicating a near-perfect specimen. Mean values were significantly higher for CPD specimens for all groups (Chi-square, $P=0.01$). Data were pooled for Aphelinidae, Mymaridae, Pteromalidae, Torymidae and Trichogrammatidae.

		rank						
		5	**4**	**3**	**2**	**1**	**n**	**mean rank**
Eulophidae	CPD	126	114	7	0	0	247	4.48
	HMDS	87	60	22	0	0	169	4.38
Encyrtidae	CPD	46	19	6	0	0	71	4.56
	HMDS	29	32	0	0	0	61	4.48
Aphelinidae	CPD	7	2	0	0	0	44	4.82
	HMDS	56	2	2	2	0	117	4.51
Pteromalidae	CPD	7	4	1	0	0		
	HMDS	13	9	9	1	0		
Mymaridae	CPD	4	4	1	0	0		
	HMDS	6	6	0	0	1		
Trichogrammatidae	CPD	11	1	1	0	0		
	HMDS	8	2	0	0	0		
Torymidae	CPD	1	0	0	0	0		
	HMDS	—	—	—	—	—		

Eulophidae treated had a score of 5, and, although a much higher proportion than the CPD method, only 13.0% of the specimens received a score of 3, and none received a 1 or 2. Many Eulophidae are reasonably well-sclerotized and do not have problems similar to those of *Cirrospilus*. Often the most noticeable artifact was a slight wrinkling of the gastral tergites (score of 4), which was common in both treatments. Pteromalidae generally have a well-sclerotized head and mesosoma, but the gaster of males is particularly susceptible to collapse. Both Trichogrammatidae and Aphelinidae are soft-bodied but responded well to either technique except for some collapse of the antennae, which occurred with use of either method. Other than Eulophidae, all of the chalcidoid groups responded well to either technique, with consistent scores of 4 or 5, both of which are acceptable for museum collections.

For statistical comparisons, Eulophidae and Encyrtidae were common in all samples and were treated separately; results for Aphelinidae, Pteromalidae, Mymaridae, Torymidae and Trichogrammatidae were pooled. In all three comparisons, the CPD specimens were of significantly higher quality (rank) than the HMDS specimens (Chi Square, $P=0.01$), although the differences in the mean rank scores for each treatment were marginal (Table 1). The CPD method after ethanol fixation also ranked better than HMDS in a study of pre- and post-fixation techniques in four taxa (Swearingen et al. 1997). In contrast to the techniques used by Swearingen et al. (1997), we have not found fixation in osmium tetroxide to be a necessary step in preparation for either museum or SEM specimens.

CPD and HMDS methods left little or no residue on the specimens, as noted by Swearingen et al. (1997). Specimens treated by HMDS appeared to be slightly cleaner, but we could see no way to quantify this characteristic accurately. HMDS also works as a good degreasing agent for some insects such as tiger beetles and robber flies. We also found various labels and ink types (including laser-printed labels) to be unaffected by HMDS, allowing their inclusion during processing. The same is possible for the CPD method, although processing is usually in small capsules making inclusion of larger labels impossible. At $30 U.S. per 400 ml of HMDS and 5 ml per large lot of about 100 chalcidoids, we estimate a cost of about 37.5 cents per run, or 0.4 cents per specimen. We have tried HMDS on a variety of insects, including Collembola, flies, beetles and other Hymenoptera (*Perdita* and *Bombus*), with generally excellent results. Heavily sclerotized individuals processed using HMDS are as good as CPD specimens. Internally, muscles and nerve tissue are preserved in the same manner as using the CPD process. For larger specimens, wings are often crumpled in smaller CPD capsules, but this was not a factor with HMDS. In addition to improved specimen quality, it is also noteworthy that mitochondrial DNA was successfully extracted from dried CPD and HMDS specimens of Ichneumonidae and Encyrtidae (Austin & Dillon 1997).

In summary, the use of HMDS is a viable alternative to use of CPD for retrieving soft-bodied insects from alcohol. CPD specimens are marginally better in quality than those treated with HMDS, but HMDS is cost-effective and less labor intensive than CPD. If the equipment is not available, HMDS may be the preferred technique.

ACKNOWLEDGMENTS

John Pinto, Gary Platner and Serguei Triapitsyn (University of California, Riverside) reviewed an earlier draft of this manuscript.

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1. Title of publication: ENTOMOLOGICAL NEWS
2. Date of filing October 1, 1998.
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)

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VOLUME 109, 1998

No.	Date of issue	Pages	Mailing Date
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2	Mar.& Apr.	81-152	April 14, 1998
3	May & June	153-224	June 22, 1998
4	Sept. & Oct.	225-296	October 22, 1998
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INDEX: Volume 109

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