







# ENTOMOLOGICAL NEWS

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(Continued on inside of back cover)

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***COPROPHILUS STRIATULUS* (COLEOPTERA:  
STAPHYLINIDAE): CONFIRMATION OF  
ESTABLISHMENT OF A PALEARCTIC OXYTELINE  
ROVE BEETLE IN NORTH AMERICA<sup>1</sup>**

E. Richard Hoebeke<sup>2</sup>

ABSTRACT: Confirmation of the establishment of *Coprophilus striatulus*, a common and widespread Palearctic oxyteline staphylinid, in eastern North America (New York, Quebec, Ontario) is documented. Known North American distributional data are recorded and mapped. Recognition features are described and illustrated, and habitat preferences and native distribution are summarized.

In early spring 1987, a single specimen of a rather large and striking species of oxyteline Staphylinidae was collected while sweeping streamside vegetation in a local state park in the Finger Lakes region of central New York. Since then, several additional specimens from other localities in the eastern United States and eastern Canada have also been examined (see "Specimens Examined" below). Using a key to the world genera of Oxytelinae by Herman (1970), these specimens easily trace to the genus *Coprophilus* Latreille. In North America, there are currently 2 recognized species, *C. sexualis* Leech which occurs in the Pacific Northwest, and *C. castoris* Campbell described from beaver lodges in eastern Canada (Campbell, 1979). The above-mentioned specimens represented neither. A close examination of the European literature (Reitter, 1909; Portevin, 1929; Joy, 1932; Lohse, 1964), and use of a key to the American species of *Coprophilus* by Campbell (1979) enabled me to identify the specimens as *C. striatulus* (F.), a widespread Palearctic species. *Coprophilus striatulus* was included in Campbell's (1979) key "only because it has been recorded from North America in the literature" (see Fauvel, 1878). So far as known, the locality data listed below and mapped (Map 1) represent the first confirmed records of this species in North America.

**Specimens Examined.**

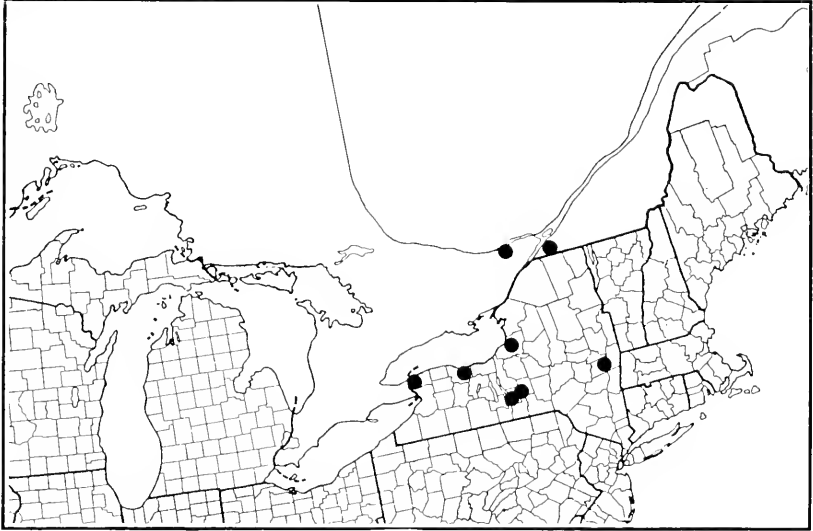
CANADA: Ontario: Ottawa, 23-IV-1984, A. Davies (CNCI) 1. Quebec: Ste-Clothilde, 2-VI-1981, G. Boivin (CNCI) 1.

UNITED STATES: New York: *Albany Co.*, Rensselaer, II-IV-1994, 2-V-1994, S. Palmer (CUIC) 3. *Cortland Co.*, 3 mi. NE Dryden, 20-IV-1974, E. R. Hoebeke (CUIC) 1. *Monroe Co.*, Rochester, 8-IV-1994, C. Conrow (CUIC) 1. *Niagara Co.*, Niagara Falls, 28-IV-1990, E. R. Hoebeke (CUIC) 1. *Oswego Co.*, Mexico, 20-IV-1994, 22-VI-1994, C. Zippel (CUIC) 2. *Tompkins Co.*, Ithaca, 24-31-V-1981, E. R. Hoebeke (CUIC) 1; Ithaca, R. H. Treman State Park, 24-III-1987, A. Millman (CUIC) 1; Shindagin Hollow, 3-V-1975, E. R. Hoebeke (CUIC) 1.

<sup>1</sup> Received September 2, 1994. Accepted September 12, 1994.

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The Canadian specimens are deposited in the Canadian National Collection of Insects, Ottawa (CNCI), while the New York specimens are deposited in the Cornell University Insect Collection, Ithaca (CUIC).



Map 1. Known North American distribution of *Coprophilus striatulus* (F.)

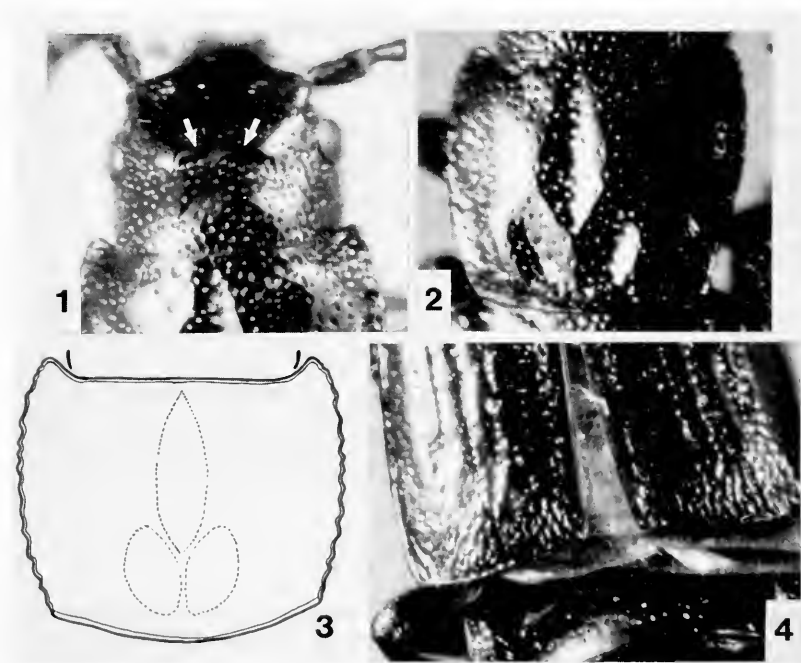
**Historical Occurrence.** – Although *C. striatulus* has been recorded from North America for well over a century (Fauvel, 1878), the record has been determined to be erroneous. Upon examining the specimen (a male from Canada in the LeConte collection) that was the basis for the Fauvel record, Campbell (1979) found that it was not conspecific with specimens of the Palearctic *C. striatulus*, but instead was identical to specimens he described as *C. castoris*, collected from beaver lodges. As a result, *C. striatulus* was removed from the list of North American species. All catalogues and checklists (Austin, 1880; Henshaw, 1885; Scheerpeltz, 1933; Blackwelder, 1973) that have listed *C. striatulus* from North America apparently have also been based on the Fauvel record.

**Recognition Features.** – Among the numerous genera of Oxytelinae, adults of *Coprophilus* are easily distinguished by their characteristic dorsal habitus (see Fig. 1 in Campbell, 1979), and by the following combination of characters as given by Herman (1970):

Strongly sclerotized body, stout fourth segment of maxillary palpus, absence of epistomal suture, separation of gular sutures for entire length, open procoxal fissure, broadly exposed procochantin, striate elytra, separation of mesocoxae by mesosternal process, and abdominal segments III-VI with four laterosclerites per segment.

Of the three species of *Coprophilus* known to occur in North America, *C. sexualis* can be recognized chiefly by its smaller body size (less than 5 mm), by the head without a trace of a transverse groove between the posterior margins of the eyes, and by its geographic distribution in southern British Columbia. *Coprophilus castoris* and *C. striatulus*, on the other hand, closely resemble each other in body size (5-9 mm), and their geographic distribution in eastern North America. Campbell (1979) provided the following diagnosis for *C. striatulus* in contrasting it with *C. castoris*:

Transverse groove across head at level of posterior margin of eyes deeper and much more distinct (Fig. 1), frons along anterior margin of groove raised and impunctate (Fig. 1, arrows), eyes very finely pubescent, median impression of pronotum longer, deeper and extending forward almost to anterior margin (Figs. 2-3), lateral margins of pronotum more coarsely and distinctly renulate (Fig. and posterior portion of elytra much more coarsely and distinctly rugose (Fig. 4).



Figs. 1-4. *Coprophilus striatulus* (F.). 1, Dorsal aspect of head; note distinct transverse groove between posterior margin of eyes and raised, impunctate frons along posterior margin of groove (arrows). 2-3, Dorsal aspect of pronotum-photomicrograph (Fig. 2) and line drawing of same (Fig. 3). 4, Apices of elytra; note coarsely rugose outer posterior angles.

**Habits and Habitat.** – Available European literature suggests that *C. striatulus* is commonly encountered in decomposing plant matter and compost, and occurs on roads and pavements during the spring months. The species has been found “in haystacks and vegetable refuse and hotbeds” (Fowler, 1888); under rotting beets, cow dung, and decaying leaves, occasionally beneath cadavers, stones, wetbark of deciduous trees, in sap exudations of trees, and in mole nests in the winter (Johansen, 1914; Horion, 1963); at manure boxes (Johansen, 1914); and in stables and in chaff at borders of barnyards (Horion, 1963).

In Lincolnshire, England, it is “common on pavements in early spring, running in the sun, but not found later in the year...” (Fowler, 1888). Johansen (1914) noted beetles are often found crawling on walls of homes, especially in the autumn, and Ganglbauer (1895) cited a similar phenomenon of finding beetles on masonry walls of houses in the spring.

Adults are generally found from March to June, and more rarely in the autumn and winter (Du Chatnert, 1986), while the larval stages occur in August (Horion, 1963).

Interestingly, six specimens, taken at Rensselaer, Mexico, and Rochester, NY, in April, May, and June 1994 (see “Specimens Examined” above) were collected from traps (Lindgren funnel traps) designed to attract specifically targeted exotic bark beetles in New York State. The Rensselaer and Mexico specimens were taken from traps baited with the lure component alpha-pinene, while the Rochester specimen was taken from a trap with the attractant chalcoprax.

**Geographic Distribution.** – *Coprophilus striatulus* is widely distributed in the Palearctic region, occurring from northern continental Europe (Denmark, Sweden, Norway, and Finland) and the British Isles and Ireland through middle and southern continental Europe (Holland, Belgium, Germany, Austria, France, Switzerland, Italy, Hungary, Czechoslovakia, Poland, and the former USSR) (Lohse, 1964). In North America, it is presently known from eastern Canada (Ontario, Quebec) and eastern United States (New York) (see Map 1).

#### ACKNOWLEDGMENTS

I thank J. Milton Campbell (formerly of the Centre for Land and Biological Resources Research, Agriculture Canada, Ottawa) for confirming the identification and for kindly providing data for the Canadian records listed in this paper; Quentin D. Wheeler (Cornell University) for allowing the use of photo-micrographic equipment in his laboratory; and JMC, QDW, and Joseph V. McHugh (Cornell University) for critically reviewing a draft of the manuscript.

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## NEW RECORDS AND DISTRIBUTION OF AQUATIC INSECT HERBIVORES OF WATERMILFOILS (HALORAGACEAE: *MYRIOPHYLLUM* SPP.) IN MINNESOTA<sup>1</sup>

Raymond M. Newman, Lynn Mizner Maher<sup>2</sup>

**ABSTRACT:** A survey of 19 lakes in Minnesota and six lakes in Wisconsin, for the presence of watermilfoil herbivores, indicated the presence of three taxa: a weevil *Euhrychiopsis lecontei* (Dietz) (Curculionidae), a lepidopteran, *Acentria ephemerella* (Denis & Schiffermüller) (Pyrallidae) and a midge *Cricotopus myriophylli* Oliver (Chironomidae). We located the weevil, *Euhrychiopsis lecontei*, at 13 sites in 10 lakes; 11 of these sites were in Minnesota. The midge, *Cricotopus myriophylli*, was found at eight sites in six lakes, including two sites in Wisconsin, and the moth, *Acentria ephemerella*, was found at five sites, including one site in Wisconsin. The weevil and caterpillar had been recorded previously in Wisconsin, but not in Minnesota. The midge has not been reported previously outside of eastern Ontario and British Columbia.

Eurasian watermilfoil (*Myriophyllum spicatum* L.) is an exotic aquatic weed that was introduced to North America between the late 1800s and the early 1940s (Aiken *et al.* 1979, Smith and Barko 1990). It is a major nuisance species in eastern North America, the Pacific Northwest and the upper mid-west (Grace and Wetzel 1978, Aiken *et al.* 1979, Smith and Barko 1990). It was first reported in Minnesota in 1987 and now occurs in over 60 lakes and two streams in Minnesota (Exotic Species Programs 1993).

The nuisance impact of this plant is obvious from the continual and expensive efforts used to control it (Aiken *et al.* 1979). Recently, interest has increased in potential biological controls of Eurasian watermilfoil, and declines of the plant have been associated with populations of native and naturalized invertebrates which are known to be herbivores of Eurasian watermilfoil. These herbivores include a lepidopteran, a chironomid and a curculionid. The moth *Acentria ephemerella* (Denis & Schiffermüller) (= *Acentria nivea* (Olivier), see Passoa 1988), is a naturalized Pyralidae (Forbes 1938, Buckingham and Ross 1981) which consumes Eurasian watermilfoil (Buckingham and Ross 1981, Creed and Sheldon 1994a). The midge *Cricotopus myriophylli* Oliver, appears to be indigenous to North America (Oliver 1984, and personal communication) and consumes Eurasian watermilfoil and the native northern watermilfoil (*M. sibiricum* Komarov = *M. exalbescens* Fernald) (Kangasniemi and Oliver 1983, MacRae *et al.* 1990). The weevil *Euhrychiopsis lecontei* (Dietz) (= *Euhrychiopsis lecontei*), also consumes Eurasian and northern watermilfoils (Creed *et al.* 1992, Creed and Sheldon

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1993a, 1994a) and also appears to be indigenous to North America (O'Brien and Wibmer 1982, Creed and Sheldon 1994b). The caterpillar of *A. ephemera* has been associated with Eurasian watermilfoil declines in Ontario (Painter and McCabe 1988). The larvae of the midge *C. myriophylli* have been associated with Eurasian watermilfoil declines in British Columbia (Kangasniemi and Oliver 1983, MacRae and Ring 1993, Kangasniemi *et al.* 1993). Adults and larvae of the weevil *E. lecontei* have been associated with declines of Eurasian watermilfoil in Vermont (Creed *et al.* 1992, Creed and Sheldon 1993b, 1994a) and British Columbia (Kangasniemi 1983).

To the best of our knowledge, there are no published reports of the occurrence of these insects in Minnesota and no specimens were previously present in local collections (R. W. Holzenthal, personal communication). *Cricotopus myriophylli* has only been reported from Ontario and British Columbia (Oliver 1984, and personal communication). *Acentria ephemera* and *E. lecontei* have been reported to occur in Wisconsin (Buckingham and Ross 1981, Lillie 1991), however we are not aware of reports of *A. ephemera* west of Wisconsin and reports of *E. lecontei* have been restricted to the North East, Iowa, Wisconsin, Alberta, British Columbia and Washington.

The aim of this paper is to provide new state records for these organisms in Minnesota and to provide a brief description of their distribution and occurrence in the 25 lakes we sampled in 1992 and 1993. Because these invertebrate herbivores have been associated with declining populations of the nuisance aquatic plant Eurasian watermilfoil (*M. spicatum*) in other regions, and because there is a paucity of information on macrophyte herbivores (Newman 1991), their occurrence is of interest to ecologists and biological control investigators as well as to taxonomists.

## METHODS

We sampled 25 sites (lakes or bays) in 19 lakes in Minnesota and six additional sites (lakes) in Wisconsin for the presence of milfoil herbivores. Most of these sites were sampled once in August and September 1992; however, eight sites in Minnesota and two in Wisconsin were sampled at least twice, in both 1992 and 1993. At all but one site, invertebrates were sampled using a 0.1m<sup>2</sup> quadrat sampler operated by a SCUBA diver; plants were clipped at the sediment interface and all plants and invertebrates collected within 0.1m<sup>2</sup> area were placed into a sealable plastic bag. Generally 6-12 samples were collected at each site. At 11 sites, including the sites sampled in both 1992 and 1993, invertebrates were also collected with a Mobile Invertebrate Sampler (Creed and Sheldon 1993b), which is a 0.2m<sup>2</sup> submersible tube; plants were clipped at the sediment interface and a 500 µm mesh lid was placed on the end of the tube before it was lifted to the surface. At each site, divers also examined plants for the presence of herbivores and additional samples of plant

material were collected in shallow water along the shore. At one site, Bierbrauer Pond, no quantitative sampling was used, but the pond was visually surveyed for 4 hrs by two snorkelers who collected and examined plants.

Samples were returned to the lab and refrigerated until processing, or after 30 days they were preserved in 10% formalin. Samples were rinsed well and invertebrates collected in 420  $\mu\text{m}$  mesh. For the 0.1m<sup>2</sup> quadrat samples, stems were examined and clinging and endophytic organisms were removed. Invertebrates were sorted at 8X under a dissecting scope. A subsample of chironomids from each site was mounted and identified by Bozena Kuklinska. Potential control agent identifications were verified by experts for all initial locations and most of our site records. Weevil identifications were verified by Charles W. O'Brien (Florida A & M University, Tallahassee, FL), caterpillar identifications were verified by Steven Passoa (USDA, APHIS PPQ, Reynoldsburg, OH) and *Cricotopus* identifications were verified by Don R. Oliver (Centre for Land and Biological Research Resources, Ottawa, ON).

Specimens upon which these records are based are housed in the University of Minnesota Insect Collection, St. Paul, MN 55108, U.S.A., and additional vouchers have been deposited with the above mentioned taxonomic experts.

## RESULTS AND DISCUSSION

We located milfoil herbivores at over half of the sites we sampled (Table 1). We located the weevil *E. lecontei* at 13 sites in 10 lakes; 11 of these sites were in Minnesota. All but three sites sampled had Eurasian watermilfoil; Gull Lake, Christmas Lake and Bierbrauer Pond, WI, had no Eurasian watermilfoil, but did have northern watermilfoil. Gull and Christmas Lakes had populations of *E. lecontei*. We found no weevils in Bierbrauer Pond, WI, noted by Lillie (1991) to contain *E. lecontei* with northern watermilfoil, even though we surveyed the pond extensively. We did collect *E. lecontei* from Devil's and Fish Lakes, WI, both of which had verified populations of the weevil from the early 1980s (R.A. Lillie, WI DNR, personal communication).

The midge, *C. myriophylli* was found at eight sites in six lakes, including two sites in Wisconsin (Table 1). These are the first verified records of this species outside of Ontario and the Pacific northwest. The moth, *A. ephemerella*, was found at only five sites, all but one in Minnesota (Table 1).

Our observations suggest that although they have not been reported previously from Minnesota, all three species are likely widespread. Both *E. lecontei* and *C. myriophylli* appear to be native to North America and have not been reported in Europe. Although they usually seem to be associated mostly with the exotic Eurasian watermilfoil, it is likely that they occurred in Minnesota before the introduction of Eurasian watermilfoil, first observed in 1987. We collected *E. lecontei* from *M. sibiricum* in Gull Lake (46°25'N, 94°22'W),



which is over 30 km from the nearest *M. spicatum* infestation, and 150 km northwest of common infestations. In the fall of 1994, we also collected *E. lecontei* from *M. sibiricum* in Squaw Lake (47°16'N, 95°14'W; T143N, R36W, S5), which is over 120 km from the nearest *M. spicatum* infestation, and 250 km northwest of common infestations. These records, along with records from *M. sibiricum* in Alberta (Creed and Sheldon 1994b), where *M. spicatum* does not yet occur, suggest that *E. lecontei* is native to Minnesota. Similarly, although we only collected *C. myriophylli* on *M. spicatum*, it is likely that *C. myriophylli* also is native to Minnesota, given the disjunct distribution of previously reported occurrences (British Columbia and southern Ontario). Kangasniemi *et al.* (1993) suggested that *C. myriophylli* is native to British Columbia and its original host plant is *M. sibiricum* based on their findings of populations on *M. sibiricum* in regions of British Columbia where *M. spicatum* does not yet occur. One lake in which we found *C. myriophylli* (Long Lake), had just been identified in 1992 as having *M. spicatum*. It is not possible to tell if the pyralid, *A. ephemerella*, was in Minnesota prior to the introduction of Eurasian watermilfoil because *A. ephemerella* appears to be exotic to North America (Forbes 1938, Buckingham and Ross 1981) and it was found on *M. spicatum* in the five lakes where it occurred. More sampling of lakes without Eurasian watermilfoil would be useful to determine if these herbivores are expanding their distribution with Eurasian watermilfoil or in response to Eurasian watermilfoil. Such studies also would help clarify the original hosts of these species. *Acentria ephemerella* appears to be a generalist herbivore (Buckingham and Ross 1981), but both *E. lecontei* and *C. myriophylli* appear to be specialists and have been reported to feed and develop only on Eurasian and northern watermilfoils (Creed and Sheldon 1993a, 1994b, MacRae and Ring 1993).

Although quantitative data were collected using the methods outlined above, our initial observations of the three taxa were often made serendipitously during searches of large quantities of milfoil in shallow water, snorkeling or examining plant material collected during surveys of the plant community from our boat. We suspect that these organisms are somewhat patchy in their distribution, both temporally and spatially. For example, the initial observations of *E. lecontei* in Lakes Otter, Auburn and Minnewashta were made during the collection of plants, not from quantitative samples. Year to year variation in abundance of weevils was also apparent, although the extent to which this occurs will only be established by more long term monitoring. For example, in our 1992 sampling effort (22 lakes), *E. lecontei* was only found in Lake Auburn, Gideons Bay (Minnetonka), Devils Lake and Fish Lake. In 1993, *E. lecontei* was found at 10 of 12 sites sampled. Similarly, damage to milfoil meristems typical of that produced by *C. myriophylli* was observed at Otter Lake, but we have not been able to find the midge at that site.

Numbers of the herbivores have been low at most sites. Only one  $0.1\text{m}^2$  quadrat sample yielded more than one *Acentria* larva (three were found in one sample from Lake Auburn), however, *E. lecontei* densities have averaged  $> 20/\text{m}^2$  at several sites. Because of this variability, we wish to emphasize that the fact that we have not collected specimens of these taxa at some sites does not imply that they do not occur there.

Table 1. Lakes sampled for the occurrence of potential milfoil herbivores. <sup>1</sup>Year in which the occurrence of *M. spicatum* was first recorded (None = not known to be present). *Myriophyllum spicatum* is not known to occur in Gull Lake (*M. sibiricum* is abundant) and the nearest known *M. spicatum* population is approximately 30 km away. <sup>2</sup>Township, Range and Section of sampling sites. <sup>3</sup>A minor infestation of *M. spicatum* was found and chemically treated in 1992 and no *M. spicatum* has been seen since. Organisms collected in Gull and Christmas Lakes were taken from *M. sibiricum*. <sup>4</sup>Mississippi River sites. \*These identifications have not been verified by a taxonomic specialist. All other identifications have been verified.

LAKE NAME	COUNTY	STATE	M.s. obs. <sup>1</sup>	LOCATION <sup>2</sup>	Herbivore
Auburn	Carver	MN	1989	T116N;R24W;S10	E.I.,A.e.
Bierbrauer	St. Croix	WI	None	T31N;R17W;S4	
Calhoun	Hennepin	MN	1989	T28N;R24W;S5	
Cedar	Hennepin	MN	1990	T29N;R24W;S29	E.I.
Christmas	Hennepin	MN	1992 <sup>3</sup>	T117N;R23W;S35,36	E.I.
Clearwater	Wright	MN	1989	T121N;R27W;S17	
Devils	Sauk	WI	≤1976	T11N;R6E;S13	E.I.,C.m.
Fish	Dane	WI	1967	T9N;R7E;S3	E.I.
Green	Chisago	MN	1990	T33N;R21W;S13	
Gull	Cass	MN	None	T134N;R30W;S24,25	E.I.
Independence	Hennepin	MN	1989	T118N;R23,24W;S7,12	
Lake of the Isles	Hennepin	MN	1988	T29N;R24W;S32,33	
Long	Hennepin	MN	1992	T118N;R23W;S34,35	C.m.
Mallalieu	St. Croix	WI	<1990	T29N;R19W;S18,19	C.m.*,A.e.*
Minnetonka					
Gideons Bay	Hennepin	MN	1987	T117N;R23W;S27	E.I.
Grays Bay	Hennepin	MN	1987	T117N;R22W;S8	E.I.*,C.m.
Halsted Bay	Hennepin	MN	1987	T117N;R24W;S34	
St. Albans Bay	Hennepin	MN	1987	T117N;R23W;S26	
Shady Is	Hennepin	MN	1987	T117N;R23W;S30	C.m.
Smiths Bay	Hennepin	MN	1987	T117N;R23W;S10,11	E.I.,C.m.*
Veterans Bay	Hennepin	MN	1987	T117N;R23W;S23	E.I.
Minnewashta	Carver	MN	1989	T116N;R23W;S5	E.I.,C.m.,A.e.*
Onalaska <sup>4</sup>	La Crosse	WI	≤1987	T17N;R7W;S31	
Otter Lake	Anoka/Ramsey	MN	1989	T30N;R22W;S3,35	E.I.
Parker	Hennepin	MN	1991	T118N;R22W;S28	
Sarah	Hennepin	MN	1990	T118N;R24W;S2	A.e.*
Spring <sup>4</sup>	Buffalo	WI	≤1989	T20N;R12W;S17,20	
Vadnais	Ramsey	MN	1989	T30N;R22W;S30	E.I.*
Virginia	Carver	MN	1988	T116N;R23W;S6	A.e.
Waverley	Wright	MN	1991	T119N;R26W;S32	
Zumbra	Carver	MN	1989	T116N;R24W;S2	C.m.

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### BOOK RECEIVED AND BRIEFLY NOTED

HOST-PLANT SELECTION BY PHYTOPHAGOUS INSECTS. E.A. Bernays and R.F. Chapman. 1994. Chapman & Hall. 312 pp. \$24.50 ppbk.

This book focuses on the behavior of host-plant selection by plant-feeding insects. It describes the patterns of host use, the chemical features of plants that determine host selection, the physiology of insect sensory systems, and the insect behaviors, with an emphasis on mechanisms. The book also discusses genetic variability and the effects of experience, and concludes with a review of the evolution of host-plant ranges.

**THE DRUMMING SIGNALS OF TWO STONEFLY  
SPECIES *COSUMNOPERLA HYPOCRENA*  
(PERLODIDAE) AND *PARAPERLA WILSONI*  
(CHLOROPERLIDAE); A NEWLY DISCOVERED  
DUET PATTERN IN PLECOPTERA<sup>1</sup>**

**Kenneth W. Stewart<sup>2</sup>, John C. Abbott<sup>2</sup>, Richard L. Bortorff<sup>3</sup>**

**ABSTRACT:** The drumming signals of the stoneflies *Cosumnoperla hypocreana* and *Paraperla wilsoni* are reported for the first time. The *Cosumnoperla* male call consisted of 3 mode beats with 594 ms beat intervals; comparisons of this unique call with other known Isoperlinae are made. Possible evolutionary convergence to 3-beat calls in the Plecoptera are discussed. *Paraperla wilsoni* males call with 101 mode beats with 153 ms intervals, and the female answer of 7 mode beats with 1554 ms intervals is fully interspersed within the latter two-thirds of the male call. This represents a newly discovered duetting pattern in Plecoptera.

Recent studies of over 100 species of stoneflies have established that the Northern Hemisphere suborder Arctoperlaria has evolved the most complex patterns of intersexual vibrational communication known in insects (Maketon and Stewart 1988, Stewart and Maketon 1991, Stewart *et al.* 1991). Males and females produce low-frequency vibrational signals in natural substrates such as leaf mats, wood debris or live plants by percussive drumming, rubbing or tremulation, using vertical strokes of their abdomens. The species-specific male calls and female answers establish a duetting pattern that significantly aids the male in finding the female (Abbott and Stewart 1993).

The Isoperlinae species *Cosumnoperla hypocreana* Szczytko & Bortorff (Perlodidae) was recently described (Szczytko and Bortorff 1987), but its drumming signals have not previously been reported. The drumming of the Paraperlinae species *Paraperla wilsoni* Ricker have also not been studied, but its only congener, *Paraperla frontalis* (Banks), was reported as having a diphasic call of about 75 and 3 beats, respectively in the two phases (Stewart and Zeigler 1984). The purpose of this study was to record and describe the signals of these two key species, to provide further behavioral evidence for phylogenetic inference within the families Perlodidae and Chloroperlidae, and in the Plecoptera.

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## MATERIALS AND METHODS

Nymphs of *Cosumnoperla hypocrena* were collected 1-V-1987 from an unnamed intermittent creek about 2 km west of Martinez Creek, south of the town of El Dorado in El Dorado Co., California. A virgin pair was successfully reared from these nymphs on 2-V-1987; they were subjected to the recording procedure each day thereafter, for four days at 20-24°C room temperature with natural light coming through a window. We also attempted to record drumming from adults collected from another unnamed intermittent creek in the area, 3 km west of Martinez Creek. Males and females were kept separately as individuals or groups in milk carton holding cages, with access to water and sugarwater. Drumming activity was monitored by listening for sounds produced by drummers on the carton walls; active drummers were moved into the drumming chamber for recording sessions.

The recording chamber consisted of a divided manilla paper box with a clear plastic petri lid, designed after the one used by Szczytko and Stewart (1979). The male and female were gently transferred into their respective sides of the divided chamber that rested on foam pads about 1-3 mm above a Sony Electret condenser microphone (ECM220T), plugged into a Sony Cassette Recorder (TCM-111).

Taped signals were displayed, measured and printed using the IBM-compatible computer program SIGNAL, developed in our laboratory. The program enabled conversion of each recorded signal into a graphic facsimile that was viewed on a monitor. The number of signal beats was counted, and desired time intervals were tagged with a mouse and then measured by the computer. Signal measurements were exported to an ASCII file, and raw data were imported into a SAS<sup>®</sup> statistical program for analysis. Displayed signals were saved and laser printed using the screen capturing program PIZZAZ Plus<sup>®</sup>, version 1.3. This system was effective for analyzing the percussive signals of the two studied species.

Nymphs of *Paraperla wilsoni* were collected 7-VII-1989, near the margins of Picnic Lakes and their connecting, snow-melt streams in Jewel Basin, Flathead Co., Montana, at an elevation of about 2150 m. Jewel Basin is an alpine meadow located about 16 km northeast of Bigfork, Montana. Nymphs were backpacked out of the basin in a styrofoam chest cooled with snow, and subsequently reared in a laboratory stream fed by Roys Creek into the Elrod Laboratory at the nearby University of Montana Flathead Biological Station. Reared virgin males and females were kept isolated between the recording sessions, in vials held above the laboratory stream for temperature and humidity control. The recording procedure, at 21-23°C room temperature

with natural light coming through a window, was the same as described above for *C. hypocrena*. Display, measurement and analysis of recorded signals was done with the same SIGNAL program and procedures described for *C. hypocrena*.

## RESULTS AND DISCUSSION

*Cosumnoperla hypocrena*. Seventeen calls were recorded from one virgin male. They consisted of 3 mode beats ( $\bar{x}$  3.5  $\pm$  0.5 SD) with 594.1  $\pm$  6.5 ms beat intervals (Table 1, Fig. 1). One of the field-collected males was also observed and heard drumming, but we were not able to record him in the drumming chamber.

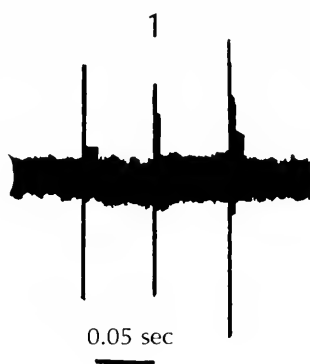


Fig. 1. Male drumming call of *Cosumnoperla hypocrena*.

This 3-beat call is simple and monophasic, and can therefore be classified as ancestral, and similar to 21 of the 24 signals of other known Isoperlinae species. Our experiences with recording many species over the past two decades lead us to suggest these signals from the one male are probably typical for the species, and therefore useful for evolutionary and comparative purposes, but of course do not allow any analysis of potential intraspecific variation. Of the other known Isoperlinae signals, *Clioperla clio* (Newman) and 20 species of *Isoperla* call with ancestral signals composed of 3-26 beats and highly varied, but species-specific intervals ranging from 26-3350 ms (Stewart and Maketon 1991). Only three species of Isoperlinae have derived call patterns: *Calliperla luctuosa* (Banks) has a grouped, bi-beat call, *Isoperla phalerata* (Smith) and *I. slossonae* (Banks) have diphasic calls and *Isoperla ouachita* Stark and Stewart strikes the substrate with a scraping, forward

motion that we have previously interpreted as a derived method of signal production. Therefore, the isoperlines *Clioperla*, most extant *Isoperla*, and *Cosumnoperla* have retained a basically ancestral drumming pattern, with modest alterations of numbers of beats and beat intervals possibly to achieve behavioral isolation. A roughly similar proportion of species with ancestral/derived signal patterns has been found in the other perlodid subfamily Perlodinae, leading to the suggestion that the ancestors of both subfamilies were percussive drummers, with simple monophasic signals. More behaviorally advanced Perlodinae species in the genera *Isogenoides*, *Kogotus* and *Susulus* have derived complex, grouped signal patterns (Stewart and Maketon 1991).

It is interesting to note here that several species of stoneflies in different families and genera have "converged" their calls into 3-beat signals: *Sierraperla cora* (Needham & Smith) and *Yoraperla sp.* (Peltoperlidae), *Clioperla clio* (Newman) and *Osobenus yakamae* (Hoppe) (Perlodidae) and *Hansonoperla appalachia* Nelson, *Perlinella drymo* (Newman) and *Perlinella ephyre* (Newman) (Perlidae) (Stewart and Maketon 1991). Such 3-beat calls may represent the minimal amount of information that can be effectively conveyed via low-frequency substratum vibrations from males of a given species to females (e.g., at least two time intervals). If this hypothesis is correct, then 3-beat stonefly calls may represent an evolutionary end-point of derived reduction of beats with their corresponding interval alterations, of ancestral signals, that possibly achieve communicative isolation. There is no overlap in intervals of the seven species above, that have 3-beat calls; none of them are known to co-occur in time or place, except possibly *S. cora* and *Yoraperla sp.*

***Paraperla wilsoni.*** The male call is a long, continuous signal of 101 mode beats ( $\bar{x}$  107.3  $\pm$  47.2 ms) with average 153 ms intervals (Table 1, Fig. 2). The female responds with an answer signal of 7 mode beats with average intervals of 1554 ms (Table 1); this answer is fully interspersed within the latter two-thirds of the male call (Fig. 2). This is a new discovery in stoneflies of a duetting pattern that involves a long, continuous call containing the fully imbedded female answer sequence. Such a pattern could hold substantial advantage in protecting drumming females, with their great reproductive investment, from detection by predators such as spiders that could potentially orient to the source of the vibrational signals. The long intervals and embedded nature of these answers might tend to confuse a predator and cause it to attempt to home in on the male stonefly, that in turn has some protection because of his searching mobility and possible triangulation search pattern (Abbott and Stewart 1993) between calls, during the duetting/local search sequence.

Intersexual signalling for mate-finding seems to be a highly derived behavior in the stonefly family Chloroperlidae, and different avenues of sig-



## 2

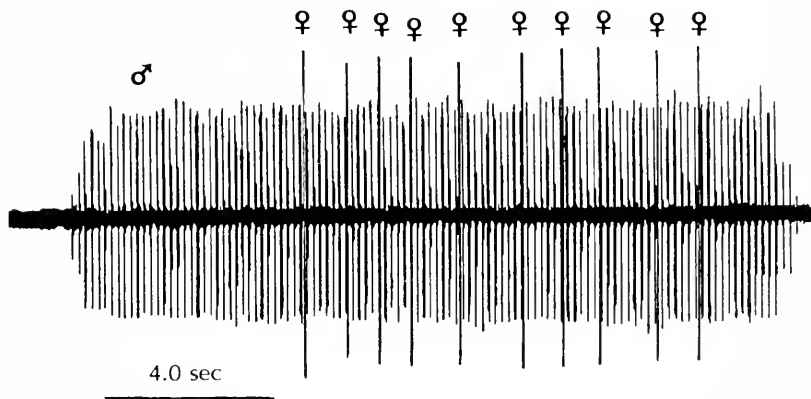


Fig. 2. Interspersed duet of *Paraperla wilsoni*.

nal alteration have apparently been followed to achieve behavioral isolation. The European *Siphonoperla* produces substrate vibrations by non-percussive up-down strokes of the abdomen (tremulation) (Rupprecht 1981), probably derived from ancestral drumming. We believe that further research in this group will reveal tremulation to be an important communication method in many of the largely unstudied Chloroperlinae. The only chloroperline species known to have retained an ancestral drumming pattern is *Haploperla brevis* (Banks).

All three of the six North American chloroperlid species in the subfamily Paraperlinae that have now been studied, have derived patterns of drumming. *Kathroperla perdita* Banks calls are short, diphasic bursts of 6/4 beats and short, 36/23 ms intervals, and the calls of *Paraperla frontalis* are long, diphasic bursts of 74/2 beats with very different phase intervals of 51/285 msec (Stewart and Zeigler 1984). The calls here reported for *P. wilsoni* are therefore similar to those of its only congener, in having a relatively large number of beats (mode 101, Table 1), but they have remained ancestral in the sense of being monophasic, and have undergone some possibly modest alteration of intervals to a mode 153 ms. *P. frontalis* females have never been recorded, and it will be interesting to discover whether their answers are embedded within their males' long, diphasic call, as are those of *P. wilsoni*.

Table 1. Drumming signals of *Cosumnoperla hypocrena* and *Paraperla wilsoni*.

Species and locality	Rec. temp., °C	No. individuals/total signals		No. beats/mode ( $\bar{x} \pm SD$ )		Beat intervals/Signal, msec ( $\bar{x} \pm SD$ )	
		♂	♀	♂	♀	♂	♀
<i>Cosumnoperla hypocrena</i> California, El Dorado Co., unnamed cr., 2 km W Martinez Creek	20-25	1/17	—	3(3.5 ± 0.5)	—	594.1 ± 6.5	—
<i>Paraperla wilsoni</i> Montana, Flathead Co., Jewel Basin., ca. 16 km NE of Bigfork, MT.	23	3/18	2/3	101(107.3 ± 47.2)	7.3 ± 2.5	152.5 ± 18.9	1554.0 ± 676.3

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**LABIOBAETIS (EPHEMEROPTERA: BAETIDAE):  
NEW STATUS, NEW NORTH AMERICAN SPECIES,  
AND RELATED NEW GENUS<sup>1</sup>**

W. P. McCafferty<sup>2</sup>, R. D. Waltz<sup>3</sup>

**ABSTRACT:** *Labiobaetis* Novikova and Kluge is raised to generic rank and includes 27 nominal species, including most of those previously considered in the *Baetis propinquus*, *Baetis atrebatinus*, and *Baetis molawinensis* species groups, which are known, respectively, from North America, Eurasia, and the Orient. The genus represents a clade evidently derived near the base of the *Baetis* complex. *Labiobaetis apache*, n. sp. is based on larvae studied from Utah and Arizona, and is distinguished by profuse spinelike setae on the legs and body. Notes on the habitat of *L. apache* and comments on the western North American species are given. An illustrated key to the larvae of all six species of *Labiobaetis* in North America is provided. A new, closely related genus, *Cymulabaetis*, presently consists of two species from northern Africa and eastern Europe, respectively. *Labiobaetis* and *Cymulabaetis* preliminarily appear to represent sister lineages.

The *Baetis propinquus* species group as defined by Morihara and McCafferty (1979a), the *B. atrebatinus* species group as defined by Müller-Liebenau (1969, 1973), and the *B. molawinensis* species group as defined by Müller-Liebenau (1984a) form a distinct grouping of species distributed in North America, Eurasia, and the Orient, respectively (see also Morihara and McCafferty 1979b; Müller-Liebenau 1981, 1982, 1984b; Müller-Liebenau and Hubbard 1985). The larvae in this grouping share the possession of the apomorphic femoral villopore found only in *Baetis* and certain other closely related baetid genera, considered the "*Baetis* complex" by Waltz and McCafferty (1987a). *Acentrella* Bengtsson, *Baetiella* Ueno, *Baetis* Leach, *Barbaetis* Waltz and McCafferty, *Heterocloeon* McDunnough, *Liebebiella* Waltz and McCafferty, *Platybaetis* Müller-Liebenau, and *Pseudocloeon* Klapalek sensu auctt. are also included in this complex. The importance of the villopore in understanding the generic relationships of the Baetidae was discussed by McCafferty and Waltz (1990), and those species lacking it have been removed from *Baetis* (see, e.g., Waltz and McCafferty 1987b). Although species in the *propinquus*, *atrebatinus*, and *molawinensis* groups traditionally have been considered in *Baetis*, Morihara and McCafferty (1979a) showed that they are defined by unique apomorphic characteristics not found in other *Baetis*, and

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thus they form a monophyletic grouping. Novikova and Kluge (1987) gave subgeneric rank to this grouping within *Baetis* under the name *Labiobaetis*, and we now consider it to constitute a genus. Two species that have been considered in the *atrebatinus* species group by some workers but that do not actually possess larval apomorphies that define *Labiobaetis* are placed in a new genus (see below).

### **Genus *Labiobaetis*, NEW STATUS**

The reasons we recognize *Labiobaetis* as a genus are as follows. We consider its relative phylogenetic position to be near the base of the *Baetis* complex because the villopore is only poorly developed, being rudimentary or absent, for example, on the fore- and midlegs of many species. Also, the plesiomorphic sclerotized plate between the bases of the male forceps is retained to various degrees in this clade. In *Baetis* sensu stricto and some other more remotely derived genera in the complex, the villopore has become well established and the genital plate has been lost. The recognition of relatively later derived clades as genera in this latter lineage mandates the additional recognition of the genus *Labiobaetis*, if indeed a phylogenetic classification is sought for the Ephemeroptera as discussed by McCafferty (1991). Larvae of *Labiobaetis* are best defined by the unique, synapomorphic excavation of the maxillary palps (Fig. 14) (only weakly developed in two Oriental species). Also, the presence of a distal lobe on the antennal scapes (Fig. 12) (not apparent in one Oriental species and slightly developed in one other) is evidently another important larval apomorphy, which delineates this group.

Müller-Liebenau (1984a) provided a synopsis of the larval characteristics that are associated with this genus, and a first key to the Holarctic genera of Baetidae, including *Labiobaetis*, is being prepared for publication by Waltz and McCafferty.

A number of *Labiobaetis* species from the Orient remain unknown as adults (see Müller-Liebenau and Hubbard 1985); however, on the basis of known and provisionally placed adults, this stage of *Labiobaetis* either possesses hindwings with two longitudinal veins and a very weakly developed or absent costal process, or they lack hindwings. (Thus, all larvae also have narrow hindwing pads except for a few species in the Oriental region that lack hindwing pads.) In addition, known adults have short, apically rounded terminal segments on the male forceps and a variously developed sclerotized plate between the base of the forceps. The reduction of the costal process and the loss of the hindwings themselves are apomorphic character states; however, they are not unique to *Labiobaetis*, being homoplasies associated with size reduction in general that have occurred in many diverse lineages of baetids (see, e. g., McCafferty and Waltz 1990). The degree to which the short

terminal segments of male genitalia may be found throughout the genus remains to be known, but we expect this characteristic to be consistent.

The larval stage of three species of *Labiobaetis* from the Sunda Islands (Müller-Liebenau 1981) and one species from India (Gillies 1949) remain unknown. The placement of these species, which are asterisked in the species composition list below, requires substantiation with reared larvae at a future time. There is little doubt, however, that *Baetis calcaratus*, although also known only in the adult stage, should be placed in *Labiobaetis* because of its detailed resemblance to *Labiobaetis* species for which the larvae are well known (see Keffermüller 1972).

*Labiobaetis*, as defined here, includes the following species: *L. apache* n. sp. (North America); *L. atrebatinus* (Eaton) n. comb. (type species of the genus from Eurasia); *L. borneoensis* (Müller-Liebenau) n. comb. (E. Malaysia); *L. calcaratus* (Keffermüller) n. comb. (Eurasia); *L. dardanus* (McDunnough) n. comb. (North America); *L. desertus* (Novikova and Kluge) n. comb. (Kazakhstan); *L. difficilis* (Müller-Liebenau) n. comb. (W. Malaysia); *L. diffundus* (Müller-Liebenau) n. comb. (W. Malaysia); *L. ephippiatus* (Traver) n. comb. (North America); *L. frondalis* (McDunnough) n. comb. (North America); \**L. fulmeki* (Ulmer) n. comb. (Sunda Islands); *L. geminatus* (Müller-Liebenau and Hubbard) n. comb. (Sri Lanka); *L. longipalpus* (Moriyama and McCafferty) n. comb. (North America); *L. molawinensis* (Müller-Liebenau) n. comb. (Philippines); *L. moriharai* (Müller-Liebenau) n. comb. (W. Malaysia); *L. multus* (Müller-Liebenau) n. comb. (W. Malaysia); \**L. necopinatus* (Müller-Liebenau) n. comb. (Sunda Islands); *L. neglectus* (Navas) n. comb. (Algeria); *L. numeratus* (Müller-Liebenau) n. comb. (W. Malaysia); *L. operosus* (Müller-Liebenau) n. comb. (W. Malaysia); *L. ordinatus* (Müller-Liebenau and Hubbard) n. comb. (Sri Lanka); \**L. palmyrae* (Gillies) n. comb. (India); *L. propinquus* (Walsh) n. comb. (North America); *L. pulchellus* (Müller-Liebenau and Hubbard) n. comb. (Sri Lanka); *L. sumigarensis* (Müller-Liebenau) n. comb. (Philippines); *L. tricolor* (Tshernova) n. comb. (Eurasia); and \**L. ulmeri* (Müller-Liebenau) n. comb. (Sunda Islands).

We do not recognize *L. tricolor* as a junior synonym of *L. propinquus*, as was designated by Novikova and Kluge (1987). This is because, as pointed out by Moriyama and McCafferty (1979a), there exists a clinal but distinct difference in the development of the apicomedial corner of the basal portion of the male forceps in these two species, albeit they are very similar sister species as shown cladistically by Moriyama and McCafferty (1979a). Keffermüller (1972) studied the variability of this structure in *L. tricolor*, and, among the range of variability of some 330 males examined, she did not show any forceps with an apicomedial corner as well developed as in *L. propinquus*.

### *Labiobaetis apache*, new species

**Larval description.** Body length: 5-6 mm; cerci: 2.5-3.0 mm. Head: Intra-antennal process present, parallel-sided between antennal bases. Antennal scape and pedicel with fine setae and sharp, robust setae dorsally and ventrally; scape with distal lobe. Labrum (Fig. 1) with one medial seta and 7-11 submarginal setae, submarginal setae slender, tapering distally, two submarginal setae nearest medial seta nearly contiguous; marginal setae bifurcate; dorsally with fine setae and setal bases. Right mandible (Fig. 2) incisors 3(1)+3 or apparently 3(2)+3, the latter reflecting an additional spur on the reduced tooth of the outer incisor in some individuals, possibly a bifurcate condition; prosthema prominent, base recessed into mandible; plane of mandible between incisor bases and molar region arched and scabrate. Left mandible (Fig. 3) incisors 3(1)+3; prosthema prominent; plane of mandible between incisor bases and molar region arched; process of molar region slightly elevated. Maxillae with two-segmented palps, ratio of segment 1 to segment 2 = 4:5; apex of palps exceeding apex of galealacinae; palps excavated distally. Hypopharynx typical of other Baetidae, heavily setate; lingua with distal tuft. Labium (Fig. 4) with palps three segmented; segment 2 strongly expanded distally, with medially expanded lobe; lobe with four or five strong dorsal setae and many scattered, smaller setae; base of segment 3 subequal to one-half distal width of segment 2; paraglossae medial width subequal to twice medial width of glossae, with three rows of apical setae; glossae with three strong distal setae and 10-11 medial setae and simple row of ventral setae.

Thorax: Hindwingpads present. Legs (Fig. 5) each with villopore, villopores most developed on hindlegs, poorly developed on fore- and midlegs; all legs strongly setate with sharp, spinelike setae on all surfaces; forelegs slightly shorter than mid- or hindlegs.

Abdomen: Terga with fine setae and many scales; scale bases angulate; scales slightly longer than wide, ovoid; posterior marginal spine length subequal to width; fine setae between spines; robust, spinelike setae present proximal to pleural suture. Gills asymmetric, ovoid, with margins mostly smooth, and basally with scattered fine setae; serrations of gill margin increasing in frequency toward distal margin of gills, and with fine, interspersed setae; gill surfaces also with fine setae. Male sternite 9 (Fig. 6) with weakly developed lobes (see Morihara and McCafferty 1979a: Figure 9 for comparison) and with 8-11 spines between lobes. Paraprocts with numerous spines (>30), and profusion of spines distally; spine length subequal to twice basal width. Terminal filament ca. 0.6x-0.75x length of cerci.

**Material.** HOLOTYPE: male larva (in alcohol), Arizona: Apache Co., straight S of St. John's, 12 July, 1967, R. & D. Koss, deposited in the Purdue Entomological Research Collection (PERC), West Lafayette, Indiana. PARATYPES: 40 larvae, same data as holotype and 6 larvae, Utah: Wayne Co., Capitol Reef National Park, Pleasant Creek, 5 August, 1993, J. F. MacDonald, deposited in PERC; 39 larvae, same data as holotype, deposited in the California Academy of Science, San Francisco; and 39 larvae, same data as holotype, deposited in the National Museum of Natural History, Washington, D.C.

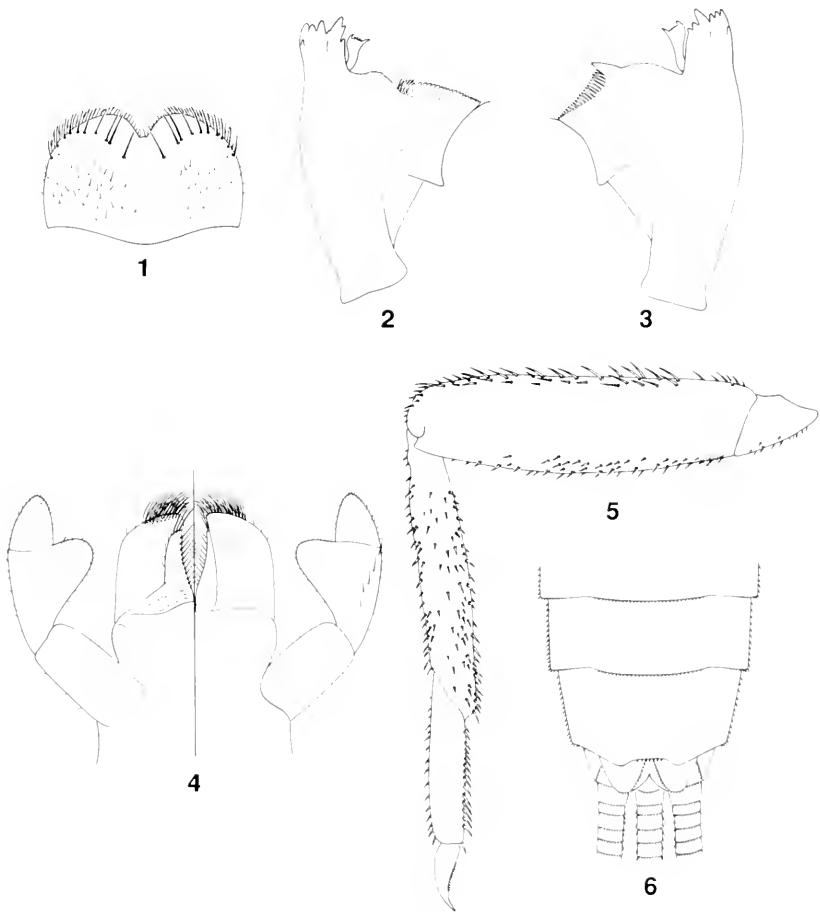
**Etymology.** This new species is named after the Apache tribe of native American southwestern peoples, who historically occupied northern Mexico, Arizona, New Mexico, and Texas.

**Diagnosis.** *Labiobaetis apache* is a uniformly colored species without strongly contrasting color patterns. The body is covered with numerous distinct, spinelike setae. The prominent bristles of the legs (Fig. 5), thoracic sterna, and lateral margins of the abdominal terga (Fig. 6) are diagnostic of this new species. It differs from the presumably closely related *L. propinquus* in having more numerous submarginal setae on the labrum (Fig. 1), numerous sharp, robust setae covering the body as mentioned above, and in body col-

oration. See below for a key to the larvae of all North American species of *Labiobaetis*.

### DISCUSSION

*Labiobaetis apache* was recently collected in Utah by J. F. MacDonald from a fast flowing, cold water stream, less than six inches deep (lacking con-

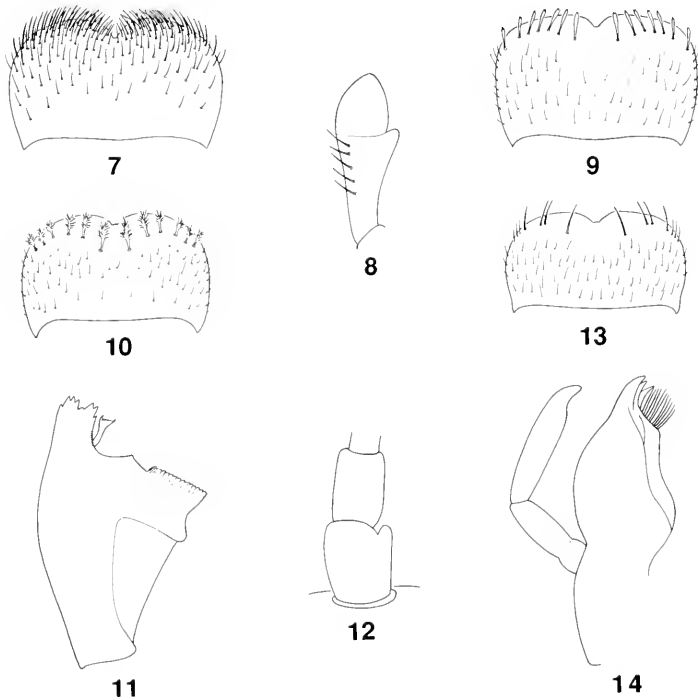


Figs. 1-6. *Labiobaetis apache* n. sp. larva. 1. Labrum. 2. Right mandible. 3. Left mandible. 4. Labium (left-ventral/right-dorsal). 5. Hindleg. 6. Posterior abdominal sterna (male).

spicuous vegetation), at approximately 1,900 m elevation [for more habitat details see McCafferty and MacDonald (1994)]. Most specimens were collected near the stream margin. The exact elevation at which the Arizona material was taken in the Little Colorado River south of St. John's was not recorded.

As pointed out by McCafferty and MacDonald (1994), *Chloroterpes inornata* is also found in the same locations that the new species described here has been taken. The distribution pattern shown by *C. inornata* includes much of the Colorado Plateau but not the Great Basin, and this may also prove to be the case for *L. apache*. This may in part explain why it has not been taken in Utah previously, since much of the historical collecting in that state has been in the Great Basin area.

With the addition of *L. apache*, there are now six nominal species of *Labiobaetis* in North America, at least three of which are western. The figure



Figs. 7-14. *Labiobaetis* larvae. Figs. 7-8. *L. Longipalpus*. 7. Labrum. 8. Labial palp. Fig. 9. *B. frondalis*, labrum. Figs. 10-11. *L. ephippiatus*. 10. Labrum. 11. Right mandible (redrawn from Soluk 1981). Figs. 12-14. *L. propinquus*. 12. Antennal base. 13. Labrum. 14. Maxilla.



of a labium of "*Baetis* sp." from California that was provided by Day (1956: Fig. 3:26h) is referable to *Labiobaetis*. It possibly represents a new species, or any one of the known western species: *L. apache*, *L. dardanus* (see Soluk 1981), which is known from the Northwest as far south as Utah and Colorado (Durfee and Kondratieff 1994), and *L. propinquus* a widespread, somewhat ubiquitous species (Berner and Pescador 1988) that, in the West, has recently been reported from Colorado and was previously known from New Mexico (see McCafferty *et al.* 1993).

A close relationship of *L. apache* and *L. propinquus* may be assumed on the basis of similarities in their larvae (see key below). If this is the case, the as yet undescribed adults of *L. apache* may also key out near *L. propinquus* when using the adult key provided by Morihara and McCafferty (1979a).

#### KEY TO THE LARVAE OF NORTH AMERICAN SPECIES OF *LABIOBAETIS*

1. Labrum with submarginal setae similar to other, relatively dense, dorsal labral setae in form and arrangement (Fig. 7); labial palp segment 2 not expanded medially (Fig. 8) . . . . . *L. longipalpus*
- Labrum with few regularly spaced dorsal setae and with submarginal setae distinct from these in form and arrangement (Figs. 1, 9, 10, 13); labial palp segment 2 well developed as in Figure 4 . . . . . 2
2. Labrum with submarginal setae spatulate (Fig. 9), often fringed apically . . . . . *L. frondalis*
- 2'. Labrum with submarginal setae not as above (Figs. 1, 10, 13) . . . . . 3
3. Labrum with submarginal setae branched as in Figure 10 . . . . . 4
- 3'. Labrum with submarginal setae simple (Figs. 1, 13) . . . . . 5
4. Right mandible with abrupt prominence between incisor and molar region (Fig. 11) . . . . . *L. ephippiatus*
- 4'. Right mandible without abrupt prominence between incisor and molar region, this area being more similar to Figure 2 . . . . . *L. dardanus*
5. Distinct spinelike setae on legs (Fig. 5), thoracic sterna, and pleural margins of abdomen (Fig 6); labrum submarginal setal formula 1+7-11 (Fig. 1); maxillary palp exceeding apex of galealaciniæ . . . . . *L. apache*
- 5'. Body without armature as above; labrum submarginal setal formula 1+2-7 (Fig. 13); maxillary palp extending nearly to apex of galealaciniæ (Fig. 14) . . . . . *L. propinquus*

#### *Cymulabaetis*, new genus

We define this genus as having adults and larvae generally similar to those of *Labiobaetis* except for a unique combination of larval traits, i.e., a labrum with a row of branched submarginal setae, non-excavated maxillary palps, and non-lobed antennal scapes. The larval femora also appear to be broader than is typical of *Labiobaetis*.

We include in this genus: *C. balcanicus* (Müller-Liebenau and Soldán), n. comb. from Bulgaria and Greece (which we designate as the type of the genus); and *C. cleopatrae* (Thomas and Soldan), n. comb. from Egypt.

The derivation of the name *Cynulabaetis* is from the Latin, *cymula*, diminutive of young sprout, combined with *Baetis*, as an allusion to the phylogenetic branch represented by the genus, as discussed below.

The two species placed in *Cynulabaetis* were previously classified in *Baetis* and have been considered to belong to the *atrebatinus* species group by Müller-Liebenau and Soldán (1981) and Thomas and Soldán (1989). As indicated above, they possess a number of characteristics found in *Labiobaetis*. For example, submarginal setae of the labrum appear to be similar to those of the North American species *L. ehippiatus* (Fig. 10), and the hindwings and male genitalia of *C. balcanicus* (the only one of the two known as an adult) are similar to those of known *Labiobaetis* adults. These species, however, have been problematic because the larvae of both lack the excavation of the maxillary palp and the lobe of the scape and therefore presently do not fit previous definitions of the *atrebatinus* group (or our definition of *Labiobaetis*).

It appears highly probable that *Cynulabaetis* shares a recent common ancestor with *Labiobaetis*, evidenced by possible synapomorphic reduction of the costal process in the hindwings and reduced apical segment of the male forceps. General similarities in mandibles, labium, and tergal armature may have also evolved in a recent common ancestor. Unlike *Baetis* sensu stricto, the plesiomorphic sclerotized genital plate has been retained just as it has been retained variously in *Labiobaetis*. From this, it would appear that *Cynulabaetis* represents an early offshoot from the lineage that led to *Labiobaetis*, i.e., the species involved do not share the further synapomorphies of the maxillary palps and antennae found in *Labiobaetis*. We speculate that the branched submarginal setae on the labrum of *Cynulabaetis* represent a convergence with *L. ehippiatus*, related perhaps to some feeding, tactile, or cleaning function. Supportive of this speculation is the fact that the labral condition is not identical: the branched setae in *L. ehippiatus* are much fewer in number and appear to be relatively larger in size.

There is, of course, also the possibility that the excavated maxillary palps and the lobe of the scapes have been secondarily lost in *C. balcanicus* and *C. cleopatrae*, and these species are simply anomalous members of *Labiobaetis*.

We obviously do not know which of the two possibilities discussed above regarding *C. balcanicus* and *C. cleopatrae* is correct. Either possibility, however, indicates that, with respect to constructing a phylogenetic classification, they should not be classified as *Baetis* sensu stricto. Therefore, it appears to us that an interim practical classificatory position must be taken until such time that more conclusive cladistic analysis is possible. To include *C. balcanicus* and *C. cleopatrae* in *Labiobaetis* (even as a subgenus) would not allow a clear universal definition of this widespread genus as larvae; nonetheless, this may eventually be necessary. In the meantime, therefore, we have taken the only

alternative remaining, i.e., to place them in a separate genus that could, if necessary, be synonymized with *Labiobaetis* in the future or placed as a subgenus within it.

#### ACKNOWLEDGMENTS

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### BOOK RECEIVED AND BRIEFLY NOTED

PLANTHOPPERS. THEIR ECOLOGY AND MANAGEMENT. R.F. Denno and T.J. Perfect, eds. 1994. Chapman & Hall. 799 pp. \$85.00 hdbk.

This volume summarizes what is known about planthopper ecology and biological control. Its contents include host-plant relationships of planthoppers; planthopper/plant interactions; life history strategies and reproductive biology; population dynamics and migration; interactions of planthoppers with predators, parasitoids, and vectored plant viruses; structure of planthopper communities; ecological approaches to planthopper management including biological control, the genetics of host-plant adaptation, varietal resistance, and insecticide resistance.

**CLOEODES HYDATION, N. SP. (EPHEMEROPTERA:  
BAETIDAE): AN EXTRAORDINARY, DROUGHT  
TOLERANT MAYFLY FROM BRAZIL<sup>1</sup>**

W. P. McCafferty, C. R. Lugo-Ortiz<sup>2</sup>

**ABSTRACT:** The baetid mayfly *Cloeodes hydation*, n. sp., is described from larvae and adults from Mato Grosso, Brazil. It is the first species of the genus *Cloeodes* known from Brazil. It is most similar to the Paraguayan species *C. irvingi*. These species are shown to be intermediate in character to what have been considered different subgenera, and thus, subgeneric classification is no longer recognized, and the subgenus *Notobaetis* is suppressed. The new species can live in temporary pools, and it is the first mayfly shown to withstand diel drying conditions.

A baetid mayfly along with the chironomid midge *Apedilum elachistus* Townes were found to be the dominant benthic species in a highly dynamic habitat of small temporary rock pools in central Brazil. The two species were discovered during studies conducted on the Rio Bento Gomes intermittent tropical river system in Mato Grosso, Brazil by an ecological research team headed by Dr. Ulrike Nolte. Upon contacting us with regard to the identification of these mayflies, we found them to be a new, undescribed species of *Cloeodes* Traver, a genus of Baetidae that until recently has been very poorly known, but is proving to be a major group of mayflies in the American tropics and subtropical areas (Waltz and McCafferty 1987a, 1987b; Kluge 1991; Lugo-Ortiz and McCafferty 1993, 1994; Waltz 1993). Although known only from Puerto Rico (Traver 1938) for many years, *Cloeodes* is now known from central Argentina to southwestern United States and southeastern Asia, and it was recently discovered in South Africa (Waltz and McCafferty 1994), indicating a somewhat pantropical distribution pattern.

Besides being the first species of *Cloeodes* discovered from Brazil, the new species, described below, demonstrates some exceptional attributes with respect to known biology of mayflies. Most remarkable is an ability to withstand repeated drying conditions—larvae being able to survive in dried ephemeral pools up to nine hours before rehydration takes place. This observation of drought tolerance, made by Nolte and his colleagues in Brazil, apparently represents the first demonstration of such an adaptation in mayflies. Little is known about the biology of other species of *Cloeodes*, and thus we do not know if this phenomenon is more widespread in the genus, or for that matter, other tropical mayflies. The biology and mode of drought tolerance for the new *Cloeodes* species in Brazil have now been studied in detail.

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and comprehensive ecological and phenological information on the species has been accumulated.

The purpose of this paper is to describe and make available a name for this new species of *Cloedes*. Although brief habitat characterization is included here along with detailed comparative morphology, the substantial quantitative treatment of life history and ecological data associated with this species will be forthcoming in a paper being prepared by Nolte, Tietböh, and McCafferty.

### *Cloedes hydation*, new species

**Mature larva.** Body length 3.4-4.7 mm (females generally larger than males); terminal filaments 1.5-2.2 mm. Head capsule dorsally brown between compound eyes, with some scattered light flecks and light median longitudinal stripe ranging from very thin and almost imperceptible to broad as in Figure 1, and continuing anteroventrally on frons to about level of antennal sockets; median ocellus small, round, and highlighted by median longitudinal light stripe of head capsule. Frons not developed into intra-antennal process. Antennae nearly half length of body (Fig. 1); scape and pedicel of antennae with few or no small, blunt, spinelike setae. Labrum (Fig. 2) with 1 + 1-3 elongate, dorsal hairlike setae and 4-5 lateral submarginal short, spinelike setae, and with most anterior marginal setae plumose. Right mandible as in Figure 3, with setal tuft at base of molar well developed, and prosthema highly branched apically. Left mandible as in Figure 4, with median process below molar well developed, elongate, and rounded apically. Maxillary palps (Fig. 5) long, slightly exceeding galealaciniae, with slightly discernible indication of segment 3; galealaciniae (Fig. 5) with 1 + 4-5 dorsal setae. Segment 2 of labial palps (Fig. 6) with 5-6 dorsal setae; segment 3 obliquely truncate apically; paraglossae (Fig. 6) with 4-5 inner marginal setae medioapically and 4-7 ventral inner marginal setae; glossae (Fig. 6) with 12-15 inner marginal setae.

Pronotum (Fig. 1) light, with pair of brown lateral stripes extending from posterior margin but not reaching anterior margin and with several other variable brown dashes or irregular maculae. Mesonotum variously marked with brown (Fig. 1). Minute hindwingpads present. Legs patterned similar to that shown in Figure 1, with median femoral band weaker ventrally especially on mid- and hindfemora, and generally weaker or absent in younger individuals. Trochanters without bristles or long, hairlike setae. Femora with two blunt, sublanceolate setae apically (Fig. 7). Tibiae with arc of fine, hairlike setae transverse and restricted to basal area, and with subtending blunt sublanceolate seta as in Figure 8. Tarsi with ventral row of small, spinelike setae, and with some fine, hairlike setae dorsally.

Abdominal color pattern highly variable. Terga 4, 5, and 8 usually lighter than others; terga 9 and anterior half of 10 usually dark; terga 2 and 6 often darkest; darker terga with light lateral patches. Sterna mostly light, although sterna 9 with dark borders and light medial area in mature specimens; other posterior sterna sometimes variously darkened laterally or anterolaterally. Abdominal segments 5-10 with short series of spines at extreme lateral aspect of posterior margin, becoming continuous with entire posterior row of spines. Terga 3 with 38-48 triangular, median posterior marginal spines (length of spines greater than basal width). Sterna 9 of male with 14-18 spines at median posterior margin. Gills largest anteriorly, becoming progressively smaller posteriorly (Fig. 1). Terminal filaments with darkened band subdistally (Fig. 1).

**Male adult.** Body length 3.9-4.2 mm; forewing 3.8-4.0 mm; hindwing 0.4-0.6 mm. Body coloration uniformly cream except darker thoracic suture lines and slight abdominal shading laterally on terga. Antennae with scape slightly longer than pedicel, and flagella subequal to or slightly longer than length of turbinate portion of compound eyes. Turbinate portion of compound eyes oval as in Figures 9 and 10, with relatively short but distinctly divergent stalks.

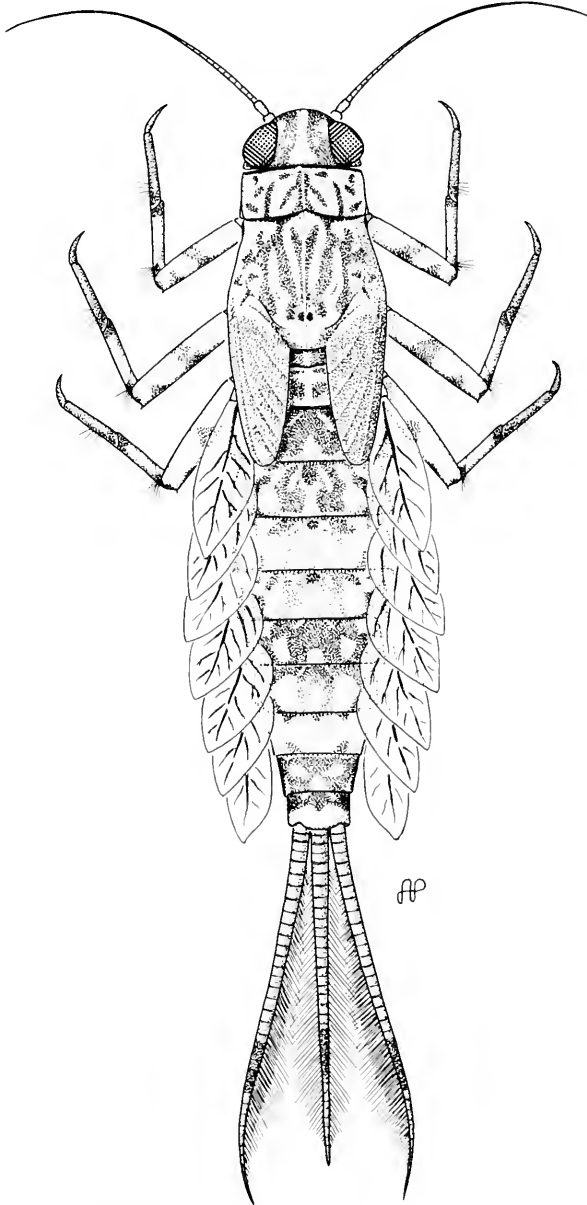


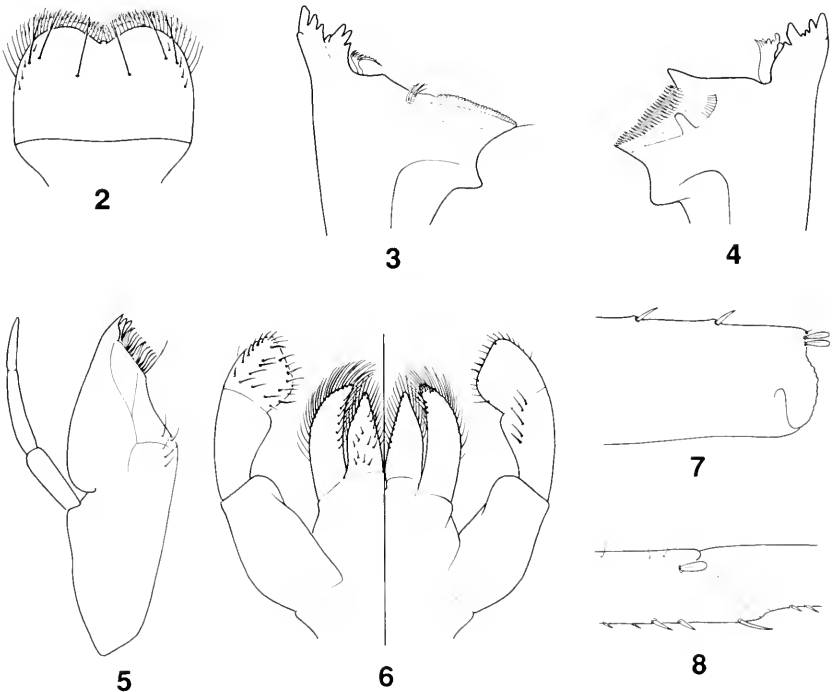
Fig. 1. *Cloeodes hydatton* larva.

Wings clear except translucent anterodistally as shown in stippled area of Figure 11. Basal costal margin with low, intermittent, sharp spines as seen in blow-up insert of Figure 11; stigmatic crossveins of forewings either complete or with one or more crossveins incomplete (Fig. 11); marginal intercalaries of forewings beginning in  $R_1$ - $R_2$  cell, and sequenced in each cell as short-long/long-short/short-long/etc. so that juxtaposed intercalaries from different but adjacent cells are either relatively short or long and alternate with next juxtaposed pair (Fig. 11). Hindwings as in Figure 11.

Abdominal terga slightly shaded with triangular patches in extreme lateral aspect. Genitalia as in Figure 12.

**Female adult** similar to male description above, except lacking turbinate eyes and genitalic characters.

**Material.** HOLOTYPE: male larva (in alcohol), Brazil, Mato Grosso, Fazenda Campo Alegre, spring pools of tributary of Rio Bento Gomes ( $15^{\circ}75'S$ ,  $56^{\circ}55'W$ ), U. Nolte, 11-1992, deposited in the collection of the Entomological Collection of the Federal University of Cuiabá, Mato Grosso, Brazil. PARATYPES: 5 larvae and 3 male adults (some dissected parts slide mounted in euporal), same locale data as holotype, deposited in Purdue Entomological Research Collection (PERC), West Lafayette, Indiana. Other material examined consisted of numerous larvae, additional male adults, female adults, and male and female subimagos, all taken from the

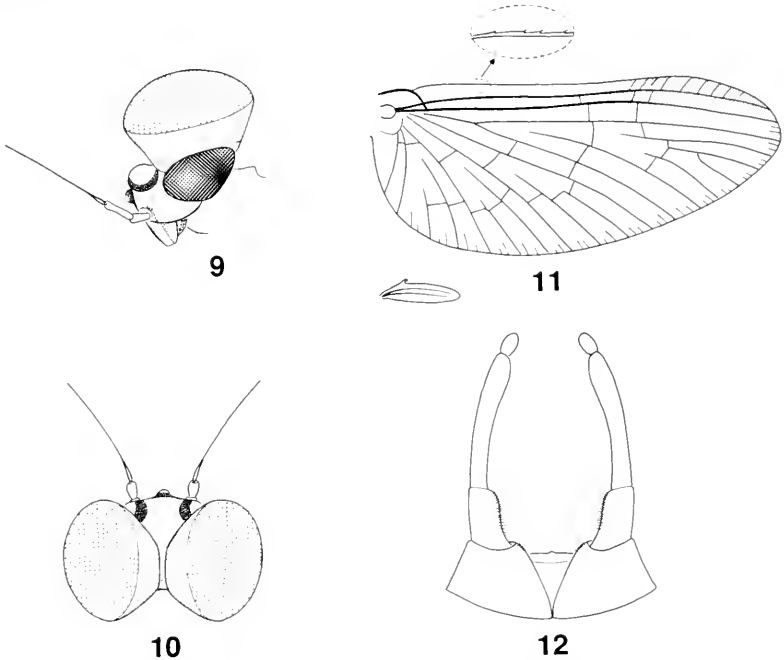


Figs. 2-8. *Cloeodes hydatation* larva. 2. Labrum, dorsal. 3. Right mandible. 4. Left mandible. 5. Maxilla. 6. Labium (left: ventral, right: dorsal). 7. Forefemora, apex. 8. Foretibia, apex.



same locality and numerous larvae taken subsequently from the adjacent spring tributary of the Rio Bento Gomes itself. The non-type material examined is deposited in PERC.

**Etymology.** The specific epithet "hydatum" is a noun in apposition taken from the Latin meaning little water, an allusion both to the habitat of the species and its propensity for drought tolerance.



Figs. 9-12. *Cloeodes hydatum* male adult. 9. Head, lateral. 10. Head, dorsal. 11. Fore- and hind-wing. 12. Genitalia, ventral.

## DISCUSSION

Waltz and McCafferty (1987b) divided the genus *Cloeodes* into two subgenera: *Notobaetis* Morihara and Edmunds and *Cloeodes* s.s. Only the rather distinctive species *C. penai* (Morihara and Edmunds) was included in *Notobaetis*. *Cloeodes hydatum* larvae share many of the distinctive characteristics originally associated with *C. penai* and *Notobaetis*: relatively long antennae, relatively long maxillary palps, and obliquely truncate apices of labial palps. *Cloeodes hydatum* larvae, however, also possess a characteristic that was associated with *Cloeodes* s.s. larvae, i.e., the absence of serrate margined bristles on the femora. In addition, the adults of *C. hydatum* also possess charac-

teristics that were attributed to one or the other subgenus—sharing the more anteriorly placed paired marginal intercalaries in the forewings and a low stalk of the turbinate portion of the compound eyes with *C. penai*, but having incomplete stigmatic crossveins in the forewings and a somewhat basally positioned costal process of the hindwings, which are typical of species placed in *Cloeodes* s.s. We have also discovered that the Paraguayan species *C. irvingi* Waltz and McCafferty (known only from larvae) demonstrates some intermediacy between *C. penai* and other species that had not been recognized before. In particular, the apices of the labial palps are atypical of all other species previously placed in *Cloeodes* s.s., the length of the antennae is intermediate between the two extremes found, and the length and segmentation of the maxillary palps are intermediate between the longer, three-segmented condition of *C. penai* and *C. hydatation* and that of the shorter, two-segmented condition found in most other species. Given the distribution of character states discussed above, the intermediacy of *C. hydatation* and *C. irvingi*, especially the intermediate combination of character states found in the adults of *C. hydatation*, and the fact that the antennal length character differs even in the two very closely related species *C. hydatation* and *C. irvingi*, we can no longer justify maintaining two subgenera in the genus, and we therefore suppress the subgenus *Notobaetis*.

Similarities and differences between *C. hydatation* and *C. penai* can be seen from the discussion above. Those species are also strikingly different in size, coloration, and many other more subtle characters. The only species with which *C. hydatation* could be confused is *C. irvingi*. The color pattern is somewhat similar in certain individuals of the two species, but color pattern is also similar in some other species of *Cloeodes* (see Waltz and McCafferty 1987b), and we do not consider it a critical character. The dorsal background color is distinct in the two species, with that of *C. hydatation* being cream, or beige, and that of *C. irvingi* being brown. *Cloeodes irvingi* also appears to be a bit larger than *C. hydatation*; however, the approximately 1 mm difference in the two could certainly be within a range of variability. The most dramatic structural difference between the two species is the larval antennal size. Antennae are about twice the frontal length of the head capsule in *C. hydatation* and about one and one half times the length of the frontal head capsule in *C. irvingi*. We assume from the close similarity of the two species that they are closely related, possibly sister species. We also assume that adults of the two will prove to be similar. The striking biological adaptations of *C. hydatation* could possibly also be found in *C. irvingi*, but little is known of the habitat of the latter species.

*Cloeodes hydatation* was originally taken in samples from small temporary rock pools adjacent to a tributary to the Rio Bento Gomes, an intermittent lowland tropical river in the southern part of the state of Mato Grosso, Brazil.

This river is one of the principal tributaries (one of approximately 200-250 springs) discharging into the northern Pantanal. The degree to which the tributary and pools are intermittent is dependent on local precipitation, which varies considerably during the year. Subsequent to *C. hydration* being taken from the rock pools, it was also found in both depositional and erosional habitats in the tributary itself. During the rainy season (December to April), the species goes through several generations in the pools, while in the tributary it occurs throughout the year. Generation time can be extremely short (18 days), and larvae are able to withstand temporary daily drying conditions in these pools. As pointed out above, details of physical and chemical habitat parameters as well as details of behavior and phenology will be treated in a subsequent paper.

#### ACKNOWLEDGMENTS

We thank Ulrike Nolte (currently guest lecturer and researcher, Universidade Federal de Mato Grosso, Brazil) for providing specimens and invaluable data, Arwin Provonsha (biological illustrator, Purdue University, West Lafayette) for providing drawings of the new species, and Bob Waltz (Head, Division of Entomology, Indiana DNR, Indianapolis) for some of the material preparation, and commenting on the manuscript. This paper has been assigned Purdue Agricultural Research Program Journal No. 14353.

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## A NEW WATER SCAVENGER BEETLE, *ENOCHRUS SPANGLERI* (COLEOPTERA: HYDROPHILIDAE), FROM MEXICO<sup>1</sup>

Silvia Santiago-Fragoso, Elizabeth Mejorada-Gomez<sup>2</sup>

**ABSTRACT:** A new species of the genus *Enochrus* is described from the state of Chiapas, Mexico. The distinguishing characters that serve to separate this new taxon from related species in the genus are described and figured.

In 1844 Melsheimer described *Phylidrus ochraceus* that is part of the Mexican fauna and was assigned later to the genus *Enochrus*. An additional six species of Mexican *Phylidrus*, now assigned to *Enochrus*, were described by Sharp in 1882. Gundersen (1978) included six species with distribution data for Mexico in his study of the Nearctic *Enochrus*.

The new species of *Enochrus* described below is known, thus far, only from San Cristobal Las Casas, Chiapas, Mexico. Specimens are deposited in the collections of the Instituto de Biología Universidad Nacional Autónoma de México (IBUNAM) and the National Museum of Natural History, Smithsonian Institution (NMNH).

### *Enochrus spangleri*, new species

(Figs. 1, 2)

**Holotype male:** Form and size: Oval and strongly convex. Length 4.6 mm; width 2.5 mm.

**Color:** Head pale reddish brown on apical two thirds; with a dark V-shaped line from lateral sides of the head to the center; basal third of head and pronotum reddish brown with dark spots in longitudinal lines and irregular maculae. Labial and maxillary palpi yellowish brown. Antennae and legs reddish brown.

Head moderately densely punctate, punctures separated by distance equal to puncture diameter; labrum moderately, densely granulate. Pronotum densely punctate as head; subrectangular, slightly more than twice as wide as long; finely margined anteriorly and laterally; anterolateral and posterolateral angles rounded; sides arcuate. Scutellum with punctures similar to those of the head. Elytron with punctures similar in size and density to those on pronotum; with feeble lateral impressions arranged longitudinally; sides finely margined; apical angles rounded; sutural angle entire. Legs with femora pubescent. All tarsi 5 segmented.

**Genitalia:** As illustrated (Figs. 1, 2).

**Female.** - Unknown.

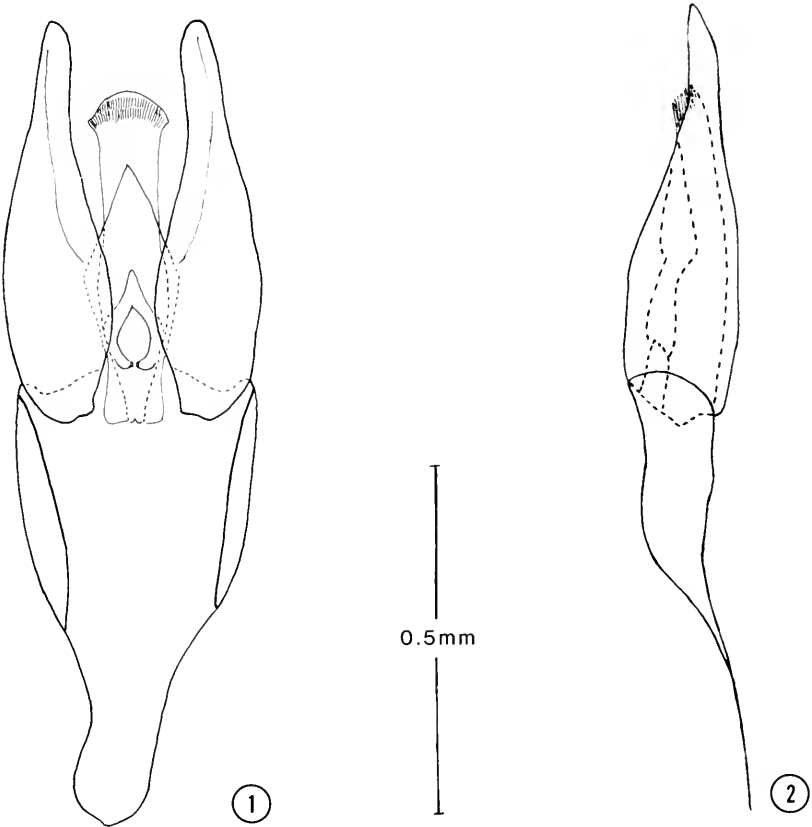
<sup>1</sup> Received August 18, 1994, Accepted September 2, 1994.

<sup>2</sup> Instituto de Biología, UNAM. Apdo. postal 70-153, Mexico, D.F. C.P. 04510.

**Type data.** - Holotype male: MEXICO: Chiapas: San Cristobal Las Casas, 21 May 1981, J. Bueno-Soria; deposited in the Entomological Collection, Instituto de Biología, Universidad Nacional Autónoma de México .

**Paratypes:** Same data as holotype, 2 specimens (IBUNAM), 2 specimens (NMNH).

**Etymology.** - In recognition of his many contributions to the study of aquatic beetles, we dedicate this species to Dr. Paul J. Spangler, our colleague and mentor of the senior author.



Figs. 1-2. *Enochrus spangleri*, n. sp.: male aedeagus: 1, ventral view; 2, lateral view.

**Comparative notes:** *E. spangleri*, n. sp., (length, 4.2 - 4.6 mm) is similar in size to *E. cristatus* (length, 3.1 - 4.2 mm). The male genitalia are diagnos-

tic; the apical one-third of each of the parameres, including the apex, of *E. cristatus* are narrower than in those of *E. spangleri*, n. sp.; in *E. cristatus* the median lobe is tapered and the apex subacute; whereas, in *E. spangleri*, n. sp., the median lobe is subparallel and the apex widely arcuate.

#### ACKNOWLEDGMENTS

We thank Joaquin Bueno-Soria for collecting the material studied, Paul J. Spangler for reviewing the manuscript, and Phyllis Spangler for kindly checking the translation.

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#### BOOK RECEIVED AND BRIEFLY NOTED

SCUTTLE FLIES: THE PHORIDAE. R.H.L. Disney. 1994. Chapman & Hall. 467 pp. \$119.95 Hdbk.

This book collates what is known about the natural history of the Phoridae of the world. It reviews eggs and oviposition, larval habits, pupae and their enemies, development, adult habits and ecological aspects. Included is an extensively illustrated key to world genera and a review of the identification literature for each of the 229 recognized genera.

**REDISCOVERY OF OXYPORUS FLOHRI,  
(COLEOPTERA: STAPHYLINIDAE), FROM  
MEXICO AND NEW DISTRIBUTIONAL RECORDS  
OF TWO OTHER MEXICAN OXYPORUS 1,2**

José Luis Navarrete-Heredia<sup>3</sup>, Juan Márquez-Luna<sup>4</sup>

ABSTRACT: First state records for three *Oxyporus* species are provided: *Oxyporus balli* from México, *O. flohri* from Veracruz, and *O. mexicanus* from Nayarit and Jalisco.

The purpose of this paper is to confirm the distribution of *O. flohri* in Veracruz and to provide new distributional records of two other Mexican *Oxyporus*. Specimens were collected associated with mushrooms as is usual in this genus. They are deposited in the following collections: Colección Entomológica del Centro de Estudios de Zoología, Universidad de Guadalajara, Zapopan (CZUG); Instituto de Biología, UNAM, Ciudad de México (IBUNAM), Instituto de Ecología, Xalapa (IE), American Museum of Natural History, New York (AMNH), Canadian National Collection, Ottawa, (CNC), Field Museum of Natural History, Chicago (FMNH), Snow Entomological Museum, University of Kansas (KSEM), J.L. Navarrete, Zapopan (JLN), and J. Márquez-Luna, Ciudad de México (JML).

*Oxyporus flohri* Sharp

*Oxyporus flohri* was described by Sharp (1887) based on two specimens collected by Mr. Flohr at Alto del Tizar, a questionable locality in México. One century later, Campbell (1990) collected two females in Guatemala "from small gilled mushrooms", and suggested that its type locality is probably in the mountainous areas of Chiapas. Two years later, Navarrete-Heredia (1992) provided a locality named Alto del Tizar in Veracruz, near Naolinco. However, since no specimens of *O. flohri* have been collected recently from or near Alto del Tizar in Veracruz, it is not certain that this locality is the same as the type locality.

During a recent field trip by the junior author to Veracruz, one female specimen was collected at Xico, Coatepec (Fig. 1) associated with a fleshy

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mushroom on a decaying log. This is the first record of an *Oxyporus* from eastern Mexico and for this reason the specimens of *O. flohri* collected in Veracruz suggest that the Alto del Tizar in this state is in fact the type locality for this species. Other beetles collected on the same sporophores were: *Triplax alvarengai* Johnson, *Aegithus rufipennis* Chevr., *Mycotretus* sp. (Erotylidae); *Epipocus* sp. (Endomychidae), and unidentified hydrophilid species. The mushroom's host was unidentified but physical description and associated beetles suggested that it belongs to *Pleurotus* sp.

Campbell (1990) described some variation in the Guatemalan specimens with respect to the lectotype. The single one examined by us is similar to the specimen from Sierra de las Minas (Guatemala) and differs from the lectotype described by Campbell (1969) in having a vitta along the midline of the pronotum and a vague vitta on the midline of head; temples, prosternum, mesosternum, pterothorax, anterior half of metasternum and the posterior half of III visible abdominal sternum picceous.

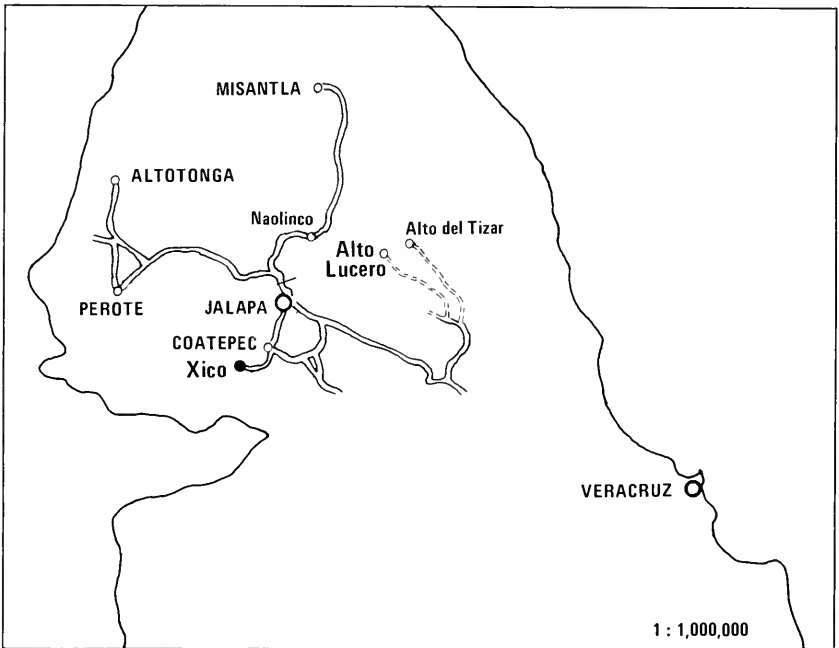


Figure 1. Alto del Tizar and Xico (Veracruz), both recorded as localities for *O. flohri* in Mexico.



The specimen is labeled: MEXICO: Veracruz, Coatepec, Xico, 20. V. 1994, J. Márquez col., *ex hongo de tronco en descomposición*. Specimen is deposited in JLN collection.

### *Oxyporus mexicanus* Fauvel

This species is known from Durango, Guerrero, Oaxaca and Morelos (Navarrete-Heredia 1992). The following label data provide additional information on distribution and hosts visited by individuals of *O. mexicanus*:

MEXICO: Jalisco, Tequila, Volcán de Tequila, Bosque de Encino, 2800 m. 24.VI.1994, E. Martínez, I. Báez, H. Fierros, D. Pérez cols. *ex Lyophyllum decastes* II, (16♂, 50♀) (first host and state records) (CNC, CZUG, IBUNAM, IE, AMNH, KSEM, FMNH, JLN, JML). From the same sporophores were collected other beetles and dermapterans belonging to: STAPHYLINIDAE; Aleocharinae (Gyrophaenina), Steninae (*Stenus*), Scaphidiinae (*Toxidium*), Tachyporinae (*Sepedophilus*, *Lordithon*, *Tachinus*), Paederinae; NITIDULIDAE; Nitidulinae (*Pallodes*, *Stelidota*); CHRYSOMELIDAE; Alticinae, Cassidinae; ELATERIDAE, CARABIDAE and a single dermapteran family: Forficulidae. Other specimens examined are labeled as: MEXICO: Nayarit, Cerro San Juan, La Noria, 5.VII.1991, M. Villegas col., *ex L. decastes* II (first state

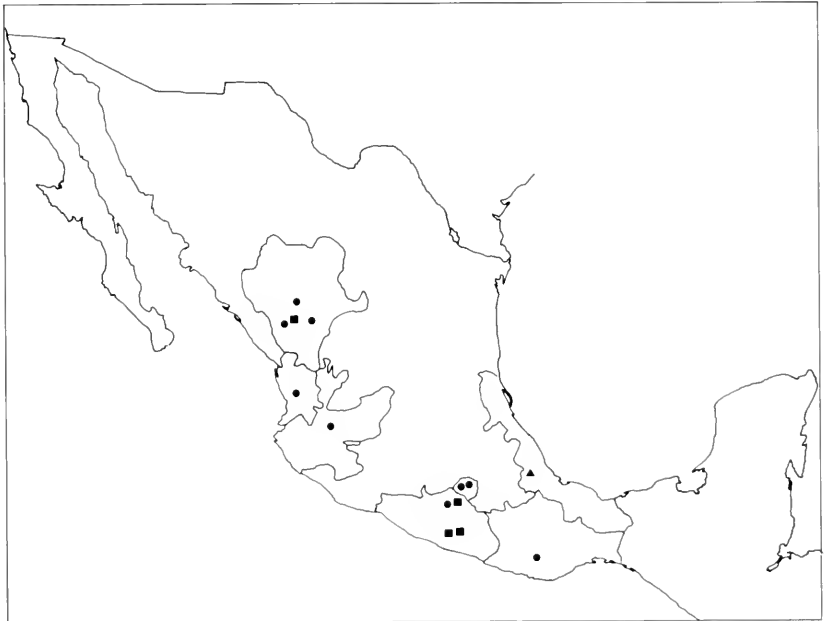


Figure 2. Distribution of species of *Oxyporus* in Mexico: *O. mexicanus* (circles), *O. guerreroanus* Bernhauer (squares), *O. flohri* (triangles).

record) (4♂, 1♀), (CZUG, JLN); MEXICO: Oaxaca, Km 21 carr Yolotepec-Juquila, 1850m, 30-31.VII.1991, J.L. Navarrete, G.A. Quiroz y L. Delgado cols., ex. *Armillariella mellea* II y IIIA, (1♀) (JLN). Fauvel (1866) described this species based on one male and one female from Oaxaca state (without precise geographic locality).

Our discovery is the first specific record from this state and extends its distribution to southern Mexico. This species is the most common and widespread in the country (Fig. 2).

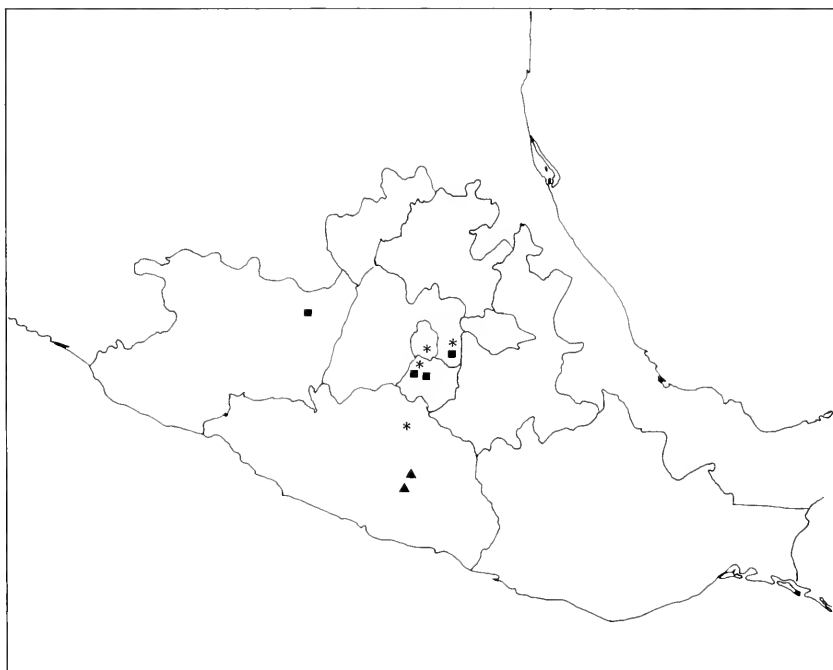


Figure 3. Distribution of species of *Oxyporus* in Mexico: *O. balli* (squares), *O. smithi* Bernhauer (triangles), *O. lawrencei* Campbell (asterisk).

### *Oxyporus balli* Campbell

This is known from Michoacán and Morelos (Campbell 1969; Navarrete-Heredia 1992). One male and four larvae were collected associated with *Cortinarius* sp. II (first host record) in Mexico state (first state record) (Fig. 3). The specimens are labeled: MEXICO: México, Atlautla, San Juan Tepecoculco, 5.XI.1991, J.L. Navarrete col., ex. *Cortinarius* II, (1♂) (JLN).

## ACKNOWLEDGMENTS

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INSECT LIPIDS. CHEMISTRY, BIOCHEMISTRY, AND BIOLOGY. D.W. Stanley-Samuelson & D.R. Nelson. 1993. Univ. of Nebraska Press. 467 pp. \$30.00 Hdbk.

Based on a recent international symposium, this volume presents research on the frontier of insect biochemistry. Subjects included are lipoproteins and lipid transport, structure and function of *Manduca sexta* hemolymph lipid transfer particle, biological significance of prostaglandins and related eicosanoids in insects, arachidonate metabolism in tick salivary glands, prostanoids and fluid balance in insects, cuticular hydrocarbons and chemical communication, cuticular polar lipids of insects, methyl-branched lipids in insects, hydrocarbon derived sex pheromones, and lipid biochemistry in aphids.

**BOOKS RECEIVED AND BRIEFLY NOTED**

**INSECT HORMONES.** H.F. Nijhout. 1994. Princeton Univ. Press. 267 pp. \$35.00 cloth.

The goal of this book is to provide a complete, concise, overview of the dynamic and wide ranging science of insect endocrinology in the study of insect metamorphosis. Topics discussed include control of molting, metamorphosis, reproduction, caste determination in social insects, diapause, migration, carbohydrate and lipid metabolism, diuresis, and behavior. Also included is a summary of current thinking on the complex roles of ecdysone and juvenile hormone in the control of metamorphosis. The book's emphasis 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.

**SWALLOWTAIL BUTTERFLIES OF THE AMERICAS. A STUDY IN BIOLOGICAL DYNAMICS, ECOLOGICAL DIVERSITY, BIOSYSTEMATICS, AND CONSERVATION.** H.A. Tyler, K.S. Brown, Jr., & K.H. Wilson. 1994. Scientific Publishers. 376 pp. 157 color plates. 1100 line drawings and figures. 8<sup>1</sup>/<sub>2</sub> x 11 format. \$49.50 cloth. \$24.50 paper student edition

A monographic treatment of all species of New World Papilionidae, the swallowtails. The text is an encyclopedia of studies on swallowtails and butterflies in general, covering subjects from morphology of all stages to chemical ecology, behavior, population biology, genetics and mimicry, biogeography, phylogenetics, and conservation. Keys and notes allow identification of all species, including all immature stages.

**NOURISHMENT & EVOLUTION IN INSECT SOCIETIES.** J.H. Hunt & C.A. Nalepa, eds. 1994. Westview Press. 448 pp. \$84.00 hdbk.

This book offers reviews of existing literature and new research on the origin and elaboration of insect sociality. The contributors place nourishment at the center of analysis for focal taxa, interpreting and evaluating the involvement of nourishment in the relevant evolutionary phenomena. Their discussions encompass morphology, physiology, behavior, and ecology. In addition to restoring nourishment to an important position in the evolutionary study of social insects, this book also moves the study of social insects into the larger realm of life history evolution.

## ARTHROPODS TAKEN IN PITFALL TRAPS IN THE PINE BARRENS OF NEW JERSEY<sup>1</sup>

Howard P. Boyd<sup>2</sup>

ABSTRACT: The diversity, abundance, and seasonal distribution of arthropods taken in barrier pitfall traps in the pine barrens of New Jersey are presented.

The pine barrens of New Jersey is the most extensive wilderness tract along the middle Atlantic seaboard and is one of the world's unique natural areas (McCormick, 1970; Forman, 1979; Boyd, 1991). It consists of some 500 to 560 thousand hectares (1.25 to 1.4 million acres) of generally flat, sandy, acidic, and sterile soils on the Outer Coastal Plain of New Jersey. It is the largest of several similar areas in the northeastern United States.

The pine barrens is almost entirely forested with pines, mainly pitch pine, *Pinus rigida*, numerous species of oaks, *Quercus* spp., and, in low lying swamps and borders of streams, Atlantic white cedar, *Chamaecyparis thuyoides*, with inroads of hardwood swamps dominated by swamp or red maple, *Acer rubrum trilobum*, as regrowths following clearcuts of the original stands of cedar. Pitch pines constitute the subclimax forest in both upland and lowland areas, the various species of oaks are found mainly in upland areas, while the Atlantic white cedar is limited to lowland areas. In all habitats, the usual understory vegetation is principally a variety of heaths and heath-like shrubs, with the ground cover consisting mainly of lichens and mosses. Seven of the 18 pitfall traps in this study were located in pine-oak upland areas.

Included within the pine barrens of New Jersey are smaller areas of dwarf or pygmy forests known collectively as the Pine Plains, of which the West, East, and Little Plains are the best known. These are upland areas (100' - 200' el.) which are located near the Burlington-Ocean County boundary. Together, they total approximately 485 to 800 hectares or 1200 to 1500 acres. The outstanding characteristic of these areas is the low coppice, usually not over four to ten feet, of the mature trees which are almost exclusively a serotinous or closed cone type of pitch pine, together with blackjack oak, *Quercus marilandica*. Again, the understory is a variety of heaths and heath-like shrubs. Another distinguishing feature of the pine plains is the frequency of fires which occur, on average, once every eight or nine years, so that only the most highly fire resistant vegetation is able to survive. Eleven of the 18 pitfalls in this study were located in pine plains areas.

<sup>1</sup> Submitted January 13, 1944. Accepted February 22, 1994.

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Both the fauna and flora of the pine barrens have a strong southern affinity. This is probably due to the gradual northward migration of southern forms beginning some 12,000 to 10,000 years ago after the retreat of the last of the glaciers when scientists believe the present pine barrens vegetation began to develop. Smith, 1910, stated that "the insect species on the whole resemble those of more southern states, and Georgian or even Floridian forms are not uncommonly met with".

The pine barrens has long been a favorite collecting area for entomologists. In the late 1800s and early 1900s railroads took New York collectors south to Lakewood, Lakehurst, and other stations down the line, while Philadelphia collectors took shore-bound trains across southern New Jersey and got off to do a day's or weekend's collecting in the vicinity of then rural sites such as Atco and DaCosta. Few places in North America have been as thoroughly collected as the Lakehurst area and many original descriptions have been based on type specimens from the pine barrens, including a number of endemics.

In spite of this, there is a dearth of literature treating the arthropods of the pine barrens. An early study of the insects of the pine barrens by Weiss and West, 1924, was based on March to October collections in a four hectare (ten acre) dry woods and an adjoining 1.6 ha (four acre) open area near Lakehurst. Approximately 85% of all species captured were taken in flight, on the ground, or by sweeping vegetation, and about one half of these were Coleoptera and Hymenoptera. Phytophagous insects were most abundant in both woods (45%) and open area while the percentages of predacious and parasitic insects were nearly the same in both habitats. Saprophagous insects were more common in the woods while more pollenizers were found in the open due to the presence of more flowers.

The chapter on arthropods (Boyd and Marucci, 1979) in Forman's book on the pine barrens is more of a general overview than a report on a specific study. Other references that refer to arthropods in the pine barrens of New Jersey are Boyd, 1973, 1978, 1985; Buffington, 1967; Darlington, 1952; Leng, 1902; Leonard, 1974; McCormick, 1970; and McCormick and Andresen, 1960.

The study reported in this paper was undertaken in the spring and summer of 1986 in an effort to obtain more data on the diversity, abundance, and seasonal distribution of ground-dwelling arthropods in the pine barrens of New Jersey. It appears from the results, however, that more than "ground-dwelling" arthropods were taken in the pitfalls.

## MATERIALS AND METHODS

Eighteen barrier pitfall traps were set out at selected sites in Burlington and Ocean Counties, New Jersey (Table 1). Some were widely scattered,

seven as far distant from each other as 19 and 25.5 kilometers (12 and 16 miles), but most (11) were placed in a stretch of about 11 km (seven mi) near the boundary between the two counties. All were within the inner core or preservation area of the pines as defined by the N.J. Pinelands Commission (N.J.P.C., 1980).

Each barrier pitfall trap consisted of five shallow, wide-mouth, peanut-butter type glass jars, each one-third filled with an ethylene-glycol base anti-freeze solution and set in the ground with the top of the jar at ground level. Barriers, usually four in number, of 10 cm high, green plastic lawn edging, were installed and staked in a rough cross formation. Each barrier extended outward from a central jar to a peripheral one so that, typically, there were five glass jars at each trap site. A glass cover was placed above each jar, on stakes, to keep out rain.

All traps were set out on March 28 and 29 and were visited weekly from April 3 through September 30 but with visits only every two weeks in July and again in September. All specimens collected were rinsed and then stored in vials in 70% ethyl alcohol for later determination.

## RESULTS AND DISCUSSION

Over the twenty five weeks that collections were made during this survey, more than 78,000 specimens were collected and, later, identified to families and counted (Table 2). Seasonal distribution of the total specimens taken varied considerably. The highest totals were taken during April through June, followed by a considerable drop-off from the end of June through August. Collection totals increased again in September but did not approach the April to June figures.

In terms of sheer numbers, the Collembola (>36,000) far exceeded any other taxon but the figures shown in Table 2 do not tell the complete story. Regularly, from June 19 through August 31, at trap #14 located in the Little Plains (Table 1), there appeared to have been an "explosion" of Collembola during intervals between collections. The Collembola became so thick in the collecting jars during these periods that by collection times all the antifreeze solution in the traps had been absorbed, leaving only a thick, muddy biomass, so thick it wouldn't even pour and had to be shaken out. Hundreds, perhaps thousands, of collembolans were lost in this process.

In descending order, the next most numerous taxa were the Formicidae (>20,000), Diptera (>6500), Araneida (>5100), Coleoptera (>3200), Phalangida (>2500), Orthoptera and Dictyoptera (>2000), and Acari (>1000). Of all the major groups, the Hemiptera and Homoptera were the most poorly represented in the samples with only 250 specimens.

Aside from statistics, a few observations seem in order. In the Phalangida,

it was interesting that nearly one third (31%) of all specimens were collected during September, thus providing at least some support for the common name "harvestmen". As expected, among the Araneida, the Lycosidae, or wolf spiders, were the most numerous.

In the Cicindelidae, *Megacephala (Tetracha) virginica* (L.) and *Cicindela unipunctata* F., both previously considered rare (Boyd, 1985), were again the most common tiger beetles (59 and 44 respectively out of 210) collected in the West Plains portion of the pine plains. Ninety-nine of these were collected in traps 2 through 7 (Table 1) located in the Coyle Field area. Among the Carabidae, by far the most numerous species was the ground beetle, *Pasimachus depressus* (127 of 460). Of these, 88 were also taken from Coyle Field traps 2-7.

The large numbers of Silphidae (108), Staphylinidae (430), and Scarabaeidae (1670) taken in these pitfall traps was surprising. Of the Silphidae, 85 were *Nicrophorus orbicollis* Say. Of the Scarabaeidae, 998 were either *Canthon nigricornis* Say or *C. bispinatus* Robinson (not counted separately). Next most numerous scarabs were *Oonthophagus* spp. (168), of which 126 were *O. hecate* Panz. and *Geotrupes* spp. (134), of which 97 were *G. splendidus* (Fab.). The presence of such large numbers of these carrion and dung beetles may be attributed, at least in part, to the numbers of amphibians and mammals that fell into and drowned in the traps and whose carcasses were often floating on the surfaces of the antifreeze solution and thus were exposed to the atmosphere. Chief among these carcasses were Fowler's toad, *Bufo woodhousei fowleri* (34), masked shrew, *Sorex cinereus* (33), pine vole, *Pitymys pinetorum* (9), and white-footed mouse, *Peromyscus leucopus* (8).

Of the 224 Lepidoptera larvae taken, 24 were of the buck moth, *Hemileuca maia* (Drury).

In the Diptera, the large number of calyptrate flies (322), most of which were Calliphoridae (Gelhaus, pers. comm.), may be explained by their natural attraction to the same carcasses that drew so many silphids, staphylinids, and certain scarabaeids.

The taking of such large numbers of Mycetophilidae (3503) and Phoridae (1775) in a series of ground-level pitfall traps was surprising. Vockeroth, 1981, stated that mycetophilids "are most abundant in humid areas, especially moist woodland ... many species congregate in moist, dark places such as ... cavities under tree roots ... many species can be swept from undergrowth in woods". Oldroyd, 1964, referred to phorids as having a liking for "dark, secretive, damp and mouldy places, penetrating far into small orifices, the larvae feeding on organic matter that has begun to dry up and mummify".

These descriptions do not apply well to the open, hot, sunny, sandy, droughty surface conditions of the pine barrens of New Jersey. Neither do they apply well to the habitats where pitfall traps were located which, in the majority of places, were in relatively high, dry sites with a minimum amount of leaf



litter on the ground and little evidence of the presence of fungi.

Thus, the presence of so many mycetophilids and phorids may need further examination for possible explanations. The mycetophilids may have been associated in logs, tree cavities, or other types of wood. Some of the phorids may have been associated with ant and termite nests (Oldroyd, 1964) both of which are abundant in the pines. Phorids in general live in such a diversity of habitats and do so many different things that their presence, along with the mycetophilids, may not be as surprising as first thought. This is the view expressed by Gelhaus (pers. comm.) who points to the high numbers of Collembola (which are known to be associated with damp conditions with decaying materials, i.e. leaf litter), and the number of other litter inhabitants like gryllids and blatellids as evidence that the overall results may be a reasonably accurate sampling of a real litter fauna.

As stated earlier, the original purpose of this project was to develop some data on ground-dwelling arthropods in the pine barrens. However, the presence of such large numbers of Silphidae, Scarabaeidae, Mycetophilidae, Phoridae, and even of so many Staphylinidae and Calliphoridae suggests that many of these insects may have been attracted to the traps by one or more odors and flew to the vicinity of the traps and either landed on the carcasses or crawled over the jar lips to drop into the anti-freeze solutions. As a result, the data with respect to ground-dwelling arthropods may be somewhat compromised because of unknown numbers of possible "fly-ins".

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Table 1. Locations of pitfall traps.

No.	County	Twshp.	Location	Habitat & vegetation
1	Burl.	Tabernacle	.9 mi e Goose Pond, off rt. 532	Gray sand and covered with pine needles & <i>Cladonia</i> . Pitch pine, oaks, Black Huckleberry, Sheep Laurel
2	Burl.	Woodland	West Plains, Coyle Field, .1 mi e of N.J. Forest Fire Service bldg.	Upland dwarf/pygmy forest. White sand, partially covered w. pine needles & dry oak leaves. Pitch pine, oaks. Mt. Laurel, Black Huckleberry, <i>Hudsonia</i> , Pyxie, <i>Cladonia</i> , deer scats
3	Burl.	Woodland	West Plains, Coyle Field, .3 mi s Rt. 72 entrance to N.J. F.F.S. bldg.	Upland dwarf/pygmy forest. White sand in pocket at edge of woods. Pitch pine, oaks, Black Huckleberry, <i>Cladonia</i>
4	Burl.	Woodland	West Plains, Coyle Field, .4 mi se off sand road over to Stevenson Rd.	Upland dwarf/pygmy forest. White sand in pocket at edge of woods. Pitch pine, oaks, Mt. Laurel, Black Huckleberry, <i>Hudsonia</i> , <i>Cladonia</i> , ant hills
5	Burl.	Woodland	West Plains, Coyle Field, .4 mi se off sand road over to Stevenson Rd., .1 mi w, s of runway	Edge of upland dwarf/pygmy forest & cleared area. White sand. Pitch pine, oaks, Black Huckleberry, <i>Cladonia</i> , <i>Hudsonia</i>
6	Burl.	Woodland	West Plains, Coyle Field, .4 mi se off sand road over to Stevenson Rd., .1 mi w, n of runway	Edge of upland dwarf/pygmy forest & cleared area. White sand. Pitch pine, oaks, Black Huckleberry, <i>Hudsonia</i> , <i>Cladonia</i> .
7	Burl.	Woodland	West Plains, Coyle Field, .1 mi n of Rt 72, opp. entrance to N.J.F.F.S. bldg. Moved 4/17 to .1 mi e of N.J.F.F.S. bldg.	Upland dwarf/pygmy forest. White sand covered w. pine needles & dry oak leaves. Pitch pine, oaks, Mt. Laurel, Pyxie, <i>Hudsonia</i> , <i>Cladonia</i>
8	Burl.	Woodland	West Plains. .7 mi s Rt 72 off Stevenson Rd. then 1.5 mi w on sand road to cul-de-sac	Upland dwarf/pygmy forest at edge of cleared turn around. White sand. Pitch pine, oaks, Mt. Laurel, Black Huckleberry, <i>Hudsonia</i>
9	Ocean	Barne-gat	West Plains. 1.3 ml s rt 72 on sand rd 350' e Stevenson Rd	Burned over upland dwarf/pygmy forest. White sand. Sparse vegetation. Pitch pine, oaks, <i>Hudsonia</i>

Table 1. Locations of pitfall traps (Continued).

No.	County	Twshp.	Location	Habitat & vegetation
10	Ocean	Lacey	Off old Cedar Bridge Fire Tower road. 2.7 mi n Rts 72 & 539, 1.3 mi e of Rt 539	Edge of woods & edge of disturbed, cleared area. Pitch pine, oaks, Black Huckleberry, Teaberry, <i>Cladonia</i> , mosses
11	Ocean	Lacey	Off old Cedar Bridge Fire Tower Road. 2.7 mi n Rts 72 & 539, 1.3 mi e of Rt 539, 625' n of C.B.F.T. rd.	In elbow of abandoned woods trail partially grown over w. mosses & <i>Cladonia</i> . Pitch pine, oaks, Black Huckleberry
12	Burl.	Bass River	East Plains. 2.8 mi s Warren Grove. .9 mi w on gravel rd from Rt 539. 1000' in on white sand trail	Upland dwarf/pygmy forest. White sand. Pitch pine. Black Huckleberry, Bearberry, <i>Hudsonia</i> . Broom Crowberry, almost no oaks
13	Burl.	Bass River	East Plains. 2.8 mi s Warren Grove. .9 mi w on gravel rd from Rt 539. 375' off on side trail	Upland dwarf/pygmy forest. White sand. Pitch pine, few oaks, Black Huckleberry, <i>Hudsonia</i> , <i>Cladonia</i> , Broom Crowberry, deer scats
14	Ocean	Little Egg Harbor	Little Plains, Former Overseas Foreign Aeronautical Communications Ctr. 1.0 mi w Warren Grove, 750' up a sloping white sand trail n of Beaver Dam Rd. opp. Aero. Ctr.	Upland dwarf/pygmy forest. White sand. 90% Pitch pine, 10% oaks, Black Huckleberry, Pyxie, <i>Hudsonia</i> , <i>Cladonia</i>
15	Burl.	Washington	Wharton St. For., adj. Rutgers BI/Cr Research Sta. W side Penn St. For. Rd.	Disturbed area, edge of cult. blueberry field. Mixed white & yellow sand. Pitch pine, oaks, Black Huckleberry, <i>Hudsonia</i> , Greenbrier
16	Burl.	Washington	Wharton St. For., adj. Rutgers BI/Cr Research Sta. E side Penn St. For. Rd.	Loose white gravel/sand in clearing in Pitch pine woods. Few oaks, Black Huckleberry, Sheep laurel, <i>Hudsonia</i> , <i>Cladonia</i>
17	Burl.	Pemberton	Chambers Camp on Buffins Meadows, adj. Whitesbog tract, Lebanon St. For., s side Rt 70	White sand area in Pitch pine woods, few oaks, heavily vegetated with <i>Cladonia</i>
18	Ocean	Manchester	Bedside unused white sand private drive off No. Branch Rd., I.I	Upland pine woods. White sand. Pitch pines & oaks.

Table 2. Tabulation of collections taken in pitfall traps in the pine barrens of New Jersey, March 17 through September 30, 1986.

Taxon	3/28 4/17	4/17 4/30	4/30 5/15	5/15 5/29	5/29 6/12	6/12 6/26	6/26 7/13	7/13 7/31	7/31 8/13	8/13 8/31	8/31 9/15	9/15 9/30
Pseudo-scorpionida												
Phalangida												
Acari (mites)												
Araneida												
Thomisidae												
Salticidae												
Lycosidae												
undetermined												
Isopoda												
Diplopoda												
Chilopoda												
Collembola												
Orthoptera												
Tetrigidae												
Acrididae												
Tettigoniidae												
Gryllacrididae												
Gryllidae												
Dyctoptera												
Blattellidae												
Dermoptera												
Isoptera												
Hemiptera												
Miridae												
Reduviidae												
Emesidae												
Tingidae												
Total	3/28 4/17	4/17 4/30	4/30 5/15	5/15 5/29	5/29 6/12	6/12 6/26	6/26 7/13	7/13 7/31	7/31 8/13	8/13 8/31	8/31 9/15	9/15 9/30
	41	1	9	8	3	8	1	38	58	122	448	341
	2,555	262	282	228	119	214	309	134	38	58	122	448
	1,101	52	112	75	123	148	190	32	14	25	252	78
	172	14	25	16	32	39	28	6	4	4	4	
	75	22	13	23	11	4			2			
	801	121	86	69	214	153	93	19	5	2	5	9
	4,055	319	674	487	616	694	718	204	54	47	67	101
	26	1	4	1	5	4	7	3		1		
	101	30	44	9	8	1	4	4	1			
	104	2	26	8	7	4	5	5	4	7	5	7
	>36,013	9,548	6,335	2,864	2,762	1,467	3,144	1,105	?	2,283	1,790	1,080
	56	7	11	5	5	7	9	4	1	3	3	1
	80	1	6	5	6	14	11	11	10	3	5	6
	6	1	4									
	15									1	5	3
	1,179	1	4	4	78	109	120	79	96	69	147	227
	666	10	4	26	5	13	41	95	111	84	137	80
	1											
	98	1	21	21	4	42	28					2
	16			1	7	2	5	1				
	9	3			3	1	1					1
	10	1	1	2	2	2	1					1
	11			2	4		5					





Taxon	3/28 <sup>1</sup>		4/17		4/30		5/15		5/29		6/12		6/26		7/13		7/31		8/13		8/31		9/15		9/30	
	Total	4/17	4/30	4/17	4/30	5/15	5/29	5/29	6/12	6/12	6/26	7/13	7/13	7/31	7/31	8/13	8/13	8/31	8/31	9/15	9/15	9/30	9/30	9/30	9/30	9/30
Acalyptatrae	158	8	6	6	6	14	38	45	6						4	14	17									
Sphaeroceridae	158	2	14	2	4	3	10	19	3	31	63	7														
Drosophilidae	53							9	2	2	32	8														
Calyptatrae	322	32	50	6	8	13	49	24	11	20	36	50														
Siphonaptera	11	2		1			2	2																		
Hymenoptera <sup>2</sup>																										
Ichneumoidea	3																									
Chalcidoidea	71																									
Cynipoidea	21																									
Evaniidae	4																									
Proctotrupoidea	8																									
Tiphidae	6																									
Solidae	10																									
Mutellidae	26																									
Formicidae	>20,303	3,122	1,602	2,991	2,888	3,534	3,845	800	?	425	278	673	145													
Pompilidae	23																									
Vespidae	29																									
Sphecidae	70																									
Colletidae	4																									
Andrenidae	12																									
Halictidae	6																									
Megachilidae	1																									
Anthophoridae	54																									
Apidae	1																									
	78,013	13,840	9,740	9,099	8,324	7,224	9,306	3,202	652 <sup>3</sup>	3,405	3,143	4,620	5,109													

<sup>1</sup> Three week period

<sup>2</sup> Weekly collection records maintained only for Formicidae

<sup>3</sup> Neither Collembola nor Formicidae included in total

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(Continued on inside of back cover)

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## A NEW SPECIES OF *STRONGYLOGASTER* (HYMENOPTERA: TENTHREDINIDAE) FROM NORTH AMERICA<sup>1</sup>

David R. Smith<sup>2</sup>, Tikhiko Naito<sup>3</sup>

**ABSTRACT:** *Strongylogaster lata*, n. sp., is described from specimens collected at two sites in Maryland. This species is the first North American representative of a species group previously known only from eastern Asia. It is separated from the North American species of the genus as well as four Asian species. The female sheath and lancet are illustrated.

North American *Strongylogaster* were last revised by Smith (1969) who treated 11 species. Known hosts are ferns. Specimens recently collected in the mid-Atlantic region represent the new species described here. It belongs to a species group of *Strongylogaster* previously known only from four species from eastern Asia and is more closely allied to them than to North American species. We describe this species because it is an important discovery in North America and an integral part of ongoing studies of relationships of world *Strongylogaster* by the junior author.

### *Strongylogaster lata* Smith and Naito, NEW SPECIES

(Figs. 1-4)

**Female Holotype.** - Length, 7.0 mm. Black with small spot at center of clypeus, central spot on lateral pronotum, and lateral posterior margin of pronotum brownish; 9th abdominal segment yellowish; tegula and legs yellowish white to yellow with following black: basal 2/3 coxae, basal 1/3 to 1/2 of femora on inner and outer surface, and outer surface of tarsi. Wings hyaline to very slightly dusky; veins and stigma black except basal fourth of costa yellowish. Antenna 2.3X head width. Head and clypeus finely rugose, meshed, and dull, with smooth and shinier areas on supra-clypeal area and around and between ocelli; clypeus truncate; malar space as broad as interantennal distance; deep postorbital groove present; postocellar area 3X broader than long and with deep pit on each side. Thorax with pronotum finely rugose, meshed, and dull; subshining with fine surface sculpture on rest of thorax except mesosternum, cervical sclerites, mesepimeron, metapleuron, lateral areas of mesonotal lateral lobes, and posttergite shinier than other parts. Abdomen shining with very fine surface sculpture. Forewing without anal crossvein. Hindwing with anal cell petiolate. Sheath long and slender in lateral view, uniformly slender in dorsal view (Figs. 1, 2); lancet as in Figs 3, 4, without ventral teeth and with several spines on annuli between segments.

<sup>1</sup> Received January 3, 1995, Accepted January 4, 1995.

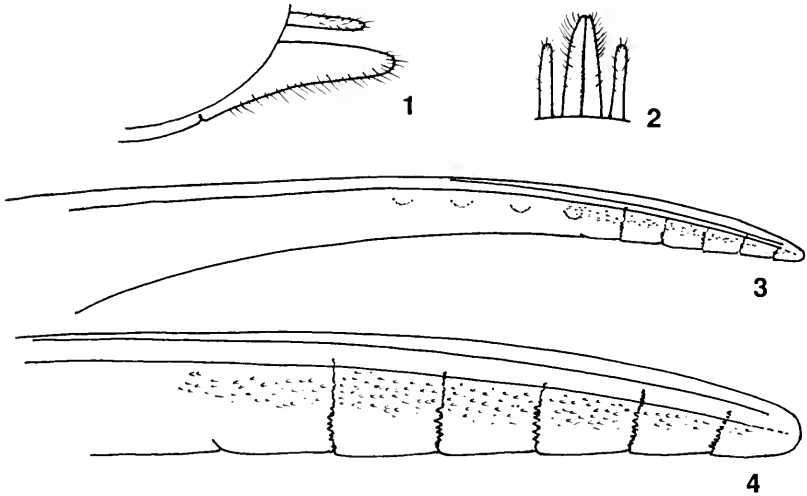
<sup>2</sup> Systematic Entomology Laboratory, PSI, Agricultural Research Service, U.S. Department of Agriculture, c/o National Museum of Natural History, NHB 168, Washington, D.C. 20560, U.S.A.

<sup>3</sup> Entomological Laboratory, Faculty of Agriculture, Kobe University, 1-1 Rokkodai-cho, Nada-ku, Kobe 657, Japan.

**Male.** - Unknown.

**Holotype.** - Female, labeled "MARYLAND: Garrett Co., Finzel Swamp, 2 km S Finzel, Malaise trap, 39°38'N, 79°00'W, 30-VI-9-VII-1992, Barrows & Smith," "Malaise trap #2." Deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

**Paratype.** - MARYLAND: Prince Georges Co., BARC, 24-V-3-VI-1991, C. Allen & C. Lowe, Beltsville Agric. Research Center, Malaise trap #1 (1 female, deposited with holotype). BARC = Beltsville Agricultural Research Center.



Figs. 1-4, *Strongylogaster lata*. 1. Sheath, lateral view. 2. Sheath, dorsal view. 3. Entire lancet. 4. Apical portion of lancet.

## DISCUSSION

For separation from other North American species of *Strongylogaster*, *S. lata* will key to couplet 6 in Smith's (1969) key, the couplet differentiating *S. remota* Rohwer, and *S. polita* Cresson. The narrow and pointed simple sheath and black mesothorax and abdomen place it closest to *S. polita*. It differs from both *S. remota* and *S. polita* by the dull, roughened head and thorax, broad malar space, truncate clypeus, presence of a postorbital groove, short postocellar area, petiolate anal cell of the hindwing, and longer, more slender sheath. Both *S. polita* and *S. remota* have the head and thorax mostly smooth and shining; the malar space less than half the interantennal distance; clypeus with a slight central emargination; lack a postorbital groove; have a longer postocellar area (about  $1\frac{1}{3}X$  broader than long); have a sessile anal cell in

the hindwing; have a shorter, either rounded or acute, sheath (see Smith 1969, figs. 42, 43, 50); and have shorter, stouter lancets (see Smith, 1969, figs. 75, 77).

*Strongylogaster lata* is most closely related to and belongs with four species from eastern Asia which form a distinct group in *Strongylogaster*: *S. osmundae* (Takeuchi) and *S. tambensis* Naito of Japan (Naito, 1980); *S. minuta* Naito and Huang from Sichuan, China (Naito and Huang, 1988); and *S. verzhutskii* Naito from Irkutsk, Russia (Naito, 1990). All have in common the rough sculpturation of the head and usually the thorax, postorbital groove, truncate clypeus, broad malar space, short postocellar area, long and slender simple sheath, and petiolate anal cell of the hindwing. *Strongylogaster tambensis* (Naito, 1980, fig. 26), *S. minuta* (Naito and Huang, 1988, Fig. 8), and *S. verzhutskii* (Naito, 1990, Fig. 4) each have ventral teeth on the lancet and lack strong spines on the annuli separating the segments. The lancet of *Strongylogaster osmundae* (Naito, 1980, fig. 25), however, is very similar to the lancet to *S. lata* as both lack ventral teeth and have rather strong spines on the annuli. However, *S. osmundae* has the head, thorax, and abdomen black with only the tegula whitish; supraclypeal, interantennal area, and ocellar area sculptured as the rest of the head; a shinier mesopleuron and mesonotum; the postocellar area about 2X broader than long; and the hairs on the sheath half or less the length of the hairs on the sheath of *S. lata*.

The paratype from the Beltsville Agricultural Research Center has the head missing, but all features of the remaining parts leave little doubt it is the same species as the specimen from Finzel. It differs from the holotype in coloration as follows: pronotum mostly yellowish laterally, coxae mostly whitish except for extreme bases.

Both specimens were collected in swampy areas. The trap at Finzel Swamp was at the edge of the swamp among various bushes and sedges. The trap at the Beltsville Agricultural Research Center was at the edge of a small lake in a coniferous forest habitat. The host plant for *S. osmundae* in Japan is *Osmunda japonica* Thunb. and that of *S. tambensis* is *Dryopteris sabaei* (Fr. and Sav.) C. Christensen (Naito, 1980). Three species of *Osmunda* and two species of *Dryopteris* are known from Finzel (Brown, 1982) and two species of *Osmunda* and two species of *Dryopteris* are known from the Beltsville Agricultural Research Center (Kirkbride, correspondence). At both sites, some plants of *Osmunda* as well as other ferns were close to the traps.

**Etymology.** - The species name is from the Latin adjective *latus*, with reference to the very broad malar space which is significant for separating *S. lata* from other North American species.

## ACKNOWLEDGMENTS

We thank Edward M. Barrows, Georgetown University, Washington, D.C., for making collections at Finzel and Maryland Nature Conservancy for allowing us to collect at Finzel. We also thank the following for kindly reviewing the manuscript: Henri Goulet, Agriculture Canada, Ottawa; N. Schiff, Bee Research Laboratory, U.S. D. A., Beltsville, Md.; and R. W. Hodges and R. W. Poole, Systematic Entomology Laboratory, U.S. D. A., Washington, D. C.; J. H. Kirkbride, Jr., Systematic Botany and Mycology Laboratory, U.S. D. A., Beltsville, Maryland, provided information on the flora of the Beltsville Agricultural Research Center.

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## MATING BEHAVIOR IN TWO TIGER BEETLES, *CICINDELA DORSALIS* AND *C. PURITANA* (COLEOPTERA: CICINDELIDAE)<sup>1</sup>

Kevin Fielding, C. Barry Knisley<sup>2</sup>

**ABSTRACT:** The copulatory behaviors of two species of tiger beetles were quantified. Mean duration of a complete copulatory sequence was much shorter for *Cicindela d. dorsalis* Say (6.1 min) and for *C. d. media* LeConte (6.2 min) than for *C. puritana* G. Horn (39 min). *Cicindela puritana* also had more pumping of the aedeagus and more reinsertions per pairing than *C. dorsalis*. Furthermore, the copulatory sequence of *C. puritana* differed from that documented from other cicindelids by exhibiting a large number of shallow pumps or movements of the aedeagus without deep insertion. Copulation in the species studied involved only partial withdrawal of the aedeagus and an absence of three clearly defined phases as described for *Pseudoxychila tarsalis* Bates. These differences in copulatory behavior among species and genera of tiger beetles may have important functional and phylogenetic significance.

Relative to many aspects of tiger beetle biology, little has been published about mating, particularly the quantification of copulatory behaviors and the variations among species. Willis (1967) reviewed the earlier literature on mating behavior (Mitchell 1902, Moore 1906, Shelford 1908, Goldsmith 1916) and observed mating in four species. He suggested the following mating behavior was typical of *Cicindela* species: 1. the male pursues the female in short runs until he overtakes her; 2. the male then uses his mandibles to grasp her on the mesepisternal coupling sulcus between the thorax and abdomen; 3. females often resist this behavior by shaking, turning, or rolling over; 4. the male then inserts the aedeagus one or several times within a several minute period; 5. then the male withdraws and dismounts. In some species the male continues "contact guarding" with the mandibles attached to the female (Kraus and Lederhouse 1983).

Palmer (1976) identified a 3-phase copulatory sequence in *Pseudoxychila tarsalis* Bates. The first phase was a deep insertion of the aedeagus, the second a complete withdrawal of the aedeagus and the third phase a deep reinsertion. Several species of *Cicindela* observed by Freitag *et al.* (1980) exhibited similar behavior except that the aedeagus was only partially withdrawn in phase 2. Schincariol (1988) reported the lack of a distinct phase 3 in *C. limbalis* Klug and *C. splendida* Hentz. Palmer (1976) suggested and Schincariol and Freitag (1986) demonstrated that in phase 1 the flagellum of the aedeagus is inserted into the spermathecal duct, possibly to clear it for subsequent transfer of the spermatophore contents in phase 3. These specific male and female mating behaviors thus relate to functional aspects of mating and

<sup>1</sup>August 25, 1994. Accepted October 1, 1994.

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can have a significant influence on sperm transfer precedence and sexual selection strategies in tiger beetles.

These studies and our unpublished observations of mating in several tiger beetle species indicated there are variations in this 3-phase sequence in *Cicindela*. Our study reports on detailed observations and quantifications of the specific copulatory behaviors of two species of tiger beetles, *Cicindela dorsalis* (subspecies *C. d. dorsalis* Say and *C. d. media* LeConte) and *C. puritana* G. Horn.

## MATERIALS AND METHODS

Adult tiger beetles used in these studies were collected (under a USFWS permit, PRT-697823) from the following sites in late June-early July, 1993: *C. d. dorsalis* from Picketts Harbor, Northampton, Co., VA; *C. dorsalis media* from Fishermans Island, Northampton Co., VA; *C. dorsalis media* from Fishermans Island, Northampton Co., VA; (permit from Eastern Shore of Virginia National Wildlife Refuge); and *C. puritana* from Calvert County, MD and from near Cromwell, Hartford Co., CT (permit from CT Department of Game and Wildlife). The *C. dorsalis* and *C. puritana* which survived to the end of the study were returned to the collection sites. The beetles were collected with an insect net and placed in individual vials and transported to the laboratory in a cooler with ice. In the laboratory the beetles were maintained in plastic chambers (18 x 8 x 11 cms) with 3-6 cms of habitat soil and a screened top. The soil was moistened daily with a squeeze bottle. Adult flour beetles (*Tribolium*) and small bits of ground beef were introduced daily as food. Each chamber contained six beetles of one species; all the same sex. Air temperature in the air-conditioned laboratory was maintained at 23-27° C. with a small thermostatically controlled space heater. Soil surface humidity in the chambers was kept high (above 85%) by evaporation from the moist soil surface. Observations of the mating sequence started by placing a pair of beetles onto damp paper toweling covering the bottom of a 2 x 4 x 5 cms plastic chamber. All behaviors were timed on a stopwatch and described on a tape recorder, starting with the male's first attempt at subduing the female. One or more complete mating sequences were observed and recorded for at least 15 pairs of each of the three taxa (see Table 1). Mean numbers and times of the specific copulatory behaviors in the three taxa were compared using Kruskal-Wallis Anova.

## RESULTS

Mating in *C. d. dorsalis* began with the male moving quickly toward the female, then attempting to mount her and fix his mandibles into her coupling

sulcus (a pair of pits on the mesepisternum at the anterior end of the elytra). Mean time from mounting to fixing the mandibles onto the female was 0.57 min (range of 0.02-8.2 min). The female usually shook violently, twisted from side to side or rolled on her back to dislodge the male from amplexus, but was seldom successful (6 of 38 times) (Table 1). Almost immediately after mounting the female and securing his mandibles, the male inserted the aedeagus nearly completely into the female's genital capsule with the top of the male's abdomen almost touching that of the female. Usually the male partially withdrew his aedeagus and reinserted deeply one or several more times (mean of 2.4, range of 1-6 times). This deep insertion or "pumping" involved the male flexing the tip of his abdomen forward, and corresponds to phase 1 of mating sequence Palmer described. Mean duration of phase 1 was 0.94 min (range 0.3-2.8). This was followed by a partial withdrawal of the aedeagus until only the 1-1.5 mm terminal portion (1/3-1/4 of the total length) was inserted. This phase was most comparable to Palmer's phase 2 which involved complete withdrawal. Next, there occurred a series of shallow pumps (mean of 5.8, range of 0-14) which moved the aedeagus only 1-2 mm deeper. Mean duration of this shallow pumping period was 5.2 min (range of 0.8-13.7). This activity most closely corresponds to Palmer's phase 3.

In 94% of the trials, the female attempted to dislodge the male (as described above) when the aedeagus was partially withdrawn. In these cases the male inserted the aedeagus deeply for several seconds, using his forelegs, middle legs or both to subdue the female. After the last shallow pump, the aedeagus was completely withdrawn and the pairing ended with the male retracting his mandibles from the coupling sulcus of the female. Mean duration of the total copulatory sequence, phases 1-3, was 6.12 min. In five of 30 trials, the male did not release his mandibles but continued contact guarding (Kraus and Lederhouse 1983) of the female for a variable length of time. In 9 of 15 cases the male attempted to remate with the female within the 60 min observation period (see below), and in 6 of these cases was successful in repeating the complete sequence. The mean number of complete mating sequences (insertions) within the 1 hour observation time was 2.0 (range 1-4) and the mean duration of pairing (insertion time and contact guarding) was 26.2 minutes.

The mating behavior of *C. d. media* was nearly identical to that of *C. d. dorsalis*, and with only slight differences in most of the parameters (Table 1). *C. d. media* had significantly more ( $p < .01$ ) copulatory sequences per 60 minutes of observation (mean of 3.5) than *C. d. dorsalis* (mean of 2.0).

Mating behavior in *Cicindela puritana* differed from *C. dorsalis* in several significant ways. Females of *C. puritana* usually did not resist the initial

contact by the male and were thus immediately mounted (mount to subdue or mandible insertion interval averaged .02 min). Males also suspended themselves over the female using the middle and hind legs for support instead of resting their abdomens on the female's dorsum. Insertion of the aedeagus usually followed immediately after mounting, but in 3 of 14 cases the male remained in amplexus for several minutes before inserting. The initial insertion of the aedeagus of *C. puritana* was shallow, only 1-2 mm. This was followed by a series of shallow pumps in which the male pivoted at the abdominal-thoracic suture so that his abdomen moved ventral and anterior to its original position. This movement was very different from that in *C. d. dorsalis* which flexed only the abdominal tip, and resulted in only a 1-1.5 mm deeper insertion than when partially withdrawn. The mean number of pumps (all shallow) by *C. puritana* during the complete mating period was significantly greater than for *C. dorsalis* (mean of 16.8 versus 7.4 [ $p < .05$ ]). Also, the interval between pumps was significantly shorter and the duration of the complete copulatory sequence significantly greater in *C. puritana* (38.9 min).

Postcopulatory contact guarding occurred in 14 of 16 cases, for a mean of 3.0 minutes. In several cases the male reinserted and repeated the mating sequence during this period (mean of 1.7 matings). Because of the longer copulatory time and the contact guarding there was little time for repeat mating sequences during the observation period (mean of 1.5 matings per 60 min). Females often mildly resisted the males reinsertion attempt by rapidly rubbing their middle legs against the male's and rolling back and forth. These attempts usually lasted only a few seconds and rarely resulted in the male releasing his grasp and dismounting. Immediately after withdrawal the male rubbed his forelegs against the female's antennae, something not seen in *C. dorsalis*.

## DISCUSSION

Studies of other cicindelids have not included sufficient details of the various copulatory behaviors for an adequate comparison with the species we studied. However, we can make a comparison with the 3-phase mating sequence described in *Pseudoxychila tarsalis* (Palmer 1976). *Pseudoxychila tarsalis* and all species of *Cicindela* studied exhibit the initial grasping behavior and insertion of the aedeagus, although in *C. puritana* there is no deep insertion as seen in the other species. Unlike the complete withdrawal in *P. tarsalis*, all *Cicindela* then withdraw the aedeagus only partially. This most closely corresponds to Palmer's phase 2, but there is nothing comparable to Palmer's phase 3 (the deep reinsertion) in the mating of these *Cicindela*. The pumping and flexing which immediately follows the partial withdrawal may correspond to phase 3. Freitag *et al.* (1980) observed in their study of five

species that there were several deep insertions prior to final withdrawal which they suggested were phase 3. Schincariol (1988) indicated there was no phase 3 in *C. limbalis*, but he did note several pumps during the partial withdrawal phase, which seem to closely match what Freitag observed. Copulation in *C. puritana* was different from all other species described in having only shallow insertion and pumps.

These differences in mating behavior, although minor, may indicate important functional differences or have significant phylogenetic implications. For example, if the initial deep pumps or insertions serve to clear sperm from the spermathecal duct as demonstrated by Freitag *et al.* (1980), the absence of this in *C. puritana* may mean clearing does not occur or may be done in a different manner. The contact guarding in *C. puritana* could be an alternative mechanism of sperm precedence, insuring that the male which is able to mate with and stay complexed with a female will fertilize her eggs. Kraus and Lederhouse (1983) suggested that contact guarding in *C. marutha*, a species very closely related to *C. puritana* and apparently with similar mating behavior, may be associated with the high level of intrasexual competition among males. Both of these species occur at high densities and male-to-male interactions are likely to be frequent.

It seems apparent that since *Pseudoxychila* is regarded as ancestral to the *Cicindela*, the three phase copulatory behavior which it exhibits may be a precursor to the modified mating pattern seen in species of *Cicindela* and/or related to morphological differences in genitalia. This is consistent with the suggestion of Freitag *et al.* (1980) that *Cicindela* has evolved the coupling sulcus (absent in *Pseudoxychila*) as a mechanism to insure successful mating in the more highly active, diurnal tiger beetles. In a similar manner, a more abbreviated mating sequence may have also been selected for in *Cicindela*.

It is hoped that these observations and interpretations will stimulate interest in this important and somewhat ignored aspect of tiger beetle biology. We agree with Schincariol (1988) that a thorough comparative study of mating behavior in tiger beetles is needed.

#### ACKNOWLEDGMENTS

These studies were done as part of a broader study examining mating compatibility among different populations or subspecies of *C. dorsalis* and *C. puritana*. The senior author conducted this work as a part of a biology department research project at Randolph-Macon College. The study was made possible because of the interest and financial support of the U. S. Fish and Wildlife Service, particularly Judy Jacobs (Annapolis, MD Office) and Annette Scherer (Pleasantville, NJ Office). We acknowledge Phil Nothnagle (Windsor, VT) for collecting and sending the Connecticut specimens of *C. puritana*. Sherman Stairs of the Eastern Shore of Virginia National Wildlife Refuge kindly granted permission to collect *C. dorsalis media* at Fisherman Island. We thank Tom Schultz for suggesting revisions to an earlier draft of this paper.

Table 1. Mating parameters for *C.d.dorsalis*, *C.d.media*, and *C.puritana*. Based on 60-90 minute observations for each pair.

Mating parameter	<i>C.d.dorsalis</i>			<i>C.d.media</i>			<i>C.puritana</i>			p value
	n	x	sd	n	x	sd	n	x	sd	
Mount to subdue interval	23	0.57	1.65	16	0.25	0.06	17	0.02	0.06	<0.001
Total number of mounts per 60 min.	16	2.5	1.87	7	4.29	0.91	14	1.5	0.91	>0.05
Pairing time per copulatory sequence	22	26.24	31.66	17	28.34	39.05	19	38.99	37.36	>0.05
Total number of copulations per 60 min.	15	2.0	0.97	6	3.5	0.28	12	1.08	0.28	<0.01
Duration of complete copulatory sequence	19	6.12	5.14	18	6.21	4.72	19	38.99	8.13	<0.01
Interval between copulatory sequences	19	16.38	25.64	22	10.87	15.1	5	29.66	24.13	>0.05
Number of reinsertions per copulatory sequence	26	0.15	0.46	18	0.11	0.46	11	1.73	0.75	<0.001
Interval between reinsertions per copulatory sequence	4	24.8	14.4	2	36.29	19.44	19	7.04	19.44	>0.05
Total number of pumps including all phases ( <i>C.d.m.</i> , <i>C.d.d.</i> , <i>C.p.</i> )	18	7.39	3.51	19	7.68	5.78	25	16.8	13.36	<0.05
Duration of Phase 1 ( <i>C.d.m.</i> & <i>C.d.d.</i> )	19	0.94	0.63	18	1.15	1.09	—	—	—	>0.05
Total number of deep pumps ( <i>C.d.m.</i> & <i>C.d.d.</i> ) (Phase 1)	17	2.41	1.46	17	3.35	2.83	—	—	—	>0.05
Duration of Phase 2 ( <i>C.d.m.</i> & <i>C.d.d.</i> )	19	5.20	4.99	18	5.08	4.44	—	—	—	>0.05
Total number of shallow pumps ( <i>C.d.m.</i> & <i>C.d.d.</i> ) (Phase 2)	16	5.75	3.7	18	4.94	3.89	—	—	—	>0.05
Interval between deep pumps (or pumps for <i>C.p.</i> )	23	0.16	0.05	37	0.17	0.07	100	0.13	0.07	<0.05
Interval between shallow pumps (or pumps for <i>C.p.</i> )	69	0.23	0.08	58	0.23	0.06	104	0.13	0.07	<0.001

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**INSECTS. LIFE CYCLES AND THE SEASONS.** J. Brackenbury. 1994. Blanford, London. Distrib. in U.S. Sterling Publish. Co., 387 Park Ave. South, NY, NY 10016-8810. 9 x 11 format. 192 pp. \$24.95 Hdbk.

This book chronicles some of the intriguing relationships between insects and their life cycles, attuned to the four seasons associated with the temperate climates. With introductory texts for easy, popular reading and with expanded legends accompanying fine photographs, all in color, this book presents a striking pictorial account of these natural sequences. Primarily directed to amateur entomologists and naturalists.

**INSECTS IN FLIGHT.** J. Brackenbury. 1992. Blanford, London. Distrib. in U.S. Sterling Publish. Co., 387 Park Ave. South, NY, NY 10016-8810. 9 x 11 format. 192 pp. \$35.00 Hdbk.

This book shows how insects take an entirely different approach from that of birds in the design of the flight machine. With easily readable texts that both fascinate and entertain and with expanded legends accompanying the many fine photographs, all in color, this book unveils the world of insect flight for the amateur entomologist and naturalist.

## **GUAJIROLUS NANUS (EPHEMEROPTERA: BAETIDAE), A NEW SPECIES FROM COSTA RICA<sup>1</sup>**

C. R. Lugo-Ortiz, W. P. McCafferty<sup>2</sup>

**ABSTRACT:** *Guajirolopus nanus* (Ephemeroptera: Baetidae) is newly described from Costa Rica and the range of the genus is slightly extended northward. The species is compared to the only other nominal species in the genus, *G. ektrapeloglossa*. It is distinguished by possessing lateral spicules on the mandibles; a large, round medial process on the lingua; basal and subapical broad brown bands on the femora; a basal broad brown band on the tibiae; and paraprocts with numerous, uniformly arranged marginal spines. A key to separate the larvae of *G. ektrapeloglossa* and *G. nanus* is provided.

Roback (1966) described and illustrated the larva of a distinct small minnow mayfly (Ephemeroptera: Baetidae) from Peru and provisionally designated it "Genus 3 nr. *Pseudocloeon* Klapálek." Later, Flowers (1985) erected the genus *Guajirolopus* to include *G. ektrapeloglossa* Flowers, a species described from Colombia and Panama, and indicated that Roback's "Genus 3 nr. *Pseudocloeon* Klapálek" clearly belonged to *Guajirolopus*. Flowers (1985), however, did not assign a formal name to Roback's material because Roback's only two specimens available did not allow an adequate morphological assessment.).

In our inventory of the Ephemeroptera fauna of Central America, we discovered that a new species of *Guajirolopus* had been collected from Costa Rica by the second author in 1969. We provide a description and diagnosis of this species below. The material upon which this study is based is housed in the Purdue Entomological Research Collection (PERC), West Lafayette, Indiana, and the United States National Museum (USNM), Washington, D. C.

### *Guajirolopus nanus* Lugo-Ortiz and McCafferty, NEW SPECIES

**Larva.** Body length: 3.0-4.0 mm; caudal filaments: 1.5-1.75 mm. Head: Coloration yellow-brown, with no distinct pattern. Antennae pale, almost half body length. Labrum (Fig. 1) with deep anteromedial emargination, numerous long, fine simple setae dorsally, and row of 15-18 submarginal simple setae ventrally (becoming longer laterally). Right mandible (Fig. 2) 2 + 3 denticles, distal set with distal denticle reduced and situated somewhat laterad, basal denticle very long, basal set with three similarly small denticles; prosthema stout, deeply recessed into mandible; tuft of simple setae between prosthema and molars; short, simple setae distally on molar; numerous minute spicules on surface, most conspicuous on lateral margin. Left mandible (Fig. 3) similar to right mandible, except with thumblike process at base of molar. Maxillae (Fig. 4) elongate; distal denticles elongate; basal setae 1 + 4-5; palps 3-segmented, all segments subequal, extending beyond galealacinia, with scattered fine, simple setae. Labium (Fig. 5) with paraglossae slightly

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longer than glossae, both slightly longer than wide; paraglossae with three apical rows of fine, simple setae; glossae with numerous fine, simple setae and three horizontal series of relatively long, simple setae; series 1 with row of 12-14 simple setae; series 2 with two to three simple setae; series 3 with single subapical simple seta; palps 3-segmented, subequal in length; segment 1 cylindrical and bare; segment 2 laterally expanded anteromedially, with many fine, long, simple setae distally; segment 3 digitate, with many fine, long, simple setae on surface, and apical patch of fine, hooked, simple setae on inner margin. Hypopharynx (Fig. 6) with lingua 3-pointed, with fine, simple setae distally; superlinguae with row of very small, stout, simple setae laterally. Thorax: Nota yellow-brown, with light median stripe. Sterna yellow-brown. Hindwingpads absent. Legs (Fig. 7) slender; forefemora broadened medially, with two rows of 12-14 small, simple setae dorsally, and two poorly defined brownish bands; middle and hindfemora parallel sided, coloration similar to forefemora, with 14-17 very small, simple setae dorsally; fore- and midtibiae with sparse, almost imperceptible simple setae ventrally; hindtibiae with 14-16 very small, simple setae ventrally; tarsi with 14-16 very small, simple setae ventrally; tarsal claws with 11-14 denticles, distal two larger than others. Abdomen: Color yellow-brown, with poorly defined light medial longitudinal stripe on terga 1-9, and tergum 10 pale. Tergal surfaces with numerous angulate scale bases; posterior margin with numerous short, sharp spines. Sternal surfaces with fine spines on posterior margin. Segments 6-7 with posterolateral spines at gill bases. Paraprocts (Fig. 8) with 20-22 marginal spines. Cerci with distinct brownish medial and subapical bands; terminal filament near .75x length of cerci.

**Adult.** Unknown.

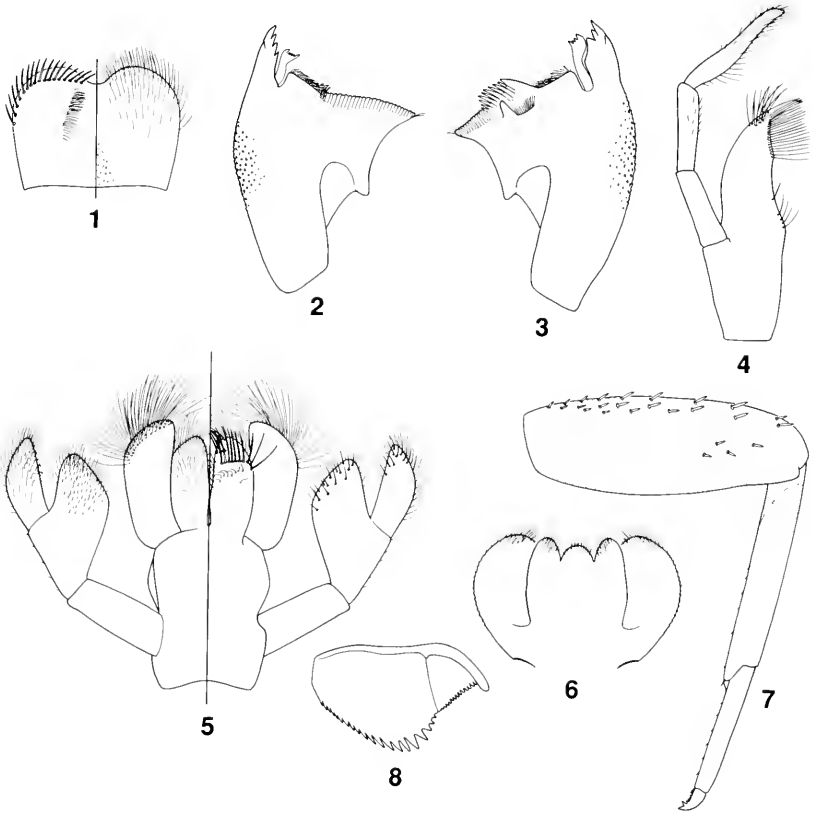
**Material.** Holotype: Male larva, COSTA RICA, Puntarenas Prov., Peninsula de Osa, Río Rincón at end of Playa Blanco Rd, III-3-1969, W. P. McCafferty, deposited in PERC. Paratypes: Two female and two male larvae, same data and deposition as holotype, except one male larva in the USNM.

**Etymology.** The specific epithet is a Latin word meaning small. It is thus an allusion to the small size of the species.

**Diagnosis.** *Guajirolus nanus* is similar to *G. ektrapeloglossa*. The two species differ in several regards, however. First, the mandibles of *G. nanus* (Figs. 2-3) possess minute spicules on the lateral margins, whereas in *G. ektrapeloglossa* those spicules appear to be absent [Flowers (1985): Figs. 6-7]. Secondly, the lingua of *G. nanus* (Fig. 6) has a relatively large, round medial process, whereas in *G. ektrapeloglossa* that process is small and pointed [Flowers (1985): Fig. 8]. Thirdly, the femora of *G. nanus* have broad brown bands basally and subapically, and the tibiae have a broad brown band basally (Fig. 7); *G. ektrapeloglossa* only has a broad brown subapical band on the femora [Flowers (1985): Fig. 13]. Finally, the paraprocts of *G. nanus* (Fig. 8) have numerous small marginal spines arranged in a more orderly manner than in *G. ektrapeloglossa* [Flowers (1985): Fig. 17].

### Key to the Larvae of *Guajirolus*

1. Femora with broad brown subapical band [Flowers (1985): Fig. 13]; paraprocts with unorganized spination [Flowers (1985): Fig. 17] . . . . . *ektrapeloglossa*
- Femora with broad brown basal and subapical bands (Fig. 7); paraprocts with organized spination (Fig. 8) . . . . . *nanus*



Figures 1-8. *Guajirolus nanus* larva: 1. Labrum (left-ventral; right-dorsal). 2. Right mandible. 3. Left mandible. 4. Right maxilla. 5. Labium (left-ventral; right-dorsal). 6. Hypopharynx. 7. Left foreleg. 8. Paraproct.

#### ACKNOWLEDGMENTS

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## DESCRIPTION OF ADULTS OF *BAETIS NOTOS* (EPHEMEROPTERA: BAETIDAE)<sup>1</sup>

Richard S. Durfee, B. C. Kondratieff<sup>2</sup>

ABSTRACT: Male and female adults of *Baetis notos* are described for the first time. Males of this southwestern species are distinguished from other described species of the *B. fuscatus* group by the creamy white coloration tinged with yellow. Biological notes for this species are given.

*Baetis notos* Allen and Murvosh (1987) was described from a single larva from Catron Co., New Mexico. Morihara and McCafferty (1979) had previously described this species as *Baetis* sp. C from a series of larvae from Arizona and New Mexico. *Baetis notos* has been included in the *Baetis fuscatus* group. The larvae in this group are characterized by short, broad labial palpi, reduced paraglossae, and similar pronotal markings (Morihara and McCafferty 1979). Other Nearctic species currently placed in this group are *B. caurinus* Edmunds and Allen, *B. flavistriga* McDunnough, *B. intercalaris* McDunnough, *B. ochris* Burks, and *B. rusticans* McDunnough (Morihara and McCafferty 1979). Recently, Waltz (1995) concluded that *B. ochris* was a synonym of *B. flavistriga*. *Baetis flavistriga* and *B. intercalaris* are known from both adults and larvae. *Baetis notos* is known from larvae only, and the remaining two species in this group are known only from adults.

During July 1993, a series of male adults tentatively determined as *B. notos* was collected from a stream in the Gila National Forest, New Mexico. Subsequent collecting and rearing from this site during July 1994 confirmed the association. The following descriptions are based on specimens preserved in alcohol. Comments on the coloration of live specimens follow these descriptions.

### *Baetis notos* Allen and Murvosh

**Adult Male** (in alcohol).—Length of body 5.0-5.5 mm, forewings 4.5-5.0 mm, hindwings 1.0 mm, caudal filaments 13-14 mm. Head ivory with small orange mark below each lateral ocellus between compound eye and scape; compound eyes purple-black; stalk of turbinate eyes ivory, light orange dorsally; ocelli with purple-black ring around base; antennae light orange brown. Thorax ivory dorsally, white ventrally. Coxae and trochanters white; femora, tibiae and tarsi ivory with narrow brown shading at tarsal articulations; claws smoky brown. Forewings hyaline; longitudinal veins and crossveins light brown; intercalaries well-developed and light brown; stigmatic area cloudy with much anastomosing. Hindwing with well-developed costal projection and three longitudinal veins (Fig. 1), sometimes with an intercalary between veins 2 and 3. Abdominal terga 2-6 translucent, 7-10 opaque white, terga 1-9 tinged with light yellow. Abdominal segments 1-7 with purplish tracheation laterally. Sterna 2-6 translucent, with slight yellow tinge, 7-9 opaque

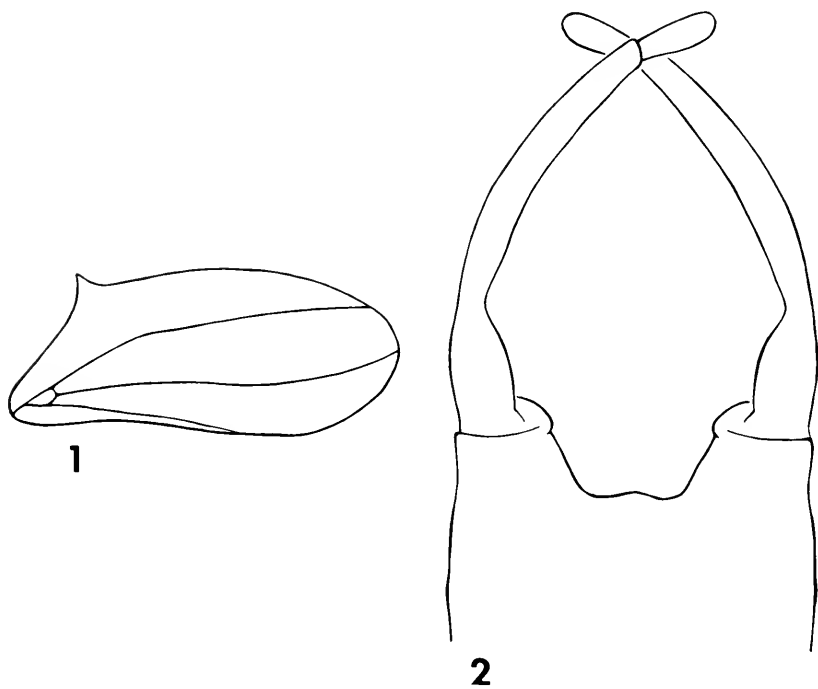
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white. Genital forceps white and of the *intercalaris* type with a small projection on the mesoapical edge of the first segment and a strong constriction near the basal third of second segment (Fig. 2). Caudal filaments white, light brown at articulations.

**Adult female** (in alcohol).— Length of body 6.0-6.5 mm, forewings 6.0-6.5 mm, hindwings 1.0-1.1 mm, caudal filaments 13-14 mm. Head light brown with orange tinge; compound eyes purple-black; ocelli with purple-black ring around base; antennal scapes and pedicels light brown, flagella smoky. Thorax light brown dorsally, ivory ventrally. Femora and tibiae light brown; tarsi smoky brown. Forewings hyaline; veins and intercalaries medium brown. Hindwings as in male. Abdominal terga light brown. Tracheation well-defined laterally on segments 2-8 and extending dorsally on segments 2-6. Abdominal sterna 1-6 translucent, appearing light yellow from eggs, 7-9 opaque white. Caudal filaments as in male.

**Material examined.**— *B. notos*: Catron Co., NM, Taylor Creek, below Wall Lake, 21 July 1993, R. Durfee, 29 males; Taylor Creek, below Wall Lake, 24 July 1994, B. Kondratieff and R. Durfee, 2 males, 6 females (reared) and 28 males.



Figures 1 and 2. *Baetis notos*, male adult. 1. hindwing, 2. male genitalia, ventral view.

## DISCUSSION

Although the larvae of *B. notos* possess distinctive, dark markings on the thoracic nota and abdominal terga (Moriyama and McCafferty 1979, Allen and Murvosh 1987), the adults lack any prominent markings. Live male adults are strikingly creamy white in color and tinged with bright lemon yellow on the face, antennae, dorsal surface of the compound eyes, femora, and abdomen. The only dark markings, except for the abdominal tracheation, are the claws, the articulations of the caudal filaments, and the narrow light orange-brown transverse bands on the posterior margins of abdominal terga 1-9 (not apparent in alcohol preserved specimens). This light coloration makes them highly visible during nuptial flights at dusk, and easily separable from other sympatric adult baetids. Live females are darker than the males, with an overall light brown coloration. They are also tinged with lemon yellow on the face, antennae, legs, and abdomen.

The hindwings of both males and females (Fig. 1) have a well developed costal projection and three longitudinal veins. Approximately 20% of the specimens examined possessed an intercalary between veins 2 and 3. Additionally, one male specimen possessed a hindwing with a forked second longitudinal vein. Variations in hindwing venation of *Baetis* spp. have been discussed by Durfee and Kondratieff (1993). Male genital forceps are of the *intercalaris* type with a small projection on the mesoapical edge of the first segment and a strong constriction near the basal third of second segment (Fig. 2).

Adult males of *B. notos* are very similar to the description of *B. caurinus* Edmunds and Allen (1957), a species reported only from Lincoln Co., Oregon. The adults of this species can be separated from *B. notos* by their darker coloration and markings. However, the discovery of the larvae of *B. caurinus* will be necessary to resolve any relationships.

*Baetis notos* is known from Arizona, Colorado (McCafferty *et al.* 1993), New Mexico, Texas (McCafferty and Davis 1992), Utah (North Fork Virgin River, Zion National Park, 16 July 1988, C. P. Gillette Museum of Arthropod Diversity, Colorado State University), and Veracruz, Mexico (Lugo-Ortiz and McCafferty 1994).

Males were observed swarming in small groups at dusk very near the waters' surface in riffle areas. Collecting these specimens required skimming the surface of the water with an aerial net. No female adults were observed or collected in the field; however, the majority of *B. notos* larvae collected on 24 July 1994 were female. This may indicate that most of the males had emerged earlier. In addition, a series of mature larvae were collected from this site on 28 April 1994 suggesting at least two generations per year.

Other mayflies that were found along with *B. notos* in Taylor Creek and surrounding streams included: *Acentrella insignificans* (McDunnough), *B. tri-caudatus* Dodds, *Camelobaetidius* spp., *Fallceon quilleri* Dodds, *Leptohyphes apache* Allen, *Tricorythodes minutus* Traver, *Epeorus margarita* Edmunds and Allen, *Epeorus longimanus* (Eaton), *Nixe criddlei* (McDunnough), *Isonychia intermedia* (Eaton), *Siphonurus occidentalis* Eaton, *Choroterpes inornata* Eaton, *Paraleptophlebia* sp., *Thraulodes arizonicus* McDunnough, and *Traverella castanea* Kilgore and Allen.

Taylor Creek also supports high densities of such interesting species of caddisflies as *Hydropsyche californica* Banks, *Cheumatopsyche* cf. *gyra* Ross, *Ochrotrichia* cf. *argentea* Flint and Blickle and *Chimarra utahensis* Ross.

#### ACKNOWLEDGMENTS

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## ***BAETIS OCHRIS*, A NEW SYNONYM OF *BAETIS FLAVISTRIGA* (EPHEMEROPTERA: BAETIDAE)<sup>1</sup>**

R.D. Waltz<sup>2</sup>

**ABSTRACT:** A comparative study of the reared larva of *Baetis ochris* led to the discovery that its larva is symmorph with the larva of *Baetis flavistriga*. Adult characters used to separate *Baetis ochris* from other *Baetis* species have been demonstrated to be variable and do not generally constitute substantiating species characters within the *Baetis fuscatus* species group. *Baetis ochris* is placed as a junior subjective synonym of *Baetis flavistriga*.

Among Nearctic *Baetis* Leach, several species are yet unknown as larvae (e.g., see Morihara and McCafferty 1979, Table 1). Previous works of Bergman and Hilsenhoff (1978) and Morihara and McCafferty (1979) have indicated several species synonyms in Nearctic *Baetis* based on the rearing of adults and association of their larvae.

The species, *Baetis ochris*, was originally described by Burks (1953) based on three male imagoes taken from Richmond, Illinois. R.L. Hall (1985) reported the collection of *Baetis ochris* in his study of mayflies of southeastern Ohio. A loan of Hall's material was requested and studied as a part of ongoing revisionary and taxonomic works on the Baetidae. Receipt of the requested material resulted in the discovery of one male larval exuviae associated with a reared adult bearing the following collection data: OH: Guernsey Co., 16-V-1975, 2 mi NW of Salesville nr. T 475, small stream, R.L. Hall (deposited at Ohio State University). This species has not previously been described in the larval stage.

The reared larval exuviae was slide mounted (euparal: abs. alc.) and compared in detail with *Baetis flavistriga* McDunnough, with which the larva of *B. ochris* most closely compared based on existing keys. No morphological or significant color pattern differences were found to separate the two species as larvae. Further, adult characters separating *B. ochris* from other nominal *Baetis* species are characters that have been demonstrated to be variable by previous workers in *Baetis* (Bergman and Hilsenhoff 1978; Morihara and McCafferty 1979). In particular, the relative size of the marginal intercalaries in the first three interspaces of the forewing and minor differences in degree of body pigmentation have been found to be variable in species previously synonymized with *B. flavistriga* (see Morihara and McCafferty 1979). Based on the discovery of symmorph larval forms and consideration of the previously demonstrated adult variability, *Baetis ochris* Burks is placed as a junior subjective synonym of *Baetis flavistriga* McDunnough, NEW SYNONYM.

<sup>1</sup> Received November 14, 1994. Accepted December 7, 1994.

<sup>2</sup> IDNR, Division of Entomology and Plant Pathology, 402 West Washington, Room W-290, Indianapolis, IN 46204.

The following summarizes the taxonomic history of *Baetis flavistriga*:

**Baetis flavistriga** McDunnough

- Baetis flavistriga* McDunnough, 1921: 120.  
*Baetis phoebus* McDunnough, 1923: 41.  
*Baetis nanus* McDunnough, 1923: 43.  
*Baetis pallidulus* McDunnough, 1924: 8.  
*Baetis levitans* McDunnough, 1925: 216.  
*Baetis cingulatus* McDunnough, 1925: 216.  
*Baetis quebecensis* Hubbard, 1974: 358.  
*Baetis ochris* Burks, 1953: 132. NEW SYNONYM.

ACKNOWLEDGMENTS

I thank R.L. Hall and Ohio State University, Entomological Collection, Columbus, Ohio, for loan of the reared *Baetis ochris* material. I thank W.P. McCafferty and A.V. Provonsha, Purdue University Entomological Research Collections, West Lafayette, Indiana, for use of comparative study materials of *Baetis*.

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## A NEW SPECIES AND NEW SYNONYM IN THE *HYPOGASTRURA* (S. STR.) *NIVICOLA* GROUP (COLLEMBOLA: HYPOGASTRURIDAE)<sup>1</sup>

J.W. Hart,<sup>2</sup> R.D. Waltz<sup>3</sup>

**ABSTRACT:** Springtails of the *Hypogastrura* (s. str.) *nivicola* group are cyclomorphic species more commonly known as snowfleas. Recent study of the Indiana species of *Hypogastrura* (s. str.) has resulted in the discovery of a new species, *H. simsi* n. sp. and a new synonym within the *H. nivicola* group. The new species is closely related to the palearctic *H. lapponica* but is distinct from that species on the basis of its size, lack of clavate body setae, differences in the mucro/dens ratios, and color differences. *Hypogastrura simsi* will key to *H. tooliki* in the most recent keys to the species of Nearctic *Hypogastrura* but clearly differs by its diminutive size at maturity, elongation of the dentes beyond the distal apex of the mucro, and PAO:eye ratio as well as other characters. Summer and winter morph forms are described for *H. simsi*. *Hypogastrura indiana*, is identified as a junior subjective synonym of *H. harveyi*, New Synonym, based on morphological similarities and on observed transformation between the two forms.

The present division of the genus *Hypogastrura* (s. str.) into distinct species groupings (Yosii, 1960, 1962; Christiansen and Bellinger, 1980, 1992) is at best difficult (however, also see Fjellberg, 1980, 1984, 1985). Eight species of this subgenus have been collected in Indiana. These eight species may be placed into three of five groups defined previously by Christiansen and Bellinger (1980, 1992) as follows: *Nivicola* group – cyclomorphic species that have both a summer and winter form. The winter form possesses thorn-like tubercles on the dentes. All species possess a single, strong, clavate tenent hair in the lower or 1-row (Yosii, 1962) of each tibiotarsus and 4+4 tenacular teeth. Five species of the *nivicola* group were studied in Indiana: *H. nivicola* (Fitch), 1847; *H. packardi* (Folsom), 1902 (= *H. notha* (MacNamara), 1922, winter form of *packardi*, see Waltz and Hart, 1985); *H. harveyi* (Folsom), 1902 (= *Hypogastrura indiana* Christiansen and Bellinger, 1980, summer form of *harveyi*, see below); *H. sparta* Christiansen and Bellinger, 1980, known only as a summer form; and *H. simsi* n. sp. *Viatica* group – species with multiple tenent hairs and 3+3 tenacular teeth. One species of the *viatica* group is known in Indiana: *H. distincta* (Axelson), 1902. *Manubrialis* group – species with a single tenent hair not as strong as in the *nivicola* group, and 4+4 tenacular teeth. Two species of the *manubrialis* group are known in Indiana: *H. manubrialis* (Tullberg), 1869; and *H. assimilis* (Krausbauer), 1898, (= *H. pannosa* (MacNamara), 1922, Babenko, in litt; = *H. essa* Christiansen and Bellinger, 1980, see Fjellberg, 1985).

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*Hypogastrura indiana* is distinct among included species of the *packardi* group (sensu Christiansen and Bellinger) because of the large number of lateral setae of the ventral tube (8+8 or more). It is among the species characterized by the possession of 1+1 setae in the area verticalis including *H. copiosa* (Folsom), *H. funesta* Christiansen and Bellinger, and *H. madera* Christiansen and Bellinger.

Within the *nivicola* group (sensu Christiansen and Bellinger), *H. harveyi*, like *H. indiana* above, is distinct among the included species on the basis of the large number of lateral setae of the ventral tube (11+11 or 13+13). Only *H. harveyi* and *H. nivicola* possess an area verticalis of 1+1 within the *nivicola* group.

Based on the morphological similarities of *H. indiana* and *H. harveyi* we investigated the possibility that these were summer and winter forms of the same species. Specimens transforming from *H. harveyi* to *H. indiana* were identified and compared to the type of *H. indiana*. We herein place *H. indiana* Christiansen and Bellinger, 1980, as a junior subjective synonym of *H. harveyi* (Folsom), 1902, NEW SYNONYM.

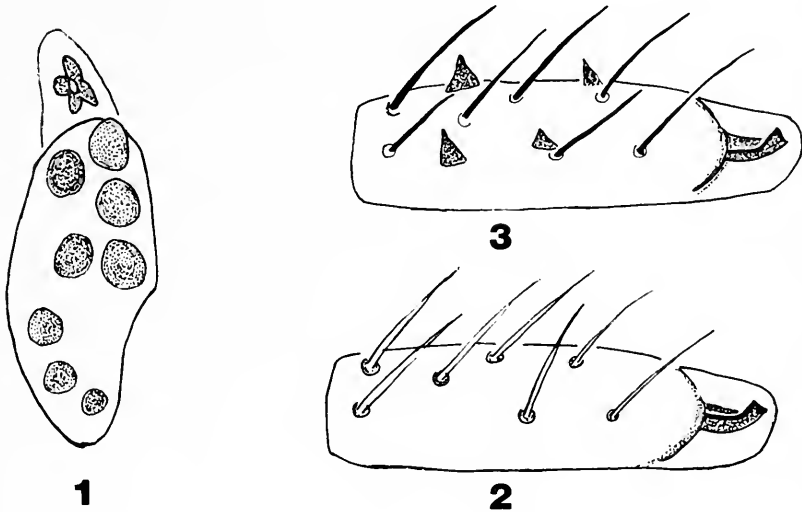
Below we describe a new species of the *nivicola* group.

### *Hypogastrura* (s. str.) *simsi* NEW SPECIES

**Description.** Color: light, yellowish brown. Size: largest individual less than 1.0 mm in length. Head: Antennal segment IV with apical bulb elongate and simple; six dorsal blunt setae. No ventral file. Normal antennal III organ present. PAO (Fig. 1) subequal in diameter to nearest eye. Eyes (Fig. 1) 8X8 with seven eyes subequal to the others and one eye slightly smaller. Area verticalis setae, 2+2. Maxilla typical of the subgenus, strong and hook-like. Sublobal setae of outer lobe, 2. **Body:** Body granulations coarse. Ungues with small tooth approximately one-third from apex. Tenent hair of 1 row well developed and weakly clavate. Ventral tube with 4+4 lateral setae. Tenacular teeth 4+4. Seta ml present on abdominal IV. Largest setae of Abd. V and VI acuminate, only slightly longer than other body setae and minutely, unilaterally serrate. Small anal spines on well defined papillae; spines subequal in length to length of papillae.

**Furcula:** Dentes of summer form (Fig. 2) with fine granulations dorsally, approximately 10x length of mucro and extending beyond distal end of mucro as a large, lateral projection; with seven dorsal setae. Dentes of winter form (Fig. 3) with fine granulations dorsally, and with three or four triangulate tubercles, of which one is typically more sharply pointed than the others, dentes approximately 7x length of mucro and extending beyond distal end of mucro as in summer form, and seven dorsal setae.

**Material.** All types were collected from the Hart Farm located: Indiana: Wayne Co., Washington Twp., near Milton, SW 1/4 Sec. 33, T16N, R19E. (Slidemounted type material). HOLOTYPE: In: Wayne Co., Milton, Hart Farm, 27-II-1985, male (winter form), slidemounted (Marc Andre:water sol.), deposited USNM. PARATYPES. 22-III-1981, female (summer form), slidemounted (Marc Andre:water sol.); 10-IV-1985, female (summer form with winter exuviae), slidemounted (Marc Andre:water sol.); 8-IV-1985, female (summer form), slidemounted (Marc Andre:water sol.); 26-III-1985, female (summer form), slidemounted (Marc Andre:water sol.); 25-I-1980, (winter form), slidemounted (Marc Andre:water sol.); 30-I-1982, (winter form), slidemounted (Marc Andre:water sol.); 13-II-1983, male (summer form), slidemounted (Marc Andre:water sol.); 22-



Figures 1-3. *Hypogastrura simsi* n.sp. 1. Eye patch and PAO. 2. Dentes (summer form). 3. Dentes (winter form).

III-1981, male (summer form), slidemounted (Marc Andre:water sol.); 9-III-1983, female (summer form), slidemounted (Marc Andre:water sol.); 25-I-1980, male (winter form), slidemounted (Marc Andre:water sol.); 6-IV-1985, female (summer form), slidemounted (Marc Andre:water sol.); 10-IV-1985, male (summer form – molting) slidemounted (Marc Andre:water sol.); 10-IV-1985, slidemounted (Marc Andre:water sol.); 10-IV-1985, slidemounted (Marc Andre:water sol.); 10-IV-1985, slidemounted (Marc Andre:water sol.); 10-IV-1985, slidemounted (Marc Andre:water sol.); 30-I-1982, female (winter form), slidemounted (Marc Andre:water sol.); 25-I-1980, male (winter form), slidemounted (Marc Andre:water sol.); 22-III-1981, 3 males (winter and summer forms), slidemounted (Gisin's medium:water sol.). (Fluid/Alcohol preserved type material). 6-IV-1985, 2 specimens; 8-IV-1985, 12 specimens; 8-IV-1985, 10 specimens; 10-IV-1985, 5 specimens; 10-IV-1985, 16 specimens. Paratypes are deposited at Purdue University, West Lafayette, IN; Illinois Natural History Survey, Champaign; and the US National Museum, Washington, D.C.

**Etymology.** *simsi* – possessive patronymic epithet of Robert and Opal Sims, to whom this species is dedicated, who purchased the land on which this species was discovered and studied, and who are relatives (in-laws) of J.W. Hart.

**Diagnosis.** *Hypogastrura simsi* is smaller (< 1mm in length at maturity) than any described Nearctic species of the *nivicola* group and is easily differentiated from *H. tooliki* to which it most readily keys by the shape of the mucro, the unusual extension of the dens beyond the tip of the mucro, and the PAO:nearest eye ratio. This new species is apparently most closely related to the palearctic species *H. lapponica* (Axelson), 1902, (see Gisin, 1960, Fjell-

berg, 1980, Leinaas, 1981a) from which *H. simsi* differs by the absence of clavate body setae on the tibiotarsi and abdominal segments, differences in body color, and *H. simsi* is distinctly smaller than *H. lapponica*.

### BIOLOGY

*Hypogastrura simsi* shares a similar biology with previously reported Nearctic (Folsom, 1902) and European (Lienaaas, 1981a, b) species of this group. Leinaas (1981a) provided detailed information on the biology of *H. lapponica* most of which is easily applied to our (JWH) observations of *H. simsi*. However, our data differs significantly from that reported by Leinaas (1981a) in that both summer and winter forms of *H. simsi* are known from the subcortical habitat. Summer and winter morph forms have been collected from beneath the bark of felled red mulberry (*Morus rubra*), ash (*Fraxinus* sp.), and American beech (*Fagus grandifolia*). Rarely have specimens been collected outside the subcortical habitat, possibly indicating a strong behavioral preference for the subcortical habitat. Specimens molting from the winter form to the summer form are known from a range of dates beginning in late February (II-27) to early April (IV-10).

### ACKNOWLEDGMENTS

We thank Jon Coddington, USNM for loan of the type of *Hypogastrura indiana* used to confirm our identification of this species and the synonymy reported herein.

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## NEW SPECIES, STAGE DESCRIPTION, AND RECORDS OF *BAETODES* (EPHEMEROPTERA: BAETIDAE) FROM MEXICO AND CENTRAL AMERICA<sup>1</sup>

C. R. Lugo-Ortiz, W. P. McCafferty<sup>2</sup>

**ABSTRACT:** *Baetodes deludens*, n. sp., is described from larvae from Costa Rica. *Baetodes pictus* is newly described from male and female adults and its range extended to include Sonora. *Baetodes deficiens* is newly reported from Sonora and Costa Rica. *Baetodes fuscipes* is newly reported from Guatemala. *Baetodes longus* is newly reported from Nuevo León. *Baetodes noventus* and *B. tritus* are newly reported from Costa Rica.

Needham and Murphy (1924) erected the genus *Baetodes* for *B. serratus* Needham and Murphy, a species from Brazil that they described from larvae only. These larvae and all those known since are consistently discernible from other small minnow mayflies (family Baetidae) by their possession of very long legs, ventrally oriented gills on abdominal segments 1-5, tergal tubercles, and stout subapical setae on the claws.

Additional species of *Baetodes* have been described from the Western Hemisphere by Traver (1943, 1944), Demoulin (1955), Mayo (1968, 1972, 1973), Koss (1972), Cohen and Allen (1972, 1978), and McCafferty and Provonsha (1993). When subsequent synonyms (Edmunds 1974, Cohen and Allen 1978) and recombinations (Flowers 1987) are considered, it brings the past total of species of *Baetodes* to 30. Of these, 13 are known from South America, five are known from North America (mainly Mexico), seven are known from Central America, and five are known from both North and Central America. Lists of *Baetodes* species for the various regions may be found in Hubbard and Peters (1981), McCafferty and Waltz (1990), and McCafferty and Lugo-Ortiz (1995). Herein we add one new species from Central America.

We also provide the first description of adults of one species, so that seven of the 30 species are now known as adults. Whereas larvae of *Baetodes* are among the most distinctive of all Baetidae, adult generic characterization has been problematic. Traver (1943) associated the first known adults of the genus with respect to the Venezuelan species *B. spinifer* Traver. She based this association on the presence of remnants of larval abdominal tubercles and very long tibiae on the adults. Koss (1972) questioned Traver's assignment of such adults to *Baetodes* because of variations from *B. spinifer* that he found in

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reared adults of *B. edmundsi* Koss. Koss (1972) and Edmunds *et al.* (1976) indicated that the hind margin of the forewing of *Baetodes* adults was subparallel to the costal margin, that interspaces between marginal intercalaries of the forewings were subequal to the intercalary lengths, and that these characteristics were diagnostic for the genus. Flowers (1987), however, did not find these characteristics present in his reared adults of *B. tritus* Cohen and Allen and *B. velmae* Cohen and Allen. We also have found these characters unreliable for generic identification [see also McCafferty and Provonsha (1993)]. Flowers (1987) suggested the use of the mesal projection of the first segment of the male forceps, the tibia to femur ratio of the male forelegs, and the attenuated metanotal projection to identify *Baetodes* adults. More species must be known as adults to confirm this.

*Baetodes* has evident Neotropical affinities (McCafferty and Waltz 1990). On the basis of demographic data McCafferty *et al.* (1992) hypothesized that the genus had a recent Mesoamerican center of dispersal. However, McCafferty *et al.* (1992) also indicated the most plesiomorphic species of the genus occur in South America, suggesting an origin in that continent. In addition, *Baetodes* shares a number of synapomorphies with the Neotropical genus *Moribaetis* Waltz and McCafferty, and evidently does not share any apomorphies with Nearctic baetid lineages (Waltz, pers. comm.).

Following is an alphabetical treatment of the new species and species for which we provide a new stage description and new distributional records from Mexico and Central America. The material examined for this report is housed in the Purdue Entomological Research Collection (PERC), West Lafayette, Indiana, and the collection of Florida A & M University (FAMU), Tallahassee.

### *Baetodes deficiens* Cohen and Allen

**Material examined.** COSTA RICA, Guanacaste Prov., Río Tenorio at Finca La Pacífica, E of Panamerican Hwy, II-2-11-1969, W. P. McCafferty, larvae, deposited at PERC; MEXICO, Sonora Sta, stream E of Yécora, VIII-24-1986, B. C. Kondratieff, larva, deposited at PERC.

**Discussion.** *Baetodes deficiens* has a widespread distribution in Central America and Mexico (see Mayo 1972, Cohen and Allen 1972, Flowers 1987, Lugo-Ortiz and McCafferty 1994). McCafferty (1985) identified the Costa Rican material as *B. caritus* Cohen and Allen, but it agrees more with the description of *B. deficiens* as modified by Flowers (1987), and the records should be rectified. Cohen and Allen (1978) described the larva of this species. Flowers (1987) described the male and female subimagos. Adults remain unknown.

*Baetodes deludens* Lugo-Ortiz and McCafferty, NEW SPECIES

(Fig. 1)

**Larva.** Body length: 3.2 mm; caudal filaments: 3.5 mm. Head: Coloration pale brown. Area between frontal suture and median ocellus medium brown, forming inverted V. Area surrounding coronal suture medium brown. Antennae pale brown; scapes and pedicels bare. Labrum narrower than interantennal distance, with anteromedial emargination and sclerotized cleft line at midline of anteromedial emargination; five to six long, simple setae arranged in row anteriorly. Right mandible [as in Cohen and Allen (1978): Fig. 2] 4 + 3 denticles; simple setae present between protheca and molar. Left mandible [as in Cohen and Allen (1978): Fig. 3] 3 + 3 denticles, distal denticle much larger than remainder and appearing worn; no setae between protheca and molar; short triangular process at base of molar. Maxillae robust; maxillary palps extending almost as far as galealacinia; palp segment 2 almost twice as long as segment 1, with very fine, simple setae distally. Labium slender; palp segment 1 almost as long as segments 2 and 3 combined; segment 2 subequal to 3; segment 3 ellipsoidal, with short, robust and long, fine, simple setae distally; glossae shorter than paraglossae, with four to five long, simple setae laterally; paraglossae with three to four distal rows of long, simple setae. Thorax: Color medium brown, with no distinct pattern. Notae bare; pro- and mesonotum with pair of very small, submedian nodules; metanotum darker than pro- and mesonotum, with well-developed median tubercle. Sterna cream to pale brown. Hindwingpads absent. Fingerlike coxal gills double and longer than median length of trochanters. Legs cream to pale brown, except for sclerotized rounded apices of femora, distal ends of tibiae (especially ventrally), and tarsal claws; dorsal margin of femora with eight to nine long clavate setae (distal two setae almost contiguous and parallel to each other), with numerous long, slender, simple setae between clavate setae, and ventral margin bare, except for almost imperceptible, robust, simple setae; tibiae with numerous long, slender, simple setae dorsally, one to two long, robust, simple setae distally, many short, stout, simple setae ventrally, and two short, robust simple setae distally; tarsi with scattered fine, simple setae dorsally and seven to eight short, robust setae ventrally; tarsal claws with five to seven small denticles. Abdomen (Fig. 1): Color medium brown, with distinct pattern. Terga 1-6 with dark brown anterior and posterior margins, width of dark margins in terga 5-6 somewhat reduced compared to anterior terga; terga 7-9 with dark anterior margins, width of dark margin in tergum 9 reduced and somewhat faded; tergum 10 pale brown. Dorsal median tubercles on terga 1-9, well developed and erect on terga 1-4, well developed and somewhat angled on tergum 5, well-developed and strongly angled on terga 6-7, and poorly developed on terga 8-9. Sterna cream to pale brown. Gills rounded, ventrally oriented, and pale; gill 5 highly reduced relative to anterior gills. Caudal filaments cream to pale brown.

**Adult.** Unknown.

**Material examined.** Holotype: Female larva, COSTA RICA, Puntarenas Prov., Río Jaba at rock quarry, 1.4 km (air) W of Las Cruces, 1150 m, 8.79°N/92.97°W, VI-14-1986, Holzenthal, Heyn, Armitage, deposited at PERC. Paratypes: Two male larvae, same data as holotype, deposited at FAMU and PERC. Additional material examined: Two immature female larvae, same data and deposition as paratypes.

**Etymology.** The specific epithet is a Latin word meaning deceptive. It is an allusion to the similarity of this species to other species in the genus with tubercles on terga 1-9.

**Discussion.** *Baetodes deludens* will key to *B. noventus* with Cohen and Allen's (1978) key on the basis of the presence of tubercles on terga 1-9. However, it differs from *B. noventus* in the presence of two coxal gills on every leg and in abdominal coloration (Fig. 1). It also appears somewhat similar to *B. bibranchius* McCafferty and Provonsha, but differs from that species in its abdominal coloration and the orientation of the abdominal tubercles.

*Baetodes fuscipes* Cohen and Allen

**Material examined.** GUATEMALA, Solala Prov., Río at Panajachel, I-16-1989, B. C. Kondratieff, larva, deposited at PERC.

**Discussion.** *Baetodes fuscipes* is known from northwestern and eastern Mexico south to Honduras (see Mayo 1972, Cohen and Allen 1972, Allen and Murvosh 1987). The new record from Guatemala was thus expected. The species is known only from the larval stage (Cohen and Allen 1972).

*Baetodes longus* Mayo

**Material Examined.** MEXICO, Nuevo León Sta., Río Ramos, XII-20-1939, L. Berner, larva, deposited at PERC; Santiago, XII-20-1939, L. Berner, larvae, deposited at PERC.

**Discussion.** *Baetodes longus* was previously known from Tamaulipas only (Mayo 1973). The new records from Nuevo León slightly extend the known range of the species and suggest that it may occur in southwestern United States also. The species is known from larvae only.

*Baetodes noventus* Cohen and Allen

**Material examined.** COSTA RICA, Heredia Prov., Quebrada Salto in SW section of teaching area at La Selva, II-25-1969, W.P. McCafferty, larva, deposited at PERC.

**Discussion.** *Baetodes noventus* has a widespread distribution in Central America (see Cohen and Allen 1972). The new record from Costa Rica slightly extends its known range southward. The species is known from the larval stage only.

*Baetodus pictus* Cohen and Allen

(Fig. 2)

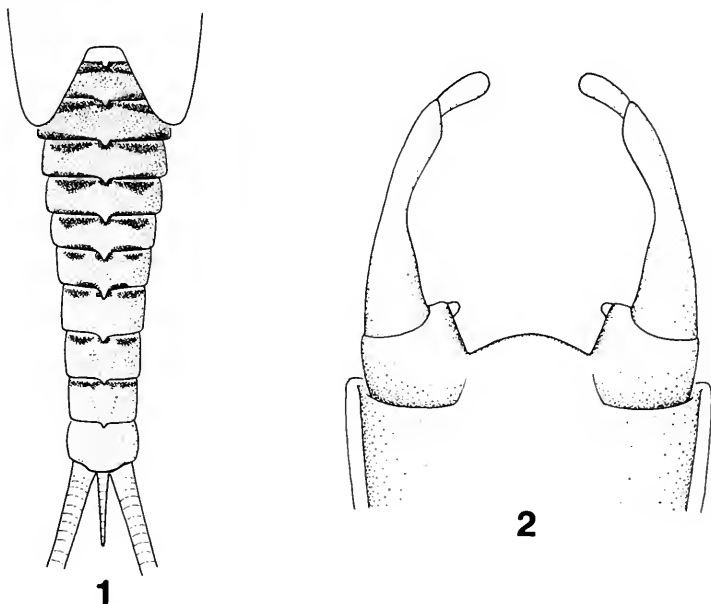
**Material examined.** MEXICO, Chihuahua Sta., Río Gavalón, Gavalón Ranch, VIII-25-1986, B. C. Kondratieff, male and female adults, deposited at PERC.

**Male Adult.** Body length: 5.0 mm; wing: 5.0 mm; caudal filaments: unknown. Head: Face brown. Flagella, scapes, and pedicels light brown. Compound eyes black, except turbinate portion yellow. Thorax: Notum medium brown. Sterna pale brown, paler medially. Legs pale brown. Wings basally tinged with brown, particularly in basal region of costal area. Abdomen: Tergal color pattern as in Figure 11 of Cohen and Allen (1978). Tubercle remnants on terga 1-7; those on terga 8-9 inconspicuous. Sterna light brown. Genitalia as shown in Figure 2, with well-developed inner lobes on basal segments of forceps.

**Female adult.** Body length: 5.0 mm; wing: 5.3 mm; cerci: unknown. Body more robust than male. Abdominal coloration lighter than in male. Basal tinged of wings more intense.

**Discussion.** The male and female adults of *B. pictus* have not been described previously. The materials examined have the distinct abdominal





Figures 1-2. 1. *Baetodes deludens*, n. sp., larva, abdomen, dorsal view. 2. *Baetodes pictus*, male genitalia, dorsal view.

color pattern of the larva of *B. pictus*. Moreover, they have conspicuous remnants of tubercles on terga 1-7, and are within the size range provided by Cohen and Allen (1972, 1978) for the larvae. There are no discernible tubercle remnants on terga 8-9, but Cohen and Allen (1972, 1978) stated that those tubercles are difficult to see on the larvae. Therefore, the specimens described above are provisionally placed under *B. pictus*. The species was previously known from Veracruz only (Cohen and Allen 1972, 1978). The new record from Chihuahua extends its range northwestward.

### *Baetodes tritus* Cohen and Allen

**Material examined.** COSTA RICA, roadside seep, Rt 2 W of km 234, 8.976°N/83.299°W, 100m, II-20-1986, Holzenthal, Morse, and Fash, larvae, deposited at FAMU.

**Discussion.** *Baetodes tritus* is known from northeastern Mexico south to Panama (see Cohen and Allen 1972, 1978; Flowers 1987). The record from Costa Rica was thus expected. The species was originally described from the larva only (Cohen and Allen 1972). Flowers (1987) redescribed the larva and described the egg, female subimago, and male adult.

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**A NEW IBERIAN SPECIES OF *PROTAPANTELES***  
**(HYMENOPTERA: BRACONIDAE)**  
**ASSOCIATED WITH THE ENDEMIC MOTH**  
***HELIOTHEA DISCOIDARIA***  
**(LEPIDOPTERA: GEOMETRIDAE)<sup>1</sup>**

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**ABSTRACT:** The genus *Protapanteles* (Hymenoptera: Braconidae) is recorded for the first time from the Iberian Peninsula. *Protapanteles santolinae*, a new Spanish species of the subfamily Microgastrinae, associated with the endemic moth *Heliothea discoidaria* which feeds on some endemic plants of the genus *Santolina* (Compositae), is described and illustrated. Moreover, it is compared with the allied species *Protapanteles triangulator* (Wesmael, 1837).

The Iberian Peninsula is one of the most peculiar areas of the Palearctic region. Its relative isolation from the rest of Europe, owing to the Pyrenees, as well as its proximity to Africa, makes it one of the most interesting centres of speciation in the Mediterranean area (Quézel 1978; López Martínez 1989). The result is a substantial number of endemic taxa, which quite often spread to zones as far away as the Maghreb. A recent study of the entomofauna associated with the genus *Santolina* (Compositae) has permitted us to discover a new species belonging to the genus *Protapanteles* (Braconidae: Microgastrinae), as well as to document a new and interesting parasitoid- host- plant relationship.

From a floral viewpoint, the Iberian Peninsula stands out as one of the most important zones in the Mediterranean region (with 7,500 species in Spain and 3,500 in Portugal), only slightly surpassed in diversity by the Turkish peninsula (Quézel 1985). The situation is repeated in a quite similar way in the Maghrebian area which also displays a high floral diversity, whose origin and evolution can only be explained from the Iberian microplate (Quézel 1983). Also, the Iberian entomological fauna, closely associated with the vegetable structures (Yela 1992), presents an identical diversity increase (Viedma & Gómez-Bustillo 1976; Balletto & Casale 1991; Baixeras 1992; Domínguez & Baixeras 1992). This endemic situation has also been detected in other arthropod and invertebrate groups (Sacchi 1962; Miracle 1982; Giusti & Manganeli 1984; Notenboom 1990; Ellis 1978; Margalef 1983), as well as in some families of vertebrates (Busack & Hedges 1984; Salvador

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1985; Hernando & Soriguer 1992). All this points to the Iberian Peninsula as one of the most significant areas of endemism in the Palearctic region.

The genus *Santolina* includes five species in the Iberian Peninsula (*S. oblongifolia*, *S. elegans*, *S. viscosa*, *S. rosmarinifolia* and *S. chamaecyparissus*). Only *S. chamaecyparissus* (Figure 1) has a vast distribution, colonizing most of the western Mediterranean (the central and southern part of the Iberian Peninsula, south of France, Italy, Corsica and Sardinia, as well as northern Africa). In contrast, the remaining species have distributions restricted to the Iberio-Maghrebian area (Guinea and Tutin 1976). It is usual to find these species in highly nitrophilic habitats, such as roadsides, fallow land, etc., as well as in large expanses of moorland and shrub steppe, accompanied by species of the genus *Artemisia* (basically *A. herba-alba* and *A. campestris*). It is also frequently observed along relict wood fringes with Spanish juniper (*Juniperus thurifera*), which occupy the most barren and xeromorphic zones in the centre of the peninsula and in the river Ebro depression (Monegros) (Braun-Blanquet & Bolós 1957).

The endemic character of these Compositae is of importance from the entomological point of view. A great number of endemic moths in the Iberian Peninsula, and the western Mediterranean area, feed on plants of this genus, as is the case for *Coleophora santolinella* Constant, *Coleophora involucrella* Chrétien, *Coleophora albicella* Constant (Coleophoridae), *Sophronia santolinae* Staudinger (Gelechiidae), *Stenodes peucedana* Ragonot, *Stenodes santolinana* Staudinger (Tortricidae), *Phyllophila numerica* Boisduval, *Cucullia santolinae* Rambur (Noctuidae), *Thetidia plusiaria* Boisduval, *Eupithecia santolinae* Mabille, *Athrolopha pennigeraria* Hübner or *Compsoptera jourdanaria* Serres (Geometridae). Likewise the presence of other groups of insects has been reported to have a close relationship with these plants, as illustrated by the family Aphididae with the aphids *Colorado moralesi* Remaudière & Leclaut and *Colorado bournieri* Remaudière & Leclaut, found only in the Iberian Peninsula and in the south of France (Remaudière & Leclaut 1969), as well as the cecidomyiid family with *Rhopalomyia santolinae* Tav., *Dictyomyia navasina* Tav., *D. setubalensis* Tav. and *Navasina santolinae* Tav., endemics in the Iberian Peninsula (Tavares 1900, 1902, 1919; Vilarrúbia 1936).

### *Protapanteles santolinae* Oltra, NEW SPECIES

A new species belonging to the genus *Protapanteles* Ashmead, 1898 is described, according to the generic concept of *Protapanteles* adopted by Mason (1981). He split the old *Apanteles* s. l. into 23 genera, including *Protapanteles* (the members of Nixon's *triangulator* and *popularis*-group of *Apanteles* Foerster). The criteria adopted for the identification of the species studied are based on Nixon (1973, 1976), Papp (1984) and Wilkinson (1945).

**Female.** - Head (Figure 4): Covered with fine setae, transverse, a little narrower than mesosoma between the tegulae. Face shiny with superficial, confluent punctuation. Antenna shorter than body (3:4), flagellomeres 10-15 cubic (Figure 5), flagellomere 9 subcubic. Facial depression nearer apex of clypeus than eye. Hind imaginary tangent of anterior ocellus not touching posterior ocellus. Face very slightly transverse. Length of temple slightly greater than one fourth the length of eye. Temples convergent and slightly angular. Longitudinal diameter of eye somewhat greater than one half times transverse diameter.

**Mesosoma** (Figure 6): Mesoscutum covered with fine setae, shiny with faint satin-like sheen, throughout with confluent punctuation; scutellum shiny with minute, virtually obsolete, sparsely placed punctures, the non-excavated area of lateral faces of the scutellum reaching up beyond middle of scutellum very slightly; phragma of scutellum narrowly visible. Propodeum mostly smooth and shiny, towards posterior corners with more or less rugulosity; polished lunule of foramen with crenulate sculpture; two groups of setae latero-medially convergent towards medial line.

**Legs:** Hind coxa smooth, shiny; inner spur of hind tibia longer than outer and scarcely reaching middle of basitarsus.

**Wings** (Figure 8): Pterostigma 2.28 - 2.5 (2.5 in holotype) times as long as wide, metacarpus virtually same length as pterostigma, its distance from apex of SR1 somewhat less than a third of its own length; r arising from middle apically of pterostigma and forming obtuse angle with 2-SR, r and 2-SR subequal in length; discal cell (D1) very slightly longer than high (1.05 - 1.13), 1.06 in holotype; vannal lobe of hindwing straight and hairless.

**Metasoma** (Figures 7, 9 and 10): First tergite parallel-sided to where it turns over, thence rounded at its hind end, very slightly excavated in about the basal third, smooth and shiny except in about the very weakly to obsolete rugose apical third or fourth with setae; median field more or less triangular-pentagonal shape because of its posterior corners losing definition and obscured in an area of vague rugosities with scattered setae, second tergite polished excepting the rugose zone; third tergite longer than second (4:3) and polished with medial or posterior scattered setae as the succeeding tergites; oviposygium very short, non truncate apex seen in profile; ovipositor sheaths short (Figure 9).

**Color:** Body black, labial palpi dark, maxillar palpi with dark basal and apical joints and infusate yellow middle joints. Legs mainly dark; coxae, trochanters, basal three-fourths of middle and hind femora, apical three-fourths to half of hind tibiae black; the front and middle tibiae, the front, middle and hind tarsi mostly brown. Basal front and middle tibiae, basal front and middle basitarsi, half to third basal hind tibia, half hind basitarsus and apical extreme hind femur infusate reddish yellow; spurs reddish yellow more or less infusate. Tegula black. Wings hyaline; the C+Sc+R and 1R1 (pterostigma + metacarpus) veins brown; r, 2-SR and pigmented portion of 2-M veins light brown; pterostigma not uniformly opaque, downwards darker than basal and apical zones; majority of remaining veins colorless.

**Male.** Antenna about equal to the combined length of mesosoma and metasoma together with twice the length of the head; the preapical flagellomeres at least as long as 1.6 times its width; legs very dark, infusate zones very reduced.

**Length.** - From 1.8 to 2mm. Holotype: 2mm.

**Cocoon.** - Length 2.5 mm, yellow, in groups because of its gregarious behavior. From 6 to 27 cocoons for each caterpillar.

**Distribution.** - Rincón de Ademuz (Valencia-Spain) and Villanueva de Alcorón (Guadalajara - Spain).

**Material examined.** - 31 type specimens (17 ♂♂ and 14 ♀♀) with different locality and collecting-time data.

**Type material:** Villanueva de Alcorón (Guadalajara), 4-VII-92, 1 ♀ holotype, 3 ♂♂ and 5 ♀♀ paratypes (leg. M. Domínguez); Rincón de Ademuz (Valencia), 20/21-VI-92, 14 ♂♂ and 8 ♀♀ paratypes (Leg. M. Domínguez).

Other material examined: Villanueva de Alcorón, 4-VII-92, 3 ♀♀ (leg. M. Domínguez); Rincón de Ademuz, 20/21-VI-92, 4 ♀♀ (leg. M. Domínguez); id., 25-VI-93, 1 ♀ (leg. M. Domínguez).

Holotype and paratypes are deposited in the Entomological Collection of the University of Valencia (Spain). Two paratypes (1 ♂ and 1 ♀) are deposited in the Hungarian Natural History Museum (Budapest).

**Comments.** - This species can be distinguished from *P. triangulator* (Wesmael, 1837), its most similar Palearctic relative, by its possession of the following combination of features:

<i>P. santolinae</i>	<i>P. triangulator</i> (Wesm.)
-♀: flagellomeres 10-15 cubic.	-♀: flagellomeres 10-15 distinctly longer than wide.
-Pterostigma less wide, 2.28-2.5 times as long as wide; D1 high, as long as high.	-Pterostigma wider, twice as long as wide; D1 less high, somewhat longer than high.
-Propodeum mostly smooth and shiny, towards posterior corners with more or less rugulosity.	-Propodeum usually medially or medially and latero-posteriorly uneven to rugulose, shiny.
-Inner spur of hind tibia obviously longer than outer.	-Hind tibial spurs equal or subequal.
-Median field of metasomal tergite 2 less wide, with rather triangular-pentagonal shape (Figure 10 B).	-Median field of metasomal tergite 2 wider, with rather triangular shape (Figure 10 A).
-Cocoon yellow.	-Cocoon white or very pale yellow.
-Host: <i>Heliothea discoidaria</i> Boisd. (Geometridae).	-Host: <i>Pseudoterpna pruinata</i> Hufn. (Geometridae), another macrolepidoptera and some microlepidoptera.

*Pseudoterpna pruinata* was the first host record for *P. triangulator*. In addition, other hosts have been mentioned in the literature: *Teichobia verhuellella* Stt. (Tineidae), *Bedellia somnulentella* Z., *Phyllonorycter strigulatella* Z. (Gracillariidae), *Coleophora ballotella* Fr., *Coleophora gryphipennella* Bché. (Coleophoridae), *Tortrix viridana* L. (Tortricidae), *Ellopija prosapia* L., *Peribatodes rhomboidaria* Den. et Schiff. (Geometridae), *Amphipyra pyramidea* L. (Noctuidae), *Dasychira pudibunda* L. (Lymantriidae), *Stauropus fagi* L. (Notodontidae) and *Strymon w-album* Knoch (Lycanidae) (Papp 1990).



Fig. 1



Fig. 2

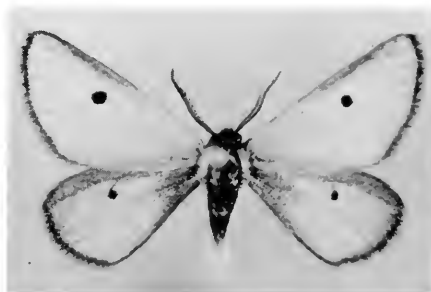


Fig. 3

Figure 1-3. 1, *Santolina chamaecyparissus* in a typical fallow land in Central Spain. 2, Last instar larvae of *Heliothea discoidaria*. 3, Adult of *H. discoidaria* moth.

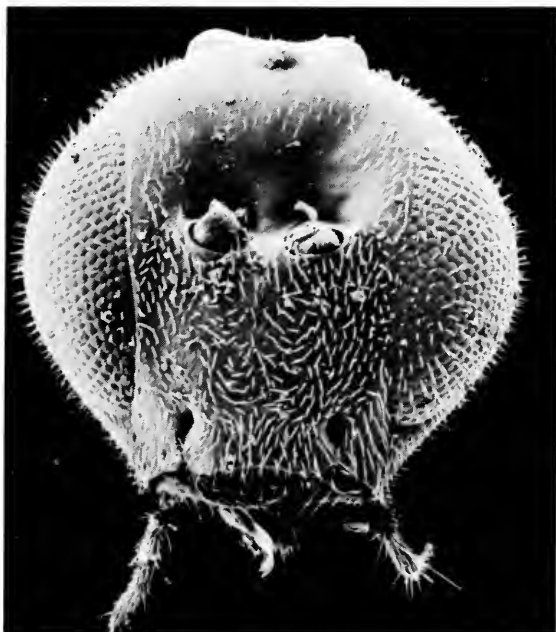


Fig. 4



Fig. 5



Fig. 6



Fig. 7

Figure 4-7. *Protapanteles santolinae*. 4, Head. 5, Apical flagellomeres of a female. 6, Mesosoma. 7, Metasoma showing the peculiar basal tergites.



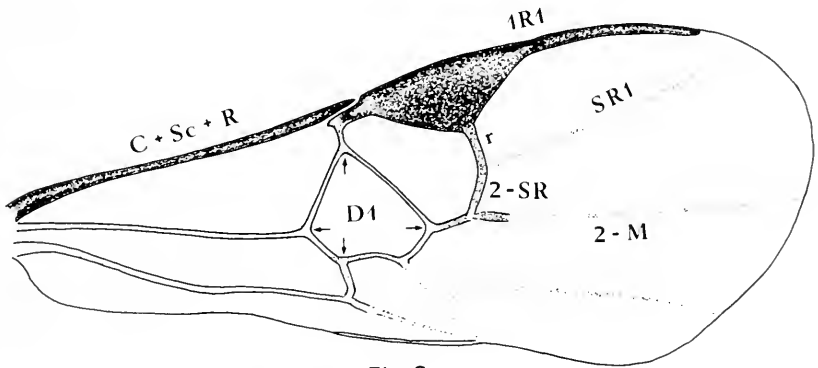


Fig. 8

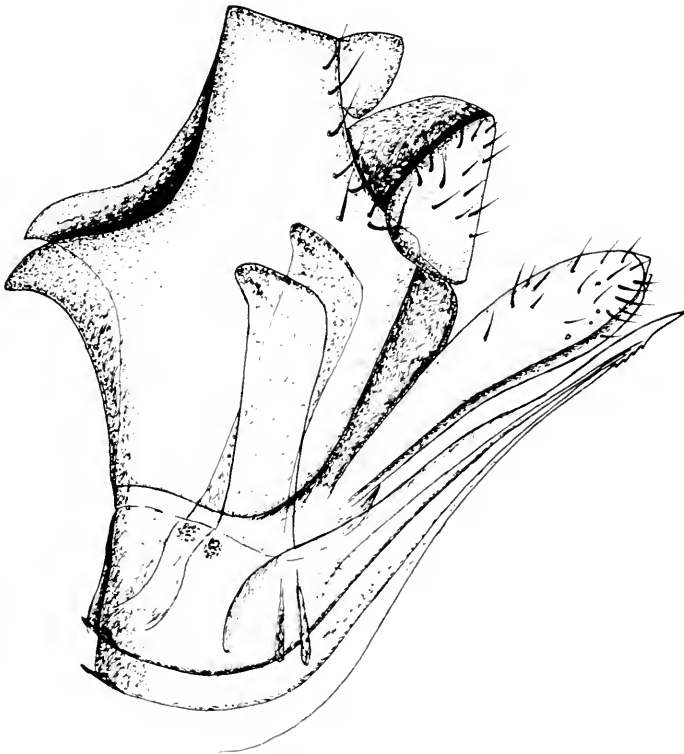


Fig. 9

Figure 8-9. *Protapanteles santolinae*. 8, Right forewing of a female (slide number 83). 9, Female genitalia (side number 85).

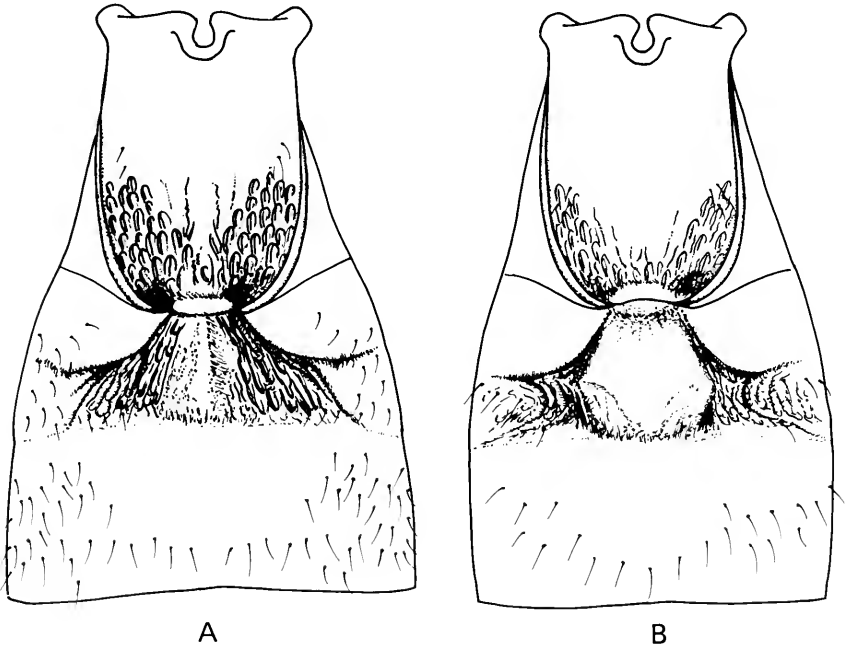


Figure 10. Basal tergites of *Protapanteles triangulator* (A) and *P. santolinae* (B).

#### DISCUSSION

Before starting our study of the entomofauna related to *Santolina*, the genus *Protapanteles* was unknown from the Iberian Peninsula. This is a small genus containing no more than thirty species; however, some species may be fairly common in the forested parts of the Holarctic Region (Mason 1981). This genus comprises 14 species in Europe, mainly parasitoids of Geometridae (Papp 1990). The present study is our first one of a planned series about this genus; surprisingly, we came to discover a new species, *Protapanteles santolinae*, a parasitoid found on the geometrid moth *Heliothea discoidaria* (Figure 2 and 3). In this way, a new parasitoid-host-plant relationship has been documented, closely associated with this group of Compositae. Up to the present, observations suggest the evolution of a peculiar and exclusive entomofauna on the species of the *Santolina* genus.

We consider it important to emphasize the endemic character of this lepidopteran, which is the only member of the Heliotheinae subfamily, and has only been found in the center of the Iberian Peninsula and in a few places in Morocco (Rungs 1982). The food plant of this species, *Santolina*

*rosmarinifolia*, was discovered in San Ildefonso (Segovia) and in the outskirts of Madrid (Chrétien 1905; Gómez de Aizpúrua 1987), and later it has also been captured feeding on *Santolina chamaecyparissus* in different places of the Iberian Peninsula.

With regard to the parasitoid, both *Protapanteles santolinae* n. sp. and *P. triangulator* have straight and hairless vannal lobes of the hind wing, an aberrant feature within *Protapanteles*. However, for the time being, we consider both species as included in this genus. If in the future new species with this peculiarity, accompanied by other significant characters, are discovered, then the possibility of describing a new genus should be considered.

When Mason (1981) established different tribes and genera from the genus *Apanteles* Förster s. l., he stressed the importance of the structures of the jaw and papillae of the tegument in full-grown larvae. Therefore, we believe the study of the *Protapanteles* larvae can provide valuable data which, added to the observations made earlier on adults, will allow entomologists to consider the proposal for a new generic taxon.

#### ACKNOWLEDGMENTS

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# ENTOMOLOGICAL NEWS

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(Continued on inside of back cover)

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## DIVERSITY AND PHENOLOGY OF TUMBLING FLOWER BEETLES (COLEOPTERA: MORDELLIDAE) CAPTURED IN A MALAISE TRAP<sup>1</sup>

J. A. Jackman<sup>2</sup>, C. R. Nelson<sup>3</sup>

**ABSTRACT:** Adult mordellid beetles were monitored at Brackenridge Field Laboratory in Austin, Texas from January 1990 through December 1990 using a Malaise trap. A total of 754 specimens representing 35 species (17% of the North American fauna) and one subspecies were taken in this study. Twenty-eight of the species and one subspecies are recorded for the first time from Texas. Specimens were collected as early as March 13-19 and as late as November 27-December 3. Up to 19 species, nearly 10% of the mordellid fauna of North American north of Mexico, were collected in a single week. However, 19 (52%) of the taxa reported in this study were represented by five or fewer specimens indicating that most species were relatively rare. The seasonal flight pattern indicated a unimodal flight activity pattern for the family and also for most species.

The Brackenridge Field Laboratory (BFL), located in Austin, Texas, is operated by the University of Texas at Austin and consists of approximately 50 hectares (80 acres) of land which has been used for a variety of purposes during its recent history. For the past 25 years the land comprising BFL has been a preserve and field laboratory used by researchers and students for various ecological and behavioral studies, e.g., Porter and Savignano (1990). BFL, with its juxtaposition of relatively undisturbed and disturbed areas presents an interesting mosaic of plant species available to various herbivores, such as tumbling flower beetles (Mordellidae). Ongoing studies of the diversity of insect species present at BFL are being conducted by researchers there. A goal of these studies is a more complete knowledge of the entire insect community at a single site in the ecologically rich central Texas area. This study of mordellid beetles complements extensive surveys of other taxa, such as digger wasps (Sphecidae), moths, robber flies (Asilidae), bees, ants, leaf-footed bugs and Odonata. This survey also intends to spur interest in other researchers so that comparisons of similar communities in different ecoregions and biotic provinces can be made. An ancillary goal of this study is to provide researchers in central Texas with an indication of groups of particular ecological concern. For instance, the rich assemblage of mordellid beetles brought to light during this study could be the impetus for additional work of general ecological interest in addressing questions of competition, niche sep-

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aration, adaptation, and other interspecific interactions. The amazing diversity of 30 species in the single genus *Mordellistena* at one site should pique research interest in this group. The family Mordellidae was chosen for particular study because it is easily recognized, relatively diverse but not overwhelming in numbers, poorly documented from the area, and species can be recognized by the senior author. This study summarizes data on Mordellidae from a Malaise trap operated at BFL to determine the species present, the phenology and to provide baseline data on this family for future comparisons to similar data from other locations and habitats.

## MATERIALS AND METHODS

**Location.** BFL is bordered on the south by Town Lake (formed by a dam on the Colorado River), on the north by a road and golf course, and by housing developments on the east and west. The land south of Town Lake where it borders with BFL is sparsely covered with houses with intervening areas of more or less natural assemblages of plants dominated by Ashe juniper (*Juniperus ashei* Buchholz) and several species of oak (*Quercus* spp. especially live oak, *Q. virginiana* Miller and Spanish oak, *Q. texana* Buckley). A possible corridor of colonization connects BFL with large tracts of land on the Edward's Plateau of the Texas Hill Country but is more isolated from the blackland prairie and post oak savannah to the east by the highly urbanized portion of Austin. BFL is a particularly interesting site for the study of geographical insect distribution because of its location on the border of these significant biotic provinces (Blair 1950).

Of the 50 hectares approximately 40 are in a natural or nearly natural state. The four most apparent community types are: dry uplands (29 ha or 58%), riparian floodplain (11 ha or 22%), disturbed old fields (8 ha or 16%) and managed grasslands (2 ha or 4%). Other habitats with distinctive communities include rocky outcrops, spring seeps, lake margins, and lentic aquatic. In general, the plant communities of BFL are diverse with over 378 species having been collected on the tract (Gary Baird, personal communication). Dominant and apparent trees characteristic of the riparian floodplain include pecan (*Carya illinoensis* [Wangenheim] K. Koch), cottonwood (*Populus deltoides* Marshall), and large hackberry trees (*Celtis laevigata* Willdenow). The drier uplands, in contrast, are dominated by Ashe juniper, live oak (*Quercus virginiana* Mill.), cedar elm (*Ulmus crassifolia* Nuttall), and exotic species of privet (*Ligustrum* spp.). The grasslands of BFL have diverse assemblages of grasses including, among others, little bluestem (*Schizachyrium scoparium* [Michaux] Nash), side-oats grama (*Bouteloua curtipendula* [Michaux] Torrey), Bermuda grass (*Cynodon dactylon* L.), and King Ranch bluestem (*Bothriochloa ischaemum* L.) A few of the disturbed sites around BHL are plowed

yearly and used for plantings of *Phlox drummondii* Hooker, sunflowers (*Helianthus annuus* L.) and cotton (*Gossypium* sp.).

**Trapping.** We used a Malaise trap of the Townes design (Townes 1972) with darkened lower panels and a mesh of approximately 20 X 24 strands per inch. The trap was operated continuously at the same location for the duration of the study. The insects were collected into alcohol at intervals of approximately one week from January 1990 to the end of December 1990. A few weekly samples were lost because the trap was damaged by wind or the trap collecting head was broken. Specific trapping intervals which yielded mordellids were: March 13-19, March 20-26, March 27-April 2, April 2-9, April 9-16, April 16-25, April 26-30, May 1-7, May 8-14, May 15-21, May 22-28, May 29-June 4, June 5-11, June 12-18, June 19-25, June 26-July 2, July 3-9, July 10-16, July 17-23, July 24-30, July 31-August 6, August 7-13, August 22-28, August 28-September 3, September 4-10, September 11-17, September 18-24, September 20-26, and November 27-December 3. Intervals not yielding mordellids are noted by zeroes in Figs. 1 & 2.

The trap was placed across a path in rather dense woodland which separated two small meadows. The path was suspected to serve as a flyway between the meadows and was selected to concentrate and intercept insects in this area. The trap was located near BFL enclosure 5 at the upstream margin of the riparian woodland and was flanked by a small man-made pond of approximately 25 m<sup>2</sup> in surface area. The trap was beneath the canopy of pecan and hackberry trees and was positioned such that it was never in direct sunlight.

Mordellid specimens were sorted from the bulk trap samples and stored in 70% ethanol before being air dried and mounted. Specimens were identified primarily using Liljeblad (1945) supplemented with Ray (1936, 1944, 1946a, 1946b, 1946c, 1947), Khalaf (1971), and Jackman (1991). New state records were determined using Bright (1986) and Jackman (1991). Specimens collected during this study were deposited in the collection at the University of Texas in Austin and in the collection of the senior author.

## RESULTS

**Diversity.** A total of 754 specimens representing 35 species and one subspecies were taken in this study and all of them were assigned to described species. The most abundant taxa collected were *Mordellistena convicta* LeConte (111 specimens), *M. andreae ancilla* LeConte (99 specimens), *M. blatchleyi* Liljeblad (66 specimens), *M. splendens* Smith (64 specimens), *Paramordellaria carinata* (Smith) (64 specimens), *M. hebraica* LeConte (51 specimens), *M. pustulata* (Melsheimer) (52 specimens) and *M. andreae ustu-*

*lata* LeConte (46 specimens). These 8 taxa were represented by 553 specimens or 73% of the total specimens. Species that were represented by only a single specimen were: *Mordellistena ferruginoides* (Smith), *M. infima* LeConte, *M. lecontei* Ermisch, *M. masoni* Liljeblad, *M. nubila* (LeConte), *M. rubrifascia* Liljeblad and *M. vapida* LeConte. Estimates of diversity using the chart of Southwood (1978) William's alpha statistic used as an estimate of diversity, was approximately 8 ( $\pm 8\%$  SE).

**Phenology.** Specimens were collected as early as March 13-19 and as late as November 27-December 3. During the week of May 15-21, 101 specimens were captured which represents 13% of the total captured in the study. There were 19 species represented during that week which was 53% of the species captured throughout this study or almost 10% of the entire mordellid fauna from North America north of Mexico.

Specimens taken from May 1 to June 4 represented 45% of the specimens and 69% of the species collected in this study. Specimens taken from April 9 to July 2 represented 89% of the specimens and 94% of the species collected

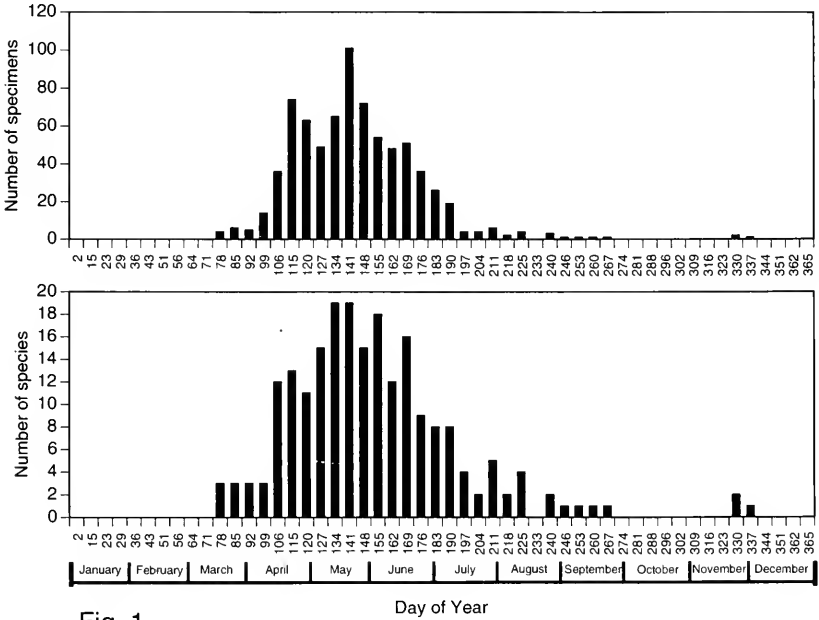


Fig. 1

Figure 1. Seasonal pattern of number of specimens and number of species of adult Mordellidae collected in a Malaise trap at Brackenridge Field Laboratory in Austin, Texas from January 1 through December 31, 1990.

in this study. Both number of specimens and number of species have basically a single peak during the year (Fig. 1) with only a few species collected in the fall.

**Single Species Example.** Trap data for *Mordellistena andreae* were selected as an example of the phenology of a single species because it was well represented in the samples and to detect a possible difference in chronology between the two subspecies. A visual comparison of the chronology of trapped adults of these two subspecies of *Mordellistena andreae* was prepared (Fig. 2). The date ranges of the adults of these two subspecies coincided closely providing little evidence of temporal separation. There is a slight tendency for *ustulata* to be later in the season with the midpoint of adult catch about 2 weeks later than that for *ancilla*. This variation in chronology of trapped adults may be partly due to sample size (99 vs. 46) or subspecies assignment. Specimens that were difficult to assign to subspecies were assigned to *ancilla*.

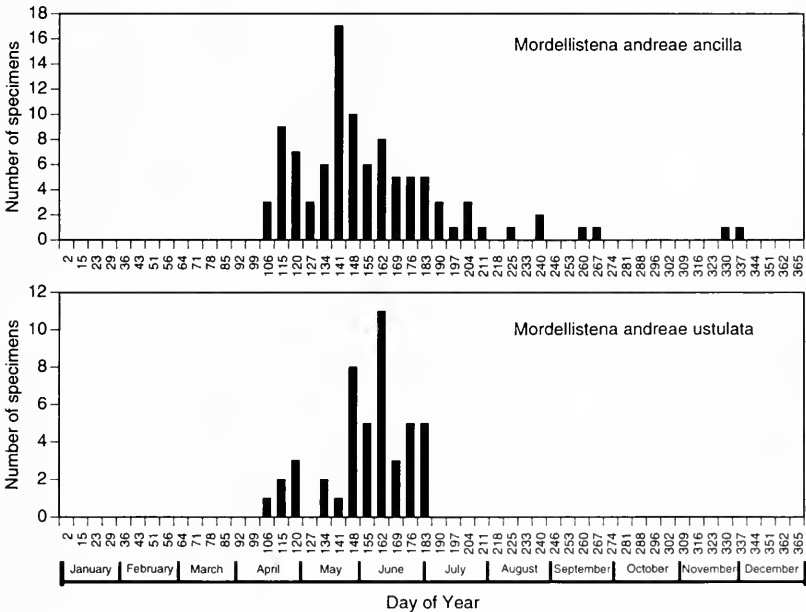


Fig. 2

Figure 2. Seasonal pattern of adult *Mordellistena andreae ancilla* and *M. andreae ustulata* collected in a Malaise trap at Brackenridge Field Laboratory in Austin, Texas from January 1 through December 31, 1990.

**Cumulative Catch.** Mordellids were very seasonal but the accumulation of species during the year was gradual during the entire flight activity season (Fig. 3). This accumulation of species changed more rapidly for the weeks beginning on April 16 and June 18 than any other time of the season. These two periods showed an increase of newly encountered species near the beginning of the main flight activity period and the other near the end of the major flight activity period.

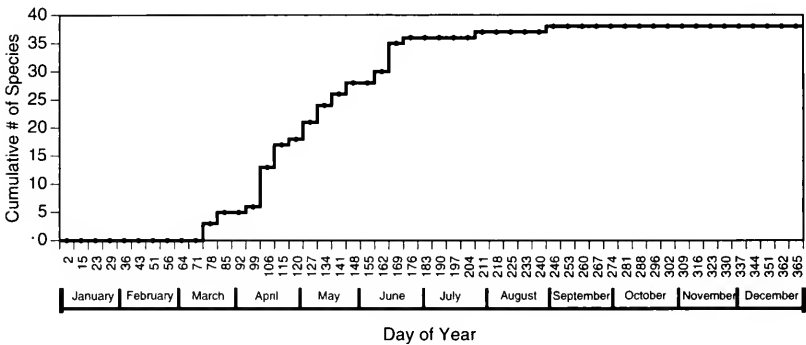


Fig. 3

Figure 3. Cumulative number of species of Mordellidae collected in a Malaise trap at Brackenridge Field Laboratory in Austin, Texas from January 1 through December 31, 1990.

**Phenology of Each Species.** A summary of the flight times for each species (Fig. 4) indicates that there are species differences in phenology. Note that the line in Fig. 4 suggests the continual presence by connecting the first and last date that the species was collected. Because there was a single flight activity peak pattern for the family (Fig. 1), we can judge that mordellids are probably univoltine and thus the solid flight activity line implying continual presence of a given species may well be valid. Also note that the common species *Mordellistena andreae* has a broad flight activity period as does the rarer *Mordellistena paxilla*. *Mordellistena convicta*, however, is abundant but was recorded from a narrower time period.

**Specimens for Each Species.** A frequency distribution of specimens by species is provided in Figure 5. The situation that a few species are abundant and many species are "rare" is apparent. Moreover, 19 of the 36 taxa (52%) collected during this study were represented by 5 or fewer specimens.

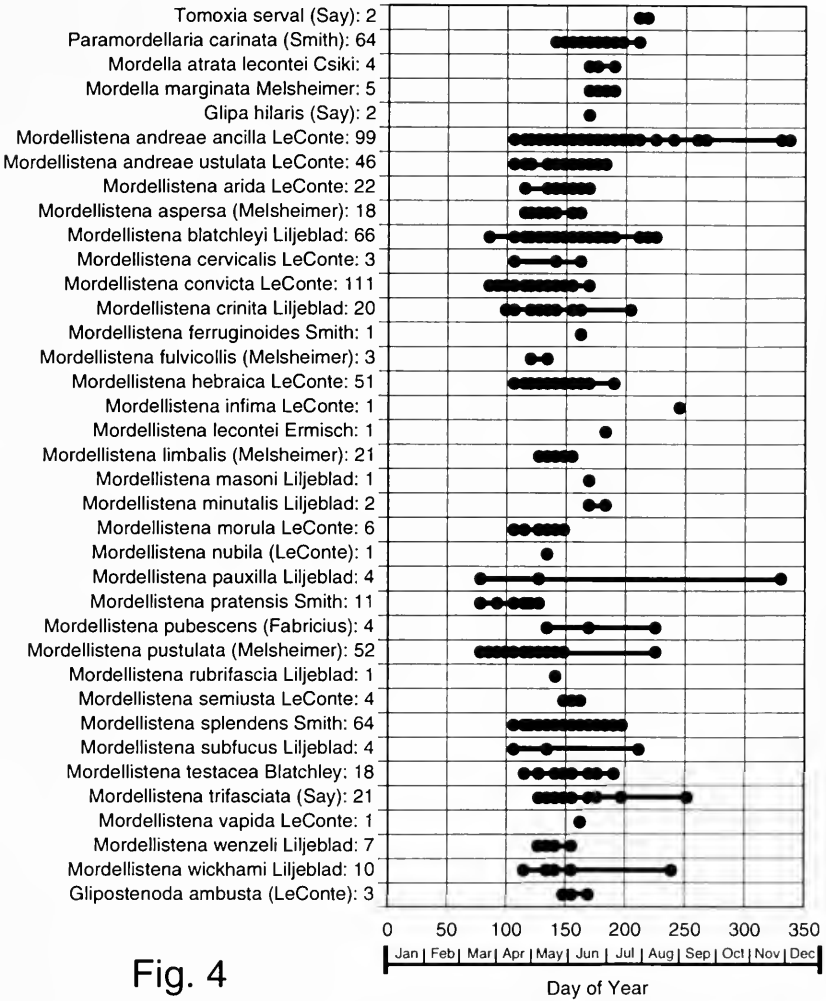


Fig. 4

Figure 4. Seasonal pattern of each species of Mordellidae collected in a Malaise trap at Brackenridge Field Laboratory in Austin, Texas from January 1 through December 31, 1990. Number of individuals trapped after each species name. Lines between circles indicate expected occurrence.

**Regression of Species and Specimens.** Despite the rarity of many species, as indicated by Fig. 5, the greatest diversity of species occurred when the total number of all mordellid specimens was high (Fig. 6). Even though several species were very abundant in some trapping periods, those same trapping periods yielded the greatest number of species.

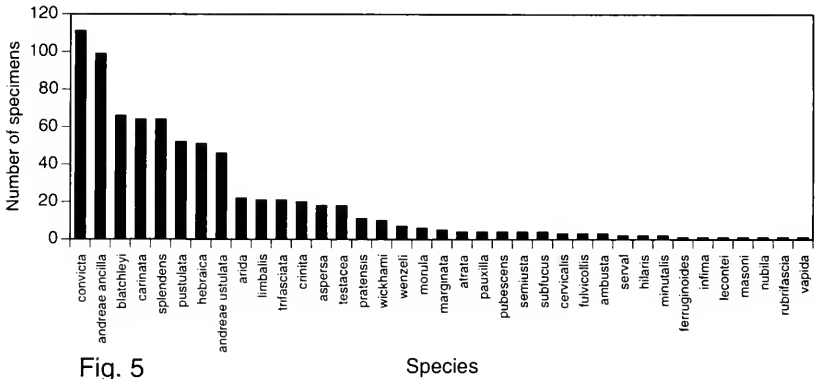
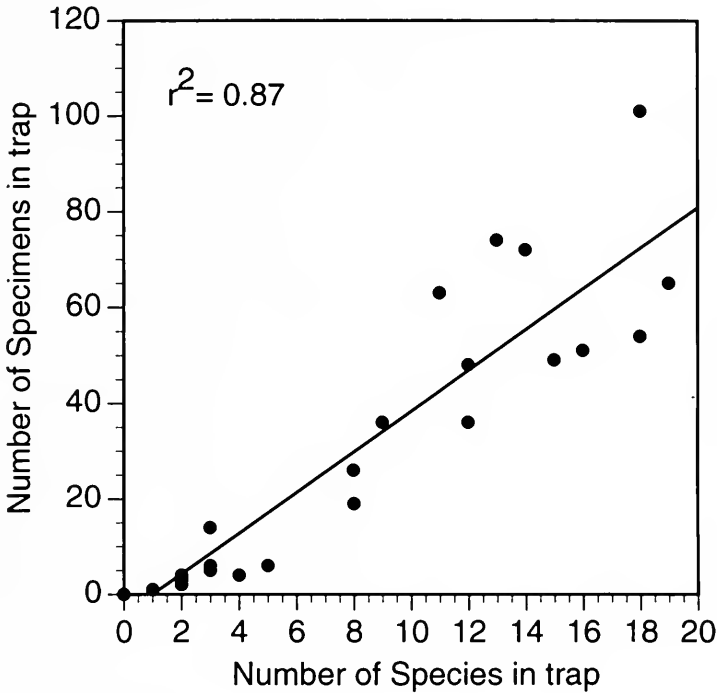


Figure 5. Frequency distribution of the number of species by number of specimens of Mordellidae collected in a Malaise trap at Brackenridge Field Laboratory in Austin, Texas from January 1 through December 31, 1990.

## DISCUSSION

Several striking observations were made in this study. The number of species collected at a single location was surprisingly high. The North American fauna of Mordellidae consists of just over 200 species and subspecies (Bright 1986) which means that over 17% of the fauna was taken by our single Malaise trap at one location. Some species that would be considered to be the most abundant in sweep net samples or collections made on flowers, e.g., *Mordella marginata*, *M. atrata* and *Mordellistena cervicalis*, were represented in low numbers in our sample. The high number of specimens of some rather uncommon species, e.g., *Mordellistena crinita*, was equally surprising. The characteristics of the Malaise trap sampling method or perhaps the trap placement seem to favor some of the little known species and disfavor some of the species that are common on flowers and in sweep net samples.





**Fig. 6**

Figure 6. Relationship between the number of mordellid specimens trapped per week and the number of Mordellid species trapped per week in a Malaise trap at Brackenridge Field Laboratory in Austin, Texas from January 1 through December 31, 1990.

Activity periods of species were generally more elongated than expected from general collecting experience. It was especially interesting to find specimens as late as December. The March collected specimens were not surprising because field experience suggests that mordellids are active early in the season. Some species seem to have a more pronounced and limited activity period while others seem to be active over much of the year.

The single activity peak of adult mordellids as shown in this study contrasts with the Syrphidae which have a bimodal graph of this sort with a peak in May and another smaller one in September-October (C. R. Nelson, unpublished data). The bimodal peak for the syrphids apparently corresponds to the spring and fall flowering seasons. We expect that mordellids are probably

pollen feeders and that the unimodal adult peak does not allow them to fully utilize the fall pollen sources. Mordellids as a family may be cuing on a single or a few factors relating to springtime weather which results in unimodal distribution of abundance and diversity. An alternative explanation may be that the larval biology of mordellids dictates spring adult activity. Where known, mordellids are borers in herbaceous stems, fungi and decaying wood (Liljeblad 1945, Lawrence 1991). Oviposition in stems during the fall may not allow sufficient time or provide sufficient nutrients for development before the onset of difficult winter conditions, when growth would be slowed.

We present the first published records for the following species in Texas: *Tomoxia serval* (Say); *Mordellistena andreae ancilla* LeConte; *M. arida* LeConte; *M. aspersa* (Melsheimer), *M. blatchleyi* Liljeblad; *M. cervicalis* LeConte; *M. convicta* LeConte; *M. ferruginoides* Smith; *M. fulvicollis* (Melsheimer); *M. hebraica* LeConte; *M. infima* LeConte; *M. lecontei* Ermisch (= *ruficeps* LeConte); *M. limbalis* (Melsheimer); *M. masoni* Liljeblad; *M. minutalis* Liljeblad; *M. morula* LeConte; *M. nubila* (LeConte); *M. pauxilla* Liljeblad; *M. pratensis* Smith; *M. rubrifascia* Liljeblad; *M. splendens* Smith; *M. subfuscus* Liljeblad; *M. testacea* Blatchley; *M. trifasciata* (Say); *M. vapida* LeConte; *M. wenzeli* Liljeblad; *M. wickhami* Liljeblad; and *Glipostenoda ambusta* (LeConte). This seemingly large number of new state records is possible because of the little published research on mordellid species since Liljeblad (1945). Based on experience of the senior author there are specimens in other collections that substantiate most of these records.

## CONCLUSIONS

Malaise traps are an excellent means to survey mordellid beetle diversity, probably because they are agile fliers. The number of species collected at a single location in a single trap was surprisingly high, representing over 17% of the fauna of North America north of Mexico. The characteristics of the Malaise trap sampling method or perhaps the particular location seem to favor some of the little known species and disfavor some of the species that are commonly taken on flowers using a sweep net.

An activity peak of adult mordellids was observed that suggests that mordellid activity is cued by springtime weather factors. The low numbers of adults collected in the fall may be limited by larval biology as borers in herbaceous stems, fungi and decaying wood. Flight times of species was generally more elongated than expected from field collected experiences although this pattern varied by species. We hope this study of mordellid diversity will encourage others to address questions of life history adaptations and general ecological interest using these unique beetles.

## ACKNOWLEDGMENTS

We thank Angela Foster for sorting of the malaise trap samples and Lawrence E. Gilbert, Director of the Brackenridge Field Laboratory for continued support.

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**LIXELLUS LECONTE,  
A NEW SYNONYM OF *LISTRONOTUS* JEKEL  
(COLEOPTERA: CURCULIONIDAE)<sup>1</sup>**

Juan J. Morrone<sup>2</sup>, Adriana E. Marvaldi<sup>3</sup>, Charles O'Brien<sup>4</sup>

ABSTRACT. *Lixellus* LeConte and its former synonyms *Anchodemus* LeConte, *Relistroides* Brèthes, and *Pseudhyperodes* Hustache, are placed in synonymy under *Listronotus* Jekel (NEW SYNONYMIES). *Listronotus* is diagnosed and compared to the South American genera *Neopachytychius* Hustache and *Haversiella* Schweiger. Eight species are transferred to *Listronotus* (all NEW COMBINATIONS): *L. bosqi* (Hustache), *L. breyeri* (Brèthes), *L. elongatus* (Hustache), *L. filiformis* (LeConte), *L. haldemani* (Burke), *L. hubbardi* (LeConte), *L. lutulentus* (Boheman), and *L. pusillus* (Hustache).

The weevil genera *Listronotus* and *Hyperodes* were established by Jekel (1865). Several authors (Henderson, 1940; Kuschel, 1962; Kissinger, 1964; O'Brien, 1977) considered them to be at best superficially separated. O'Brien (1979) analyzed the diagnostic characters of species assigned to both genera, and considered that the *Listronotus teretirostris* complex was intermediate between them. He concluded that only a single genus could be distinguished and placed *Hyperodes* in synonymy with *Listronotus*.

We have examined all species of *Lixellus* LeConte, which is supposedly related to *Listronotus*. Although species of the former form a monophyletic group, we were unable to find any apomorphic character that separates both genera. We believe that *Lixellus* merely represents a species group of *Listronotus*, and does not deserve generic status. Our objectives are to establish the synonymies involving these genera, to diagnose *Listronotus* for comparison with other Rhytirrhini, and to transfer to it the eight species of *Lixellus*.

*Listronotus* Jekel, 1865

*Macrops* Kirby, 1837:199 (not Wagler, 1830; not Burmeister, 1835; not available, type species not designated).

*Listronotus* Jekel, 1865:565 (type species: *Rhynchaenus caudatus* Say, 1824:311, subsequently designated by Henderson, 1940:231).

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- Hyperodes* Jekel, 1865:566 (type species: *Listroderes humilis* Gyllenhal, 1834:283, by original designation); LeConte, 1876:136 (= *Macrops*); Cockerell, 1906:243 (reinstated because of homonymy); O'Brien, 1979:267 (= *Listronotus*).
- Anchodemus* LeConte, 1876:181 (not Motschulsky, 1864; type species: *A. hubbardi* LeConte, 1876:181, subsequently designated by Kuschel, 1950:14). NEW SYNONYMY.
- Lixellus* LeConte, 1876:182 (type species: *L. filiformis* LeConte, 1876:182, by indication, monotypy); Kuschel, 1950:14 (= *Anchodemus*); Burke, 1963:167 (reinstated because of homonymy). NEW SYNONYMY.
- Mascaraxia* Desbrochers, 1898:52 (type species: *M. cyrtica* Desbrochers, 1898:52, by indication, monotypy); Hustache, 1921:134 (= *Hyperodes*).
- Relistroides* Brèthes, 1910:209 (type species: *R. breyeri* Brèthes, 1910:210, by indication, monotypy); Kuschel, 1950:14 (= *Anchodemus*). NEW SYNONYMY.
- Aulametopiellus* Brèthes, 1926:415 (type species: *A. dauci* Brèthes, 1926:416, by indication, monotypy); Hustache, 1939:48 (= *Hyperodes*).
- Mascaraxia* Bosq, 1935:330 (lapsus for *Mascaraxia*).
- Pseudhyperodes* Hustache, 1939:49 (type species: *P. elongatus* Hustache, 1939:49, by indication, monotypy); Kuschel, 1950:14 (= *Anchodemus*). NEW SYNONYMY.

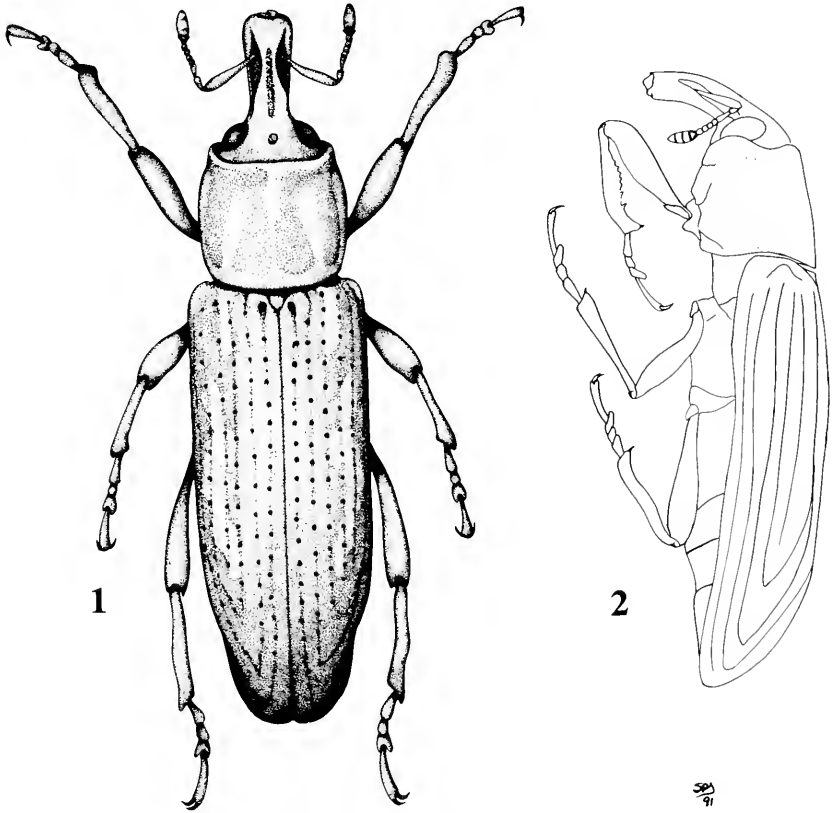
## DIAGNOSIS

*Listronotus* is distinguished from other Rhytirrhini by the funicular article 1 being subequal or shorter than article 2. In addition, the following combination of characters is diagnostic: body vestiture consisting of subcircular to suboval scales and setae; frons with fovea; eyes ovate, medium-sized to large, lateral; rostrum long, slender, curved, non-sulcate, generally tricarinate; epistome not protruding; scrobes lateral, deep, reaching eyes; pterygia poorly developed; antenna with funicular articles 3-6 moniliform; club elongate; prothorax subtrapezoidal or subcylindrical, postocular lobes well-developed; scutellum visible; metepisternal suture distinct; elytra ovate to elongate-ovate, convex to flattened; legs with clavate femora; and tibiae subcylindrical, mucronate, often with spurs.

## COMPARATIVE NOTES

The eight species herein transferred to *Listronotus* have a similar aspect, basically due to their conspicuous elongate-ovate elytra. Their separation as a distinct genus *Lixellus*, however, would leave *Listronotus* paraphyletic, an unacceptable situation under modern systematic standards.

Within the American Rhytirrhini, *Listronotus* is related to *Neopachytychius* Hustache (Marvaldi, 1994). and *Haversiella* Schweiger (Morrone, 1994), based on the long, slender, and curved rostrum, the deep scrobes, and the undeveloped pterygia. *Neopachytychius* is distinguished from *Listronotus* by its characteristic globose prothorax, and its long and slender pharyngeal process. *Haversiella* lacks postocular lobes and lacinial teeth in the maxillary mala. Outside the Americas, other genera related to *Listronotus* are *Palaech-*



Figs. 1, 2. *Listrionotus bosqi* (Hustache), male habitus. 1, dorsal view; 2, lateral view. Scale = 1 mm.

*tus* Waterhouse, *Inaccodes* Brinck, *Gunodes* Brinck, *Tristanodes* Brinck, and *Palaechtodes* Brinck, all endemic to Tristan da Cunha-Gough islands (Morrone, 1994). *Listrionotus* and its allied genera belong in the tribe Rhytirrhinini, which was formerly placed in the Brachycerinae (Kuschel, 1990) and recently transferred to the Somatodinae (Morrone and Roig Juárez, 1995).

O'Brien and Askevold (1992) proposed that the genus *Bagous* Germar may be related to *Listrionotus*. O'Brien *et al.* (1994), however, concluded that *Bagous* is not related to any Rhytirrhinini, and placed it in Molytini, indicating that the earlier proposal was based on presumed convergent character.

## SPECIES INCLUDED

*Listronotus* formerly contained 85 Central and North American species (O'Brien and Wibmer, 1982) and 24 South American species (Wibmer and O'Brien, 1986). Synonymy of *Lixellus* brings the total of *Listronotus* species to 117.

**South American species here transferred to *Listronotus***

*L. bosqi* (Hustache) 1926:216 (Figs. 1, 2). NEW COMBINATION.

*L. breyeri* (Brèthes) 1910:210. NEW COMBINATION.

*L. elongatus* (Hustache) 1939:49. NEW COMBINATION.

*L. pusillus* (Hustache) 1926:215. NEW COMBINATION.

**North American species here transferred to *Listronotus***

*L. filiformis* (LeConte) 1876:181. NEW COMBINATION.

*L. haldemani* (Burke) 1963:167. NEW COMBINATION.

*L. hubbardi* (LeConte) 1876:181 NEW COMBINATION.

*L. lutulentus* (Boheman) 1843:165. NEW COMBINATION.

## ACKNOWLEDGMENTS

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## CYCLOMORPHOSIS IN *ISOTOMA (DESORIA) ALBELLA*, (COLLEMBOLA: ISOTOMIDAE)<sup>1</sup>

R.D. Waltz<sup>2</sup>, J.W. Hart<sup>3</sup>

**ABSTRACT:** *Isotoma (Desoria) albella* is reported for the first time to have cyclomorphic forms: A summer form (type concept) with an elongate distal tooth and smaller anteapical tooth, and a late fall and winter form in which the anteapical tooth is subequal to the distal tooth and the mucro is more compact. Differences in the PAO: nearest eye ratios are also noted as the winter form PAO ratio is comparatively smaller than the summer form. Paired ventral setae of Abd. II are reported for summer and winter Indiana populations in addition to those ventral setae of Th. III.

Cyclomorphosis is a phenomenon well known to workers of the collembola (e.g., Gisin, 1960; Fjellberg, 1976a,b, 1978a,b, 1979, 1980), in which summer forms differ, sometimes dramatically, from winter forms of the same species with regard to setal placement and development, differences in mucronal form, claw structure, and dentes spination, and other characters. These seasonal differences have been especially problematic in reference to taxonomic problems created within the families Hypogastruridae and Isotomidae.

*Isotoma (Desoria) albella* Packard is a Nearctic species most recently redescribed by Christiansen and Bellinger (1980-81) and diagnosed from the European *I. (D.) nivea* Schäffer, 1896, by Fjellberg (1978a, 1979) with which it was long confused taxonomically. This species is distinct from all other Nearctic *I. (Desoria)* species in that it possesses setae on each side of the ventral line of thoracic sternite III and exhibits sexual dimorphism as reported by Fjellberg (1979). In this sexually dimorphic species, the male bears a group of strong setae on the tip femur III, and Ant. II is concave medially and bears a group of spine-like setae. Females do not show these characters, but have normal femora and Ant. II.

In studies of Indiana populations of *I. albella* two morphologically and temporally distinct forms of this species were identified. The summer form and type concept (February/April-October/November) is characterized by having a large, more elongate, distal tooth and smaller anteapical tooth of the mucro (Christiansen and Bellinger, 1980-81: Fig. 578h), shorter tibiotarsal spur hairs subequal to three-fourths of the claw inner length, the subapical antennal organ is peglike, and relatively smaller ocelli with PAO approximately 1.5-2.0X the length of the nearest eye. The late fall and winter form

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(October/November - February/April) of *I. albella* newly identified herein is characterized by a smaller, not so elongate, distal tooth and comparatively larger anteapical tooth of the mucro (Fig. 1), longer tibiotarsal spur hairs subequal to the length of the claws, the subapical antennal organ is very small, and relatively larger ocelli with PAO approximately 1-1.5X the length of the nearest eye. The overall visual impact of the mucronal differences is that the winter form has a more compactly formed mucro versus the summer form (Fig. 2). Both the summer and winter forms have been collected as early/late as February in Indiana, although the species, in one form or the other, is present year round.



Figures 1 and 2. *Isotoma (Desoria) albella*. 1. Winter form - mucro. 2. Summer form - mucro.

We also report the occurrence of paired ventral median setae on Abd. 2 in addition to those ventral median setae of Th. III in Indiana populations of this species. We have not reviewed specimens from other areas to determine how widespread this character is among other *I. albella* populations.

Voucher specimens are deposited in the Purdue Entomological Research Collection, West Lafayette, Indiana, and in the collection of R.D. Waltz.

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**FIRST REPORT OF MALES OF  
*TULLBERGIA CLAVATA*  
(COLLEMBOLA: ONYCHIURIDAE)<sup>1</sup>**

R.D. Waltz<sup>2</sup>, J.W. Hart<sup>3</sup>

**ABSTRACT:** *Tullbergia clavata* is a common thelytokous parthenogenic species previously known only from females and juveniles. Males of this widespread Nearctic species were collected in Indiana and are reported for the first time.

The majority of named *Tullbergia* species currently recognized are known from the female adults and juveniles only (Christiansen and Bellinger, 1980-81). In Indiana, extensive collections of this genus have only rarely resulted in the discovery of males out of hundreds of individuals examined. Herein we report on the first collection of male *Tullbergia clavata* Mills.

Intensive collecting of *Tullbergia* species in Fayette County and Wayne County, Indiana, has resulted in the discovery of several new *Tullbergia* species (Christiansen and Bellinger 1980-81; Rusek 1991) and good series of otherwise well known species. Within this material, a series of *T. clavata* was discovered that included male individuals. Males of *T. clavata* have not previously been reported (Christiansen and Bellinger 1980-81, Table XX). This represents only the fourth species of *Tullbergia* in the Nearctic for which males have been reported. No significant differences in males compared to females were noted (no sexual dimorphism) nor were differences noted in the chaetotaxy of late instar juveniles compared to adults (epitoky) in the material studied.

Although the specimens reported herein key to *T. clavata* in the most recent keys to the Nearctic *Tullbergia* species available (Christiansen and Bellinger 1980-81), this series of specimens represents a more or less distinct population of *T. clavata* previously noted and incorporated by Christiansen and Bellinger (1980-81). Specifically, the specimens we studied show similarities to the type of *T. clavata* in PAO shape and organization, in possessing the same pseudocelli formulae, in having the a2 seta present on Abd.V, and in possessing the same plesiomorphic clavata-type chaetotaxy of the legs (Fjellberg, 1991) a character unique to *T. clavata* as far as is currently known. The specimens we studied differ from at least some populations of *T. clavata* in having the cephalic p1 and p2 setae subequal (only cephalic seta p4 is about 3-4x longer than the other p setae), and the "a" row of Abd. V is non-linear but

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forms a step series from a1, approaching the "m" row, to a4 which is in the normal "a" row position (compare especially Abd. V chaetotaxy in Christiansen and Bellinger, 1980-81: Fig. 380 A, = most similar to our studied material, with Fig. 380 B = *T. clavata*, type specimen). Not enough is currently known about the range of variability in *T. clavata* to justify the description of these forms as a new species, as has been recognized already by Christiansen and Bellinger (1980-81; Table XX and discussion).

Male voucher specimens were taken at the following locales: IN: Wayne County, Wood Duck Pond, Milton, 12-VI-1977, J.W. Hart, mounted in Marc Andre (water sol.) and IN: Fayette County, Manlove Woods, 29-IV-1978, J.W. Hart, mounted in Marc Andre (water sol.). Vouchers are deposited at the Purdue Entomological Research Collection, West Lafayette, IN 47907, and in the collection of R.D. Waltz, Indianapolis.

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***ISOTOMA (DESORIA) TRUNCATA,*  
A NEW SPECIES OF NEARCTIC  
SPRINGTAIL (COLLEMBOLA: ISOTOMIDAE)<sup>1</sup>**

R.D. Waltz<sup>2</sup>, J.W. Hart<sup>3</sup>

ABSTRACT: A new species of Nearctic springtail, *Isotoma truncata* is described from Indiana. The new species is nearest to *I. nixonii* but differs strikingly in the form of the truncate labrum, and in characters of the maxilla and labium.

In an ongoing survey of Indiana springtails (Hart 1970, 1971, 1973, 1974, Hart and Waltz, 1995, Waltz and Hart 1985, 1987, 1995a,b) a distinctive new isotomid species near *Isotoma nixonii* Fjellberg was encountered and is described below.

*Isotoma nixonii*, in the Nearctic, is a distinctive species identified by the shape of the quadridentate mucro, the presence of a lateral mucronal seta, and a single row of labral cilia. Fjellberg (1978) noted that it shared similar maxillary characters with *I. tigrina* (Nicolet) and another new species, *I. maxillosa* Fjellberg. *Isotoma nixonii*, however, differed from these species most strongly in its possession of a lateral mucronal seta.

Herein we describe a distinctive new species closely related to *Isotoma nixonii* but differing in several characters as described below. For consistency of published comparisons we have followed Fjellberg (1978) and included terminology presented by Fjellberg (1984).

***Isotoma (Desoria) truncata*, New Species**

**Color:** Gray or dark gray, almost charcoal color in darkly pigmented forms.

**Head:** 8+8 eyes; eyes G and H reduced. PAO (Fig. 1) approximately 2 times as long as nearest eye, about two times as long as broad. Ant. IV with a short peg-like subapical seta. Subapical pin seta simple, or with extremely small basal process. Ant. I with a ventrolateral row of a few (ca. 5-7) slightly thickened sensory setae. Prelabral setae apparently smooth. Labrum (Fig. 2) without folds or with very weak folds, but with truncate membranous extension covering and extending beyond the single row of ventroapical ciliation (compare *I. nixonii* Fig. 5). Maxillae (Fig. 4) with long ciliated lamellae: lamella number 1 with a fringe of long filaments along dorsal and ventral edges; lamella number 5 with very long, delicate filaments (*nixonii* has short denticles; compare Fig. 6). Labial hooks (Fig. 3) with stylus reduced (stylus is long in *nixonii*; compare Fig. 7), the two attending setae are much enlarged, extending well beyond the end of stylus (in *nixonii* these setae are subequal to or shorter than the end of the stylus; compare Fig. 7). head with 4+4 setae along ventral line.

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**Body:** Abdominal segments V-VI separated. Clothing setae of body acuminate, smooth, similar in size except on Abd. VI where longer setae are present. Longest setae of Abd. VI smooth, acuminate, about twice as long as inner edge of claw. Tibiotarsi without differentiated setae; setae smooth and acuminate. Ventral tube with 2+2 basal, and 3 distal, lateral setae in a line on each side; 3+3 anterior setae; and 5-7 posterior setae. Manubrial thickening with pointed mesal, distal teeth; 2+2 (sometimes appearing as 3+3) distal short setae adjoining manubrial thickening (similar to Christiansen and Bellinger, 1980-81: Fig. 604). Manubrium with ca. 40-45 setae ventrally, arranged as a broad "V" with vertex proximal, and ca. 15-20 scattered setae dorsally. Dens slightly more than twice as long as manubrium (2.0-2.3X), usually with 16 dorsal setae. Mucro as in *I. nixonii* (Fig. 8), quadridentate, with lateral seta and elongate distal tooth; the basal pair of teeth at each side of midline. Tenaculum with 3-8 setae. Claws with weak median teeth, empodia with or without a small corner tooth.

**Size:** Largest specimens 1.0-1.2 mm.

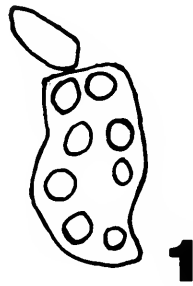
**Type materials. Holotype:** IN: Wayne Co., Culbertson's Swamp, 6-III-1980 (80-29), J.W. Hart, leg. [mounted in Marc Andre (water sol.)], deposited, Purdue Entomological Research Collection (PERC), Purdue University, West Lafayette, Indiana, USA.

**Paratypes:** 40 slides [Cited as Locale: individual slide dates from same collection site (collection number). Commas separate slides. Periods separate sites.] IN: Fayette Co., Manlove Woods, J.W. Hart, Leg. [mounted in Marc Andre (water sol.)]: 18-VI-1978 (816), 26-III-1980 (80-45C). IN: Wayne Co., Culbertson's Swamp, J.W. Hart, Leg. [mounted in Marc Andre (water sol.)]: 26-IV-1970 (024-2), 26-IV-1970 (024-1), 22-IV-1979 (903-2), 22-IV-1979 (903-1), three slides dated 15-I-1980 (80-80), four slides dated 6-III-1980 (80-29 C, E, F), three slides dated 3-IV-1980 (80-47 B, C-1, C-2), five slides dated 11-IV-1980 (80-53 B, D, E), 7-X-1984 (84-19E), three slides dated 10-X-1984 (84-21B, G). IN: Wayne Co., Hart Farm, J.W. Hart, Leg. [mounted in Marc Andre (water sol.)]: 19-I-1980 (80-1), 11-I-1980 (80-7), 18-III-1983 (83-25), 11-IV-1983 (83-33D), 4-V-1983 (83-43E), 7-VI-1983 (83-58E), three slides dated 26-VI-1983 (83-64 A-2, A-3, A-4), 5-VII-1983 (83-67D-2), 17-VII-1983 (83-71D2), 30-X-1983 (83-98D), 18-XII-1983 (83-112A-1), three slides dated 12-XI-1984 (84-26). Paratypes are deposited in PERC, Illinois National History Survey, Champaign Urbana; and US National Museum, Washington, DC.

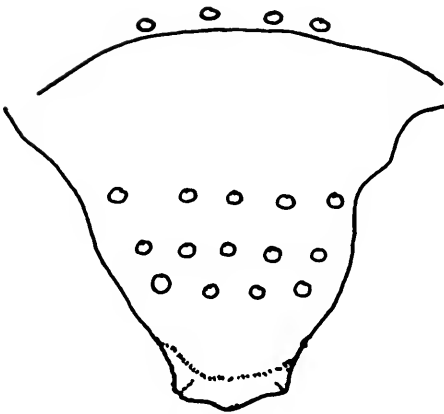
## DIAGNOSIS

*Isotoma (D.) truncata* n. sp. will key to *Isotoma (D.) nixonii* Fjellberg in the most recent keys to the Nearctic *Isotoma* (Christiansen and Bellinger 1980-81; and Fjellberg, 1978) but may be separated from that species by the extended truncate labrum (not present in *nixonii*), the relatively short labial stylus of the labial hook setae (the stylus is long in *nixonii*), the very long setae of maxillary lamella 5 (vs. short setae of *nixonii*), the PAO compared to the nearest eye approaches twice the size of the nearest eye (versus 2-3X in *nixonii*), and the relative length of the dens to the manubrium, in which the dens is more than twice as long as the manubrium (versus 2x or less in *nixonii*).

Collections of *Isotoma truncata* have come from surface collections using pitfall traps taken in all months of the year.



**1**

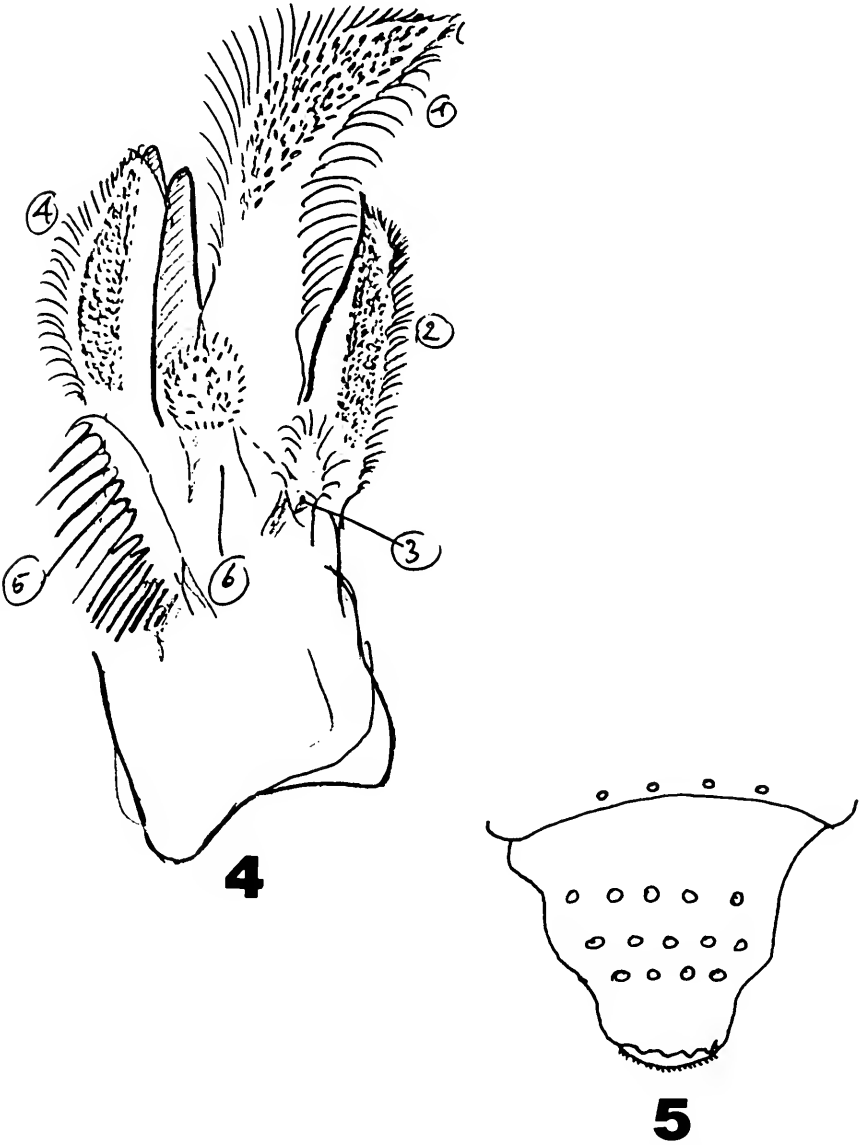


**2**



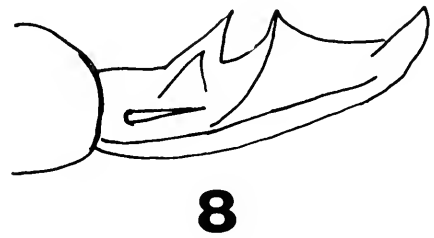
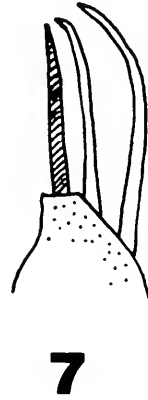
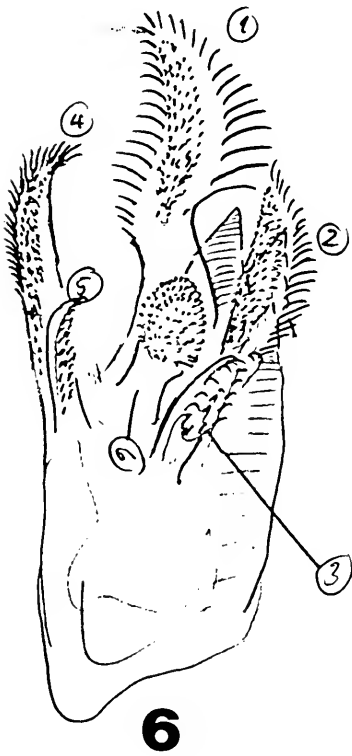
**3**

Figures 1-3. *Isotoma (D.) truncata* n.sp. 1. PAO and 8+8 eyes. 2. Labrum. 3. Labial hooks and stylus (darkened).



Figures 4-5. *Isotoma (D.) truncata* n.sp. 4. Maxilla. *Isotoma (D.) nixonii* Fjellberg. 5. Labrum.





Figures 6-8. *Isotoma (D.) nixonii* Fjellberg. 6. Maxilla. 7. Labial hooks and stylus (darkened). 8. Mucro, lateral (after Christiansen & Bellinger, 1980).

## ACKNOWLEDGMENTS

We thank Arne Fjellberg, Norway, for helpful critical comments on this species and for preliminary figures of mouthpart characters used herein.

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## A REMARKABLE RANGE EXTENSION FOR THE FISHFLY GENUS *DYSMICOHERMES* (MEGALOPTERA: CORYDALIDAE)<sup>1</sup>

Atilano Contreras-Ramos<sup>2</sup>

**ABSTRACT:** The megalopteran genus *Dysmicohermes* (Corydalidae: Chauliodinae), previously known only from the Pacific Coast Region of the United States and adjacent Canada, is recorded for the first time in southeastern United States (Mission, Texas). The external genitalia of the single female Texan specimen most closely resemble those of *D. ingens*. However, differences in wing color pattern and body size, as well as the disjunct occurrence, suggest that the Texas specimen might belong to a third and new *Dysmicohermes* species. Survey work in southern Texas and adjacent Mexico is required in order to determine the taxonomic position, and to assess the conservation status of this previously unknown fishfly.

Fishflies of the genus *Dysmicohermes* (Corydalidae: Chauliodinae) are among the most impressive North American megalopterans. They have an average wing span of 120 mm (Evans 1972), which is comparable to a large *Corydalus* dobsonfly (Corydalidae: Corydalinae). Besides their large size, *Dysmicohermes* fishflies can be easily distinguished by having a 4-branched M vein in the hindwing (Evans and Neunzig 1984, New and Theischinger 1993) and by the presence of dense, long, curly hair on the thorax (Evans 1972). The two specimens I observed have hairs also on the head and coxae. Larvae of *Dysmicohermes* can be separated from other megalopteran genera with the keys by Evans and Neunzig (1984) and Neunzig and Baker (1991). Two species, *Dysmicohermes disjunctus* (Walker) and *D. ingens* Chandler, are presently included in the genus. Both species appear to be rather infrequently collected. *Dysmicohermes disjunctus* is known from central California in the Sierra Nevada Mountains north to southern British Columbia, and *D. ingens* has been found only from several localities in the Sierra Nevada and San Bernardino Mountains of California (Evans 1972).

Recently I borrowed Megaloptera specimens from the University of Missouri, Columbia, as part of a taxonomic study of the genus *Corydalus*. A single large female specimen of a fishfly, which keyed out perfectly to *Dysmicohermes*, immediately called my attention. Moreover, the town of Mission, located in extreme southern Texas near the Rio Grande, was given as the collecting site. Knowing this genus is western, I inquired of Dr. Robert W. Sites (Museum Director at Missouri) as to the authenticity of the record and whether additional specimens were available. Dr. Sites (personal communication) contacted Dr. Wilbur Enns, former Museum Director, who informed him

<sup>1</sup> Received November 19, 1994. Accepted January 25, 1995.

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that Hans J. Bock (the collector) was the son of George Bock, M.D., who had donated approximately a third of a million beetles to their museum and was regarded as an excellent collector. Moreover, Mr. Hans Bock, now deceased, lived in Mission, Texas. Dr. Enns considered it is a virtual certainty that the label data are correct. Unfortunately, I have not encountered additional *Dysmicohermes* specimens from that area in material from other museums. Dr. David E. Bowles (Texas Parks and Wildlife Department, personal communication) has inspected personally the collection at Texas A & M University and has done extensive field work in Texas, in both instances without having seen *Dysmicohermes* specimens. Dr. Bowles is organizing collecting efforts around Mission hoping to find adults and larvae of these organisms. Despite the absence of corroborating specimens, I consider almost certain that the record is valid, and very probable that the eastern specimen belongs to a third species of *Dysmicohermes*.

The external genitalia of the Texas specimen, with the lower lobe of the 10th tergite (clasper sensu Evans 1972) longer than the upper lobe, corresponds to *D. ingens* (Evans 1972). However, the Texas specimen appears to be above the size range of *D. ingens* and its wing color pattern clearly differs from that of *D. ingens* (Figs. 1 and 2). The Texas specimen has a pale brown, almost uniform coloration. Its forewings have very small maculations along the basal (posterior) branch of Rs, as well as at mid length of Cu and along Cu<sub>2</sub>. The base of the Sc cell and the area surrounding the elevation on 1A are dark purplish. Its hindwings are similar to the forewings, but lack almost entirely any maculations. Also, the Texas specimen has the first three abdominal segments covered with long hairs, more conspicuous dorsally. The specimen of *D. ingens*, borrowed from the Smithsonian Institution for comparison, has its wings noticeably more maculated. They have small maculations along most longitudinal veins, larger spots on the cells, and a pattern of three cross bands (areas of denser maculation) at the base, midlength, and towards the apex of the wing. The elevated portion of 1A and its surrounding area are also dark purplish, but the colored area is more extensive than in the Texas specimen. The hindwing seems to have a pattern of color similar to the forewing (the specimen is fairly brittle and does not have its wings spread). Long hairs are absent on abdominal segments.

As a second step, now we need to know whether there are viable populations of the *Dysmicohermes* in Texas. Finding male specimens is crucial to clarifying its taxonomic status and providing the basis for a formal description, thus facilitating conservation efforts. According to Dr. Bowles (personal communication), aquatic habitat prospects are not very good in the Mission area. The Rio Grande is seriously degraded in its reach near Mission. There are, however, irrigation canals, a lake, and intermittent streams in the immediate vicinity of Mission. Evans (1972) reported that *Dysmicohermes* larvae inhabit



Figs. 1-2 Habitus: 1, *Dysmicohermes* sp. from Texas, female; 2, *D. ingens* Chandler, female.

sometimes small streams that dry up in late summer. It is conceivable then that viable populations of the Texas form live in this type of habitat. Collecting efforts for larvae and adults are needed in southeastern Texas and adjacent Mexico. It should be kept in mind that *Dysmicohermes* adults are reluctant to come to lights, so diurnal collecting and rearing from larvae needs to be undertaken. Finally, the disjunct occurrence of the Texas *Dysmicohermes* poses an interesting biogeographical problem to be explained. Is this pattern a reflection of a former biota extending from west to east along what is now the Rio Grande basin? *Corydalus texanus* Banks might fit a similar pattern. This is a western North American species known to occur, historically at least, as far east as Laredo, Texas. Laredo is not too far from Mission and lies in the same drainage system. Of course an isolated dispersal event forms an alternative explanation.

### Material examined:

*Dysmicohermes ingens* Chandler. — UNITED STATES: CALIFORNIA: El Dorado Co., nr. Whitehall, 21.vi.[19]31, L. Saylor, 1 ♀ [head width = 5.40 mm, forewing length = 55.35 mm] (NMNH).

*Dysmicohermes* sp. — UNITED STATES: TEXAS: [Hidalgo Co.], Mission, 28.ix.1961, H. J. Bock, 1 ♀ [head width = 6.55 mm, forewing length = 69.20 mm, wingspan approx. 137 mm] (UMC).

### ACKNOWLEDGMENTS

I would like to thank Robert W. Sites, Wilbur R. Enns Entomology Museum, University of Missouri, Columbia (UMC), for loaning me the Megaloptera material that contained the SE Texas specimen of *Dysmicohermes*, as well as for inquiring about the validity of its collecting data. Thanks also to Oliver S. Flint, Jr., National Museum of Natural History, Smithsonian Institution (NMNH) for lending me an example of *D. ingens* for comparison. I am also indebted to David E. Bowles (Texas Parks and Wildlife Department) for his input about the status of aquatic habitats in the area of Mission, Texas, and his constant enthusiasm about fishflies and dobsonflies. Ralph Holzenthal, Roger Blahnik, and two anonymous reviewers provided feedback on the manuscript. I also wish to thank the National Autonomous University of Mexico (UNAM) for supporting my graduate education in the United States. Contribution No. 21,685, Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul, Minnesota.

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## NOTES ON THE BIOLOGY OF *GNATHOPLEURA* SP. (HYMENOPTERA: BRACONIDAE) IN BRAZIL<sup>1</sup>

Angelica M. Penteado-Dias<sup>2</sup>

**ABSTRACT:** Collections of puparia of the sarcophagid fly *Peckia chrysostoma* yielded several parasitoids of the alysiine braconid genus *Gnathopleura* (Hymenoptera). Data are provided on biology, larval morphology, and the relationship of this parasitoid to *G. semirufa*.

The Alysiinae are exclusively parasitic on cyclorraphous Diptera. The genus *Gnathopleura* is one of the largest and most commonly encountered of the South American alysiines. However, host records for *Gnathopleura* sp. are few and are limited largely to species occurring in North America.

Wharton (1980) included the following species in *Gnathopleura*: *carinata*, *chiriquensis*, *bugabensis*, *semirufa*, *ruficoxalis*, *astarte*, *nigripennis*, *ridibunda*, *nigriceps*, *cariosa*, and *melanocephala*. Wharton (1986) also renamed *G. nigripennis* (Brues 1912) as *G. quadridentata* when *Alysia nigripennis* (Thomson 1895) was transferred to *Gnathopleura*.

I collected three specimens of *Gnathopleura* sp. from vegetation and reared seven *Gnathopleura* sp. from puparia of *Peckia chrysostoma* (Wiedemann 1830) (Diptera: Sarcophagidae) obtained from a wet area near the Miranda River (Passo do Lontra), MS, Brazil (Fig. 1).

This species is assigned to *Gnathopleura* based on the following characters: the border of the mandibles between teeth 1 and 2 swollen to form a fourth tooth (Fig. 2); parallel vein (*npar*) arising near upper edge of brachial cell (*B*); postnervellus (*pnv*) well developed, extending more than halfway to wing margin as a pigmented vein (Fig. 3).

This species closely resembles *G. semirufa* (Brullé 1846) in wing venation and color pattern (Fig. 3) (Fischer 1975) but appears to differ from it by the pit in basal area of the propodeal carina (Fig. 4) and by dentation of the mandible. Fischer (1975) described the second tooth as rounded and the third tooth pointed (Fig. 2) forming a straight angle. This species has the second and third teeth pointed (Fig. 2). In his description, Fischer did not make reference to the propodeal pit. Additional study is needed to determine whether this species falls within the range of morphological variation of *G. semirufa*.

**Larva:** Solitary. Last instar (Fig. 5) with the head sclerites different from the other Alysiinae figured by Capek (1970) and Short (1952). The labial scler-

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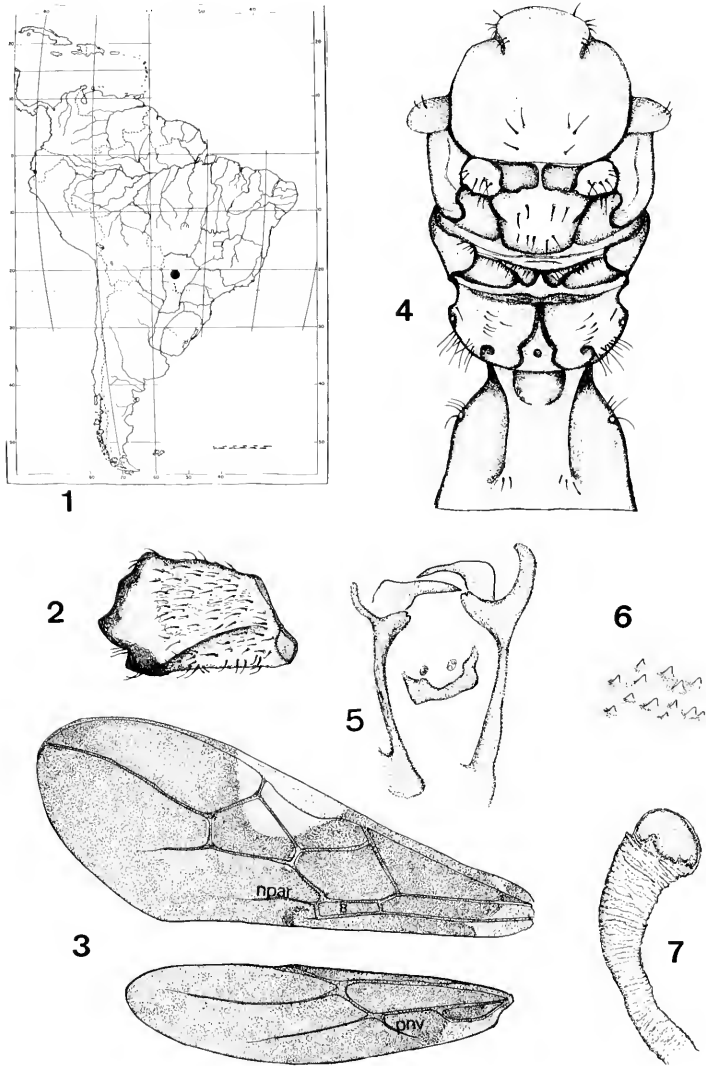


Fig. 1. Map of Brazil showing the locality of collection (●). Fig. 2. *Gnathopleura* sp., female, mandible. Scale bar = 1.0 mm. Fig. 3. *Gnathopleura* sp., female, fore and hind wings. Scale bar = 1.0 mm. *npar*, parallel vein; *pnv*, postnervellus; *B*, brachial cell. Fig. 4. *Gnathopleura* sp., female, thorax and basal parts of metasoma (dorsal aspect). Scale bar = 1.0 mm. Fig. 5. *Gnathopleura* sp., the final instar larva, head capsule. Scale bar = 0.5 mm. Fig. 6. *Gnathopleura* sp., the final instar larva, integument. Scale bar = 0.1 mm. Fig. 7. *Gnathopleura* sp., the final instar larva, spiracle. Scale bar = 0.1 mm.



rite is partly reduced and more or less transverse; hypostoma long; fork-like pleurostoma at base of mandibles; mandibles smooth, sickle-shaped; labial palpi sclerotized. The skin is different from the condition in *Alysia* where definite spines are present and from the condition in *Aspilota* where the skin is smooth (Short 1952). Cuticle of the body (Fig. 6) with small dentations. Spiracle with closing apparatus not close to atrium (Fig. 7).

**Biology:** This species parasitizes larvae of *Peckia chrysostoma* (Diptera, Sarcophagidae) which feed on animal carcasses. The period of the parasitoid larva development was approximately one month. There is one parasitoid specimen in each dipteran puparia. The adults emerged through a hole at anterior (67%) or posterior (33%) region of the puparia, cutting the suture between two consecutive segments.

#### ACKNOWLEDGMENTS

I am grateful to Angelo Pires do Prado, Universidade Estadual de Campinas, SP, Brazil for his determination of the Sarcophagidae. Also I wish to thank Luiz A. Joaquim and Luciana B. dos Reis, Universidade Federal de São Carlos, Brazil for collecting the material examined. Special thanks are due to Robert Wharton and Paul Marsh who reviewed the manuscript and provided many constructive comments. Support for this study was provided by CNPq, Brazil.

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## BOOK REVIEW

**EXOTIC ANTS: BIOLOGY, IMPACT, AND CONTROL OF INTRODUCED SPECIES.** D. F. Williams, ed. 1994. Westview Press. Boulder, Colorado. 332 pp. \$74.85 hardcover.

Humans have caused major problems by accidentally introducing exotic ant species into new habitats. Often controls (predators and parasites) are absent and the introduced species are able to effectively compete with local arthropods. For example, the Hawaiian Islands have no native ants, yet ants abound in the lowlands. These species exert a profound impact on endemic organisms (chapter 2).

The Galapagos islands experienced similar introductions. Due to problems encountered with the little fire ant, *Wasmannia auropunctata*, in these islands, a conference was convened to discuss exotic ants. It was held at the Charles Darwin Research Station (CDRS), Galapagos Islands from October 14-17, 1991. A subsequent workshop covered problems caused by pest ants in the Galapagos. Participants, plus several others, were invited to contribute articles; results were included in this book. Royalties from this book go to further research efforts at CDRS.

My overall impression of this book is that it provides a solid introduction to the recent literature dealing with pest ants. A number of authors discuss their current research. For example, the role of exotic ants as possible vectors of human disease organisms in tropical hospitals is discussed (chapter 6). In addition, some chapters provide a good synthesis of existing knowledge. Examples include characteristics of tramp species (chapter 3), impact of the red imported fire ant on native species in Florida (chapter 23), and biological control of introduced ant species (chapter 25). After reading the entire book, I was left with a desire to learn more. I was also left speculating how little work had been done on related, non-pest species.

The book concentrated upon the impact of introduced ants upon island faunas (roughly 40% of the chapters). There are no chapters dealing exclusively with problems of exotic ants in Europe or Asia (however, chapter 3 does discuss these areas among others). Additionally, nearly 1/2 of the book concentrates upon the genera *Wasmannia* and *Solenopsis*.

There are good indices, both subject and taxonomic. I randomly selected a number of entries and found the information on the page indicated. A helpful inclusion is the addresses of all participants. Anyone wishing further information can readily write the appropriate individual.

Minor points which I found distracting include the tendency to capitalize both genus and species for scientific names in titles. There are instances where scientific names are not italicized or other words are incorrectly italicized.

Overall, I found this book easy to read. It contained new and useful information and should be of interest to those dealing with pest ants. Spanish summaries at the end of each chapter are thoughtfully done, but brief. I believe the price of this book is a bit high (averaging 22.5 cents per page). This is probably due to presumed limited demand. I recommend this book to those interested in the impact of introduced *Wasmannia* and *Solenopsis*, and to those concerned with the impact of introduced ants on island ecosystems.

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## ANNOTATED INVENTORY OF THE MAYFLIES (EPHEMEROPTERA) OF ARIZONA<sup>1,2</sup>

C. R. Lugo-Ortiz, W. P. McCafferty<sup>3</sup>

**ABSTRACT:** Sixty-six nominal species in 28 genera and nine families of Ephemeroptera are reported from Arizona. *Acentrella turbida*, *Ameletus sparsatus*, *Baetis caelestis*, *Baetodes alleni*, *Callibaetis americanus*, *C. pallidus*, *Camelobaetis warreni*, *Centroptilum elsa*, *Cloeodes macrolamellus*, and *Tricorythodes explicatus* are newly reported from the state. The most diverse fauna of the state is that of Apache County, with 41 species. It is followed in decreasing species numbers by Gila, Yavapai, Coconino, Navajo, Cochise, Greenlee, Graham, Mohave, Maricopa, Pima, Santa Cruz, and Pinal Counties. *Thraulodes arizonicus* and *T. salinus* are shown to be junior synonyms of *T. speciosus* and *T. gonzalesi*, respectively. *Traverella castanea* and *Traverella* sp. A are shown to be synonyms of *T. albertana*.

Eaton (1885) provided the first records of mayflies from Arizona based on *Cinygmula par* (Eaton) and *Heptagenia elegantula* (Eaton), and later (Eaton 1892) recorded *Choroterpes inornata* Eaton from there also. Since then, only sparse Arizona records have appeared in the taxonomic works of Banks (1918), Traver (1934, 1935) McDunnough (1938, 1942), Allen and Edmunds (1962, 1963, 1965), Edmunds and Allen (1964), Allen (1967, 1968, 1974, 1978), Koss (1972), Kilgore and Allen (1973), Allen and Brusca (1978), Allen and Chao (1978a, 1978b, 1981), Morihara and McCafferty (1979), Kondratieff and Voshell (1984), McCafferty and Waltz (1986, 1995), Allen and Murovosh (1987a, 1987b), Waltz and McCafferty (1987), and Provonsha (1990), and in the ecological work of Gray (1981).

Our inventory of the Ephemeroptera of Arizona is based on published records and newly studied materials housed in the Monte L. Bean Science Museum (MLB), Brigham Young University, Provo, Utah; the Purdue Entomological Research Collection (PERC), West Lafayette, Indiana; and the entomological collection at Colorado State University (CSU), Fort Collins. Families are ordered according to the phylogenetic classification provided by McCafferty (1991). Asterisks before species names indicate new state records. Complete locale data that form the basis of the new state records are annotated, and comments regarding the species' range are given under the relevant species. Asterisks before county names indicate new county records, and asterisks before stream names indicate first records for those streams. The complete locale data on which new county and stream records are based are available from the authors upon request. New synonyms of species names are indicated and discussed under the relevant species.

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<sup>2</sup> Purdue Agricultural Research Program Journal No. 14450.

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We account for 65 nominal species of mayflies in 28 genera and nine families. Apache County has the most diverse fauna of the state, with 41 species. It is followed by Gila (31), Yavapai (25), Coconino (24), Navajo (21), Cochise (16), Greenlee (13), Graham (12), Mohave (11), Maricopa (10), Pima (9), Santa Cruz (7), and Pinal (5) Counties. No species have been reported from Yuma County, which is essentially devoid of mayfly habitat except for the Colorado River. Ten species are newly reported from Arizona.

Several mayfly genera known from the surrounding areas of northern Mexico, southern California, New Mexico, and southern Utah have yet to be found in Arizona, but may eventually be found there. They include *Acerpenna* Waltz and McCafferty, *Apobaetis* Day, *Attenella* Edmunds, *Brachycercus* Curtis, *Farrodes* Peters, *Hexagenia* Walsh, *Homoeoneuria* Eaton, *Ironodes* Traver, *Lachlania* Hagen, *Leptophlebia* Westwood, *Leucrocuta* Flowers, *Paracloeodes* Day, *Procloeon* Bengtsson, and *Timpanoga* Needham.

#### SIPHONURIDAE

*Siphonurus occidentalis* Eaton — Apache Co: \*Black R, \*Little Colorado R, \*Nutrioso Cr, White R; Cochise Co: Herb Martyr L; Coconino Co: Flagstaff; \*Gila Co: Boulder Cr; \*Yavapai Co: Boulder Cr. All previously published records are from Allen and Chao (1981).

#### AMELETIDAE

*Ameletus falsus* McDunnough — Apache Co: Greer (McDunnough 1938).

\**Ameletus sparsatus* McDunnough — Apache Co, Black R, at Forest Rd 25, Apache National Forest, V-4-1981, W. P. McCafferty, A. V. Provonsha, and D. Bloodgood, larvae, deposited at PERC.

This species was originally described from Alberta by McDunnough (1931). McCafferty *et al.* (1993) included it in their inventory of the mayflies of Colorado. Its presence in Arizona suggests that it may be found eventually in New Mexico and Utah.

*Ameletus velox* Dodds — Apache Co: Greer; \*Cochise Co: Chiricaua Mts; \*Gila Co: Christopher Cr; Graham Co: Moonshine Cr, Wet Cr; \*Pima Co: Santa Catalina Mts. All previously published records are from Allen and Chao (1981).

#### BAETIDAE

*Acentrella insignificans* (McDunnough) — Apache Co: White R; Coconino Co: Sedona; Maricopa Co: Sycamore Cr (Gray 1981), Verde R; \*Mohave Co: Burro Cr; \*Pinal Co: Gila R; Yavapai Co: Verde R. Previously published records are from Morihara and McCafferty (1979), except where noted, and all were as *Baetis insignificans* McDunnough.

\**Acentrella turbida* (McDunnough) — Apache Co, Paradise Cr, at Hawley Lake Rd, Rt 473, IX-9-1967, R. Koss and D. Argyle, larvae, deposited at PERC.

This species was previously reported from Alberta (McDunnough 1924),

Utah (Edmunds 1954), and Colorado (McCafferty *et al.* 1993). Recently, McCafferty *et al.* (1994) reported it from British Columbia and described its larval stage. Arizona represents the southernmost part of its range in western North America.

*Baetis caelestis* Allen and Murvosh — Apache Co, Fort Apache, White R, VII-6-1969, R. W. Koss, W. P. McCafferty, and A. V. Provonsha, larvae, deposited at PERC.

Morihara and McCafferty (1979) reported this species as *Baetis* sp. A from New Mexico. Later, Allen and Murvosh (1983) described it as *B. caelestis* from Baja California. Its presence in Arizona was thus expected.

*Baetis magnus* McCafferty and Waltz — Apache Co: \*Draw Cr, Hall Cr (Morihara and McCafferty 1979, as *Baetis* sp. B), \*Rosey Cr, \*Snake Cr; \*Cochise Co: Carr Canyon, Rucker Cr, Turkey Cr; \*Coconino Co: Oak Cr; \*Gila Co: Bye Cr, Christopher Cr, East Verde R, Tonto Cr; \*Graham Co: Noon Cr; \*Pima Co: Madera Canyon Cr, Molino Basin; Yavapai Co: \*Santa Maria R, \*Sycamore Cr, Verde R (McCafferty and Waltz 1986).

*Baetis notos* Allen and Murvosh — \*Apache Co: White R; \*Cochise Co: Cave Cr; \*Gila Co: Christopher Cr; \*Maricopa Co: Verde R; \*Mohave Co: Burro Cr; \*Pima Co: Cañada del Oro; Yavapai Co: Verde R (Morihara and McCafferty 1979, as *Baetis* sp. C).

*Baetis tricaudatus* Dodds — \*Apache Co: Hall Cr, Little Colorado R, Lukachukai Cr, Paradise Cr, White R; \*Cochise Co: East Turkey Cr; \*Coconino Co: Havasu Cr, Oak Cr; Gila Co: \*Christopher Cr, \*Horton Cr, Parker Cr, \*Pine Cr, Tonto Cr; \*Graham Co: Grant Cr, Marijilda Cr; \*Greenlee Co: Black R; \*Maricopa Co: Phoenix; \*Mohave Co: Virgin R; Navajo Co: White R; \*Pima Co: Sabino Cr; \*Santa Cruz Co: Madera Canyon; Yavapai Co: Beaver Cr, \*Clear Cr, \*Oak Cr, \*Page Springs, Verde R. All previously published records are from Morihara and McCafferty (1979).

*Baetodes alleni* McCafferty and Provonsha — Yavapai Co, Oak Cr, Red Rock Crossing, IV-28-1978, R. W. Baumann, larvae, deposited at MLB and PERC.

McCafferty and Provonsha (1993) described *B. alleni* from Texas. This is the first report of this species outside of that state, suggesting that it may be more generally widespread west of Texas.

*Baetodes arizonensis* Koss — Coconino Co: Oak Cr (Koss 1972).

*Baetodes edmundsi* Koss — Yavapai Co: Clear Cr, Verde R (Koss 1972).

*Callibaetis americanus* Banks — Apache Co, Snake Cr, Rt 273, IX-9-1967, R. W. Koss and D. Argyle, male and female adults, deposited at PERC.

This species has a widespread distribution in western North America (McCafferty *et al.* 1993). The present report extends its known range slightly southward.

*Callibaetis montanus* Eaton — \*Apache Co: Paradise Cr, Snake Cr; \*Cochise Co: San Pedro R; \*Coconino Co: Cheylon Cr; \*Gila Co: Salt R; Maricopa Co: Sycamore Cr (Gray 1981); \*Mohave Co: Big Sandy R; \*Navajo Co: Tool Hollow L; \*Pima Co: Quitobaquito Spring.

*Callibaetis pallidus* Banks — Coconino Co, Stoneman Lake, IV-27-1975, M. W. Sanderson, larvae, deposited at PERC; Mud Springs, Mormon Mtn, VII-23-1976, M. W. Sanderson, larvae, deposited at PERC.

McCafferty *et al.* (1993) extended the known range of this species westward into Colorado. The new records indicate an even more westward distribution and suggest that it may be found eventually in New Mexico and Utah.

*Callibaetis pictus* Eaton — \*Apache Co: Paradise Cr; \*Cochise Co: Chiricahua Mts; Coconino Co: Williams (Banks 1918, as *Callibaetis signatus* Banks); \*Gila Co: Boulder Cr, Carrizo Cr; \*Mohave Co: Wheeler Springs; \*Navajo Co: Show Low; \*Pima Co: Santa Catalina Mts; \*Yavapai Co: Boulder Cr.

*Camelobaetidium salinus* (Allen and Chao) — Gila Co: Salt R (Allen and Chao 1978a, as *Dactylobaetis salinus* Allen and Chao).

*Camelobaetidium trivialis* (Allen and Chao) — Gila Co: Gila R, Verde R; Navajo Co: White R; Yavapai Co: Oak Cr, Verde R. All records are from Allen and Chao (1978a), as *Dactylobaetis trivialis* Allen and Chao.

\**Cameolobaetidium warreni* (Traver and Edmunds) — Apache Co, Fort Apache, White R, VII-6-1969, R. W. Koss, W. P. McCafferty, and A. V. Provonsha, larvae, deposited at PERC; Yavapai Co., east side of Camp Verde, Verde R, V-6-1969, R. W. Koss and A. V. Provonsha, larvae, deposited at PERC; Clear Cr Campground, E of Camp Verde, VI-8-1982, Baumann and Clark, larvae, deposited at MLB and PERC.

This species was previously reported in the United States from west-central California (Traver and Edmunds 1968) and southern Colorado (McCafferty *et al.* 1993). More recently, Lugo-Ortiz and McCafferty (1994) reported it from the Mexican states of Baja California Sur, Chiapas, Chihuahua, Guerrero, Oaxaca, and Sonora. Its presence in Arizona was quite predictable.

\**Centroptilum elsa* Traver — Apache Co, Coyote Cr, at Forest Rd 276, V-4-1981, W. P. McCafferty, A. V. Provonsha, and D. Bloodgood, larvae, deposited at PERC; meadow brook on Williams Rd, nr Forest Rd 276 cut off, V-4-1981, W. P. McCafferty, A. V. Provonsha, and D. Bloodgood, larvae, deposited at PERC.

The present report of this species from Arizona significantly extends its range southward. *Centroptilum elsa* was previously reported only from Grand Teton National Park in Wyoming (Traver 1935). Its presence in Arizona suggests that it may be found eventually in Colorado, New Mexico, and Utah.

*Cloeodes excogitatus* Waltz and McCafferty — Coconino Co: Oak Cr Canyon (Waltz and McCafferty 1987); \*Yavapai Co: Roundtree Cr.

\**Cloeodes macrolamellus* Waltz and McCafferty — Pima Co, Santa Catalina Mts, III-13-1936, J. G. Needham, larva, deposited at PERC; Santa Cruz Co, Madera Canyon, V-7-1969, R. W. Koss and A. V. Provonsha, larvae, deposited at PERC.

In the United States, this species was known only from the type locality in New Mexico (Waltz and McCafferty 1987). Lugo-Ortiz and McCafferty (1994) reported it from the Mexican states of Chihuahua and Durango. Its presence in Arizona extends its known range northwestward.

*Fallceon quilleri* (Dodds) — Apache Co: \*Black R, Little Colorado R (Moriyama and McCafferty 1979); \*Cochise Co: Rucker Cr; \*Coconino Co: Verde R; \*Gila Co: Carrizo Cr, East Verde R; \*Graham Co: Gila R; \*Greenlee Co: Blue R; Maricopa Co: Phoenix (Moriyama and McCafferty 1979), Sycamore Cr (Gray 1981); \*Mohave Co: Beaver Dam Wash, Burro Cr; \*Navajo Co: Show Low; Pima Co: Bear Canyon (Traver 1935, as *Baetis erebus* Traver), \*Madera Canyon; \*Santa Cruz Co: Rock Corral Cr; \*Yavapai Co: Santa Maria R, Verde R. Previously published records of this species were as *Baetis quilleri* Dodds.

*Labiobaetis apache* McCafferty and Waltz — Apache Co: Little Colorado R (McCafferty and Waltz 1995).

#### ISONYCHIIDAE

*Isonychia intermedia* (Eaton) — Gila Co: E Verde R; Greenlee Co: San Francisco R; \*Maricopa Co: Verde R; Yavapai Co: Oak Cr, Verde R. All previously published records are from Kondratieff and Voshell (1984).

#### HEPTAGENIIDAE

*Cinygmula par* (Eaton) — Unknown location (Eaton 1885, as *Cinygma par* Eaton).

*Epeorus deceptivus* McDunnough — Gila Co: Christopher Cr (Allen and Chao 1978b).

*Epeorus longimanus* Eaton Apache Co: Hall Cr, Little Colorado R, \*Paradise Cr, White R; \*Cochise Co: East Turkey Cr; \*Gila Co: Christopher Cr, Pine Cr. All previously published records are from Allen and Chao (1978b).

*Epeorus margarita* Edmunds and Allen — \*Apache Co: Black R; Coconino Co: Oak Cr Canyon; Gila Co: Clear Cr Canyon, \*East Verde R, \*Tonto Cr; Navajo Co: Clear Cr Canyon; \*Yavapai Co: Oak Cr., Page Springs. All previously published records are from Edmunds and Allen (1964).

*Heptagenia elegantula* (Eaton) — \*Apache Co: Paradise Cr; \*Navajo Co: White R; Unknown location (Eaton 1885, as *Rhithrogena elegantula* Eaton).

*Heptagenia solitaria* McDunnough — Apache Co: White R (Allen and Chao 1978b); \*Graham Co: Gila R; \*Mohave Co: Black Cr.

*Nixe criddlei* (McDunnough) — Apache Co: Gooseberry Cr, Hall Cr, Nutrioso Cr, White R; \*Cochise Co: East Turkey Cr, Huachuca Canyon, Ramsey Canyon; Coconino Co: Oak Cr; Gila Co: Tonto Cr; Graham Co: Wet Cr; Navajo Co: White R; \*Pima Co: Jabino Canyon Cr; Yavapai Co; Verde R. All previously published records are from Allen and Chao (1978b), as *Heptagenia criddlei* McDunnough.

*Nixe simplicioides* (McDunnough) — Apache Co: Little Colorado R, White R; \*Coconino Co: Oak Cr Canyon; \*Navajo Co: White R. All previous records are from Allen and Chao (1978b), as *Heptagenia simplicioides* McDunnough.

*Rhithrogena hageni* Eaton — Apache Co: White R (Allen and Chao 1978b).

*Rhithrogena morrisoni* (Banks) — Apache Co: White R (Allen and Chao 1978b); \*Navajo Co: White R.

*Rhithrogena plana* Allen and Chao — Navajo Co: White R (Allen and Chao 1978b).

*Rhithrogena undulata* (Banks) — Apache Co: Paradise Cr, White R; Navajo Co: White R. All records are from Allen and Chao (1978b).

*Rhithrogena vitta* Allen and Chao — Apache Co: White R; Navajo Co: White R. All previous records are from Allen and Chao (1978b).

#### LEPTOPHLEBIIDAE

*Choroterpes inornata* Eaton — Apache Co: Little Colorado R; \*Cochise Co: Cave Cr; Gila Co: Salt R, San Carlos R; \*Greenlee Co: Blue R; \*Mohave Co: Big Sandy R; Navajo Co: Silver

Cr, White R; Santa Cruz Co: Sycamore Canyon; \*Yavapai Co: Clear Cr, Santa María R; Unknown locale (Eaton 1892). Previously published records are from Kilgore and Allen (1973), except where noted.

*Neochoroterpes kossi* (Allen) — \*Apache Co: Black R; Coconino Co: Oak Cr; Gila Co: \*Sycamore Cr, Verde R; \*Greenlee Co: Black R; \*Navajo Co: Show Low. All previously published records are from Allen (1974), as *Choroterpes kossi* Allen.

*Parleptophlebia memorialis* (Eaton) — Apache Co: \*Colorado R, \*East Verde R, Hall Cr (Kilgore and Allen 1973), \*Nutrioso Cr, \*Webber Cr, \*White R; Cochise Co: Herb Martyr L (Allen and Murvosh 1987b); \*Gila Co: East Verde R; Graham Co: Wet Cr (Allen and Murvosh 1987b); Greenlee Co: Blue R (Kilgore and Allen 1973).

*Thraulodes brunneus* Koss — Cochise Co: Cave Cr; Gila Co: Highler Cr; \*Santa Cruz Co: Sycamore Canyon; Yavapai Co: Beaver Cr. All previously published records are from Kilgore and Allen (1973).

*Thraulodes gonzalesi* Traver and Edmunds [= *Thraulodes salinus* Kilgore and Allen, n. syn.] — Apache Co: \*Black R, Salt R (Kilgore and Allen 1973, as *Thraulodes salinus*); \*Gila Co: East Verde R; \*Navajo Co: White R.

Kilgore and Allen (1973) described *T. salinus* from a small series of larvae from Apache County, Arizona, and indicated that the distinct abdominal coloration should readily separate it from other members of the genus. Later, Allen and Murvosh (1987b) reported *T. salinus* from the Mexican states of Chihuahua, Sinaloa, and Sonora. We have studied populations that possess an abdominal coloration intermediate between the typical *T. gonzalesi* and *T. salinus*, and there are no specific structural differences in any of the individuals in this gradient. Moreover, immature individuals of *T. gonzalesi* show a color pattern similar to that shown by Kilgore and Allen (1973) and Allen and Brusca (1978) for *T. salinus*, whereas more mature individuals show the *gonzalesi* pattern on some terga and the *salinus* pattern on others. Our examination of the holotype of *T. salinus* revealed that it is an immature larva assignable to *T. gonzalesi*, not a mature larva as indicated by Kilgore and Allen (1973). Based on all of the above observations, we place *T. salinus* as junior synonym of *T. gonzalesi*.

*Thraulodes speciosus* Traver [= *Thraulodes arizonicus* McDunnough, n. syn.] — \*Apache Co: Black R, Little Colorado R; Cochise Co: \*Cave Cr, Chiricahua Mts (Traver 1934), \*Rucker Cr; Coconino Co: Oak Cr (McDunnough 1942, as *Thraulodes arizonicus*); Gila Co: East Verde R, Haigler Cr, \*Tonto Cr; \*Graham Co: Gila R; Greenlee Co: Black R; Maricopa Co: Sycamore Cr (Gray 1981); Yavapai Co: Beaver Cr, \*Roundtree Cr. Previously published records are from Allen and Brusca (1978), except where noted.

McDunnough (1942) originally described *T. arizonicus* from male adults only, and indicated that these were very similar to those of *T. speciosus*. Traver and Edmunds (1967) tentatively identified larvae collected from near the type locality as *T. arizonicus*. Mayo (1969) associated the larvae and adults of *T. speciosus* through rearing, and indicated that these were very similar to those of *T. speciosus*. Mayo (1969) only suggested minor differences to separate the two species. Our examination of extensive material from Arizona,



New Mexico, and northern Mexico, however, indicated that those differences are due to variation among populations. We must consider *T. arizonicus* a junior synonym of *T. speciosus*.

*Traverella albertana* (McDunnough) [= *Traverella castanea* Kilgore and Allen, n. syn., = *Traverella* sp. A Allen] — Gila Co: East Verde R, Salt R; \*Graham Co: Gila R; Greenlee Co: Blue R; Navajo Co: White R; Yavapai Co: Oak Cr. All previously published records are from Kilgore and Allen (1973), as *Traverella castanea* Kilgore and Allen.

McDunnough (1931) described *T. albertana* from a series of male and female adults from Alberta, Canada. Later, Edmunds (1948) described its larva based on reared material collected from Dagget County, Utah. Kilgore and Allen (1973) described *T. castanea* based on larvae collected from Grant County, New Mexico. Allen (1973) separated the larvae of *T. albertana*, *T. castanea*, and what he referred to as *T. sp. A* on the basis of the size of the frontoclypeal projection, setation of the legs, abdominal coloration, and size of gill 7. We found, however, that those characters show considerable variability, even within populations. Additionally, we found that the holotype of *T. castanea* is not a mature larva, as Kilgore and Allen (1973) indicated, and that coloration, degree of development of the frontoclypeal projection and gill 7, and number of setae on the legs are typical of immature larvae of *T. albertana*. Allen's depiction of the head of *T. castanea* is inaccurate [Fig. 8 Allen (1973)] because he figured the anterior margin of the frontoclypeus extending along the entire posterior margin of the labrum, whereas in actuality the length of the anterior margin of the frontoclypeus is similar to that of *T. albertana* [Fig. 5 Allen (1973)]. All of the above leads to the conclusion that *T. castanea* and *T. sp. A* are synonymous with *T. albertana*.

#### EPHEMERELLIDAE

*Drunella coloradensis* (Dodds) — Gila Co: Horton Cr (Allen and Edmunds 1962, as *Ephemerella coloradensis* Dodds).

*Drunella grandis grandis* (Eaton) — Apache Co: Voigt R; Gila Co: Horton Cr; Graham Co: Grant Cr (Kilgore and Allen 1973); Greenlee Co: Black R. All previously published records are from Allen and Edmunds (1962), except where noted, and all were as *Ephemerella grandis grandis* Eaton.

*Ephemerella altana* Allen — Apache Co: Diamond Cr, Little Colorado R, Paradise Cr, White R (Allen 1968).

*Ephemerella inermis* Eaton — \*Apache Co: Coyote Cr, Little Colorado R, White R; Gila Co: Horton Cr; Graham Co: White R; Greenlee Co: White R; \*Mohave Co: Virgin R; \*Navajo Co: White R. All previously published records are from Allen and Edmunds (1965).

*Serratella micheneri* (Traver) — \*Apache Co: Paradise Cr; Coconino Co: Oak Cr (Allen and Edmunds 1963); Gila Co: Haigler Cr; Navajo Co: White R (Allen and Edmunds 1963); Pinal Co: Kelvin; Yavapai Co: Oak Cr. Previously published records are from Kilgore and Allen (1973), except where noted, and all were as *Ephemerella micheneri* Traver.

*Serratella tibialis* (McDunnough) — Gila Co: Horton Cr (Allen and Edmunds 1963, as *Ephemerella tibialis*).

## LEPTOHYPHIDAE

*Leptohyphes apache* Allen — Apache Co: White R (Allen 1967); Gila Co: Salt R, San Carlos R, Verde R; \*Maricopa Co: Verde R; Pinal Co: Aravapai Cr; Yavapai Co: Oak Cr, Verde R. Previously published records are from Allen (1978), except where noted.

*Leptohyphes ferruginus* Allen and Brusca — Gila Co: East Verde R (Allen and Murvosh 1987a).

*Leptohyphes mirus* Allen — Gila Co: Río Blanco (Allen 1967); Santa Cruz Co: Sonoita Cr (Kilgore and Allen 1973).

*Leptohyphes packeri* Allen — Maricopa Co: Sycamore Cr (Gray 1981); Mohave Co: Big Sandy R (Kilgore and Allen 1973).

*Leptohyphes quercus* Kilgore and Allen — Coconino Co: Oak Cr (Kilgore and Allen 1973); Pinal Co: Aravapai Cr (Allen 1978).

*Tricorythodes condylus* Allen — Apache Co: Little Colorado R; Coconino Co: Oak Cr; Greenlee Co: Black R; Navajo Co: White R. All records are from Allen (1967).

*Tricorythodes dimorphus* Allen — \*Apache Co: Black R; Cochise Co: Cave Cr (Kilgore and Allen 1973); \*Coconino Co: Oak Cr; Gila Co: East Verde R (Kilgore and Allen 1973); Greenlee Co: Black R (Allen 1967); Maricopa Co: Sycamore Cr (Gray 1981); Yavapai Co: Beaver Cr, Oak Cr (Allen 1967).

\**Tricorythodes explicatus* (Eaton) — Apache Co, Black R, at Forest Rd 25, Apache National Forest, V-4-1981, W. P. McCafferty, A. V. Provonsha, and D. Bloodgood, larvae, deposited at PERC; Mohave Co, Virgin R, at rest stop, Blacky Cr Canyon, 12 mi S of Bloomington, UT, V-2-1981, W. P. McCafferty, A. V. Provonsha, and D. Bloodgood, larvae, deposited at PERC; Yavapai Co, Verde R, above Clarksdale, IV-9-1968, R. W. Koss and R. W. Baumann, larvae, deposited at PERC; Oak Cr, Red Rocks Crossing, IV-28-1978, R. W. Baumann, deposited at MLB.

Allen and Murvosh (1983) reported this species from New Mexico and the Mexican states of Baja California Norte, Baja California Sur, Chihuahua, and Sonora. Its presence in Arizona was thus expected. It should be noted that this species and *T. minutus* are extremely difficult to separate, and the two may prove to be equivalent upon further analysis.

*Tricorythodes minutus* Traver — Apache Co: Gooseberry Cr; Coconino Co: Oak Cr; Gila Co: East Verde R, San Carlos R; Graham Co: Gila R; Navajo Co: White R; Pinal Co: Gila R; Santa Cruz Co: Sonoita Cr; Yavapai Co: Verde R. All records are from Kilgore and Allen (1973).

## CAENIDAE

*Caenis amica* Hagen — Yavapai Co: Jerome (Provonsha 1990).

*Caenis bajaensis* Allen and Murvosh — Cochise Co: Chiricahua Mts, \*West Turkey Cr; Coconino Co: Oak Cr; Greenlee Co: Black R; Santa Cruz Co: Madera Canyon, Yanks Springs; Yavapai Co: Oak Cr Canyon. All records are from Provonsha (1990).

*Caenis latipennis* Banks — Coconino Co: Oak Cr Canyon (Provonsha 1990).

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**SOCIETY MEETING OF OCTOBER 26, 1994****BIOGEOGRAPHY AND STRUCTURE OF BACKSWIMMER COMMUNITIES IN NORTH AMERICA (HEMIPTERA: NOTONECTIDAE)**

**Dr. Eric Larsen**  
**Department of Biology**  
**Villanova University, Villanova, PA**

How are aquatic insect communities assembled through evolutionary time? What factors determine whether an insect selects a habitat and remains there? Can we predict community composition from an examination of a pool's locality, size, vertebrate predators and amount of "disturbance"? These and other questions are at the core of Dr. Eric Larsen's research on notonectid assemblages in pools in the Southwest U.S. and Mexico and formed the focus of his talk at the first meeting of the Society's 1994-1995 schedule, held at the University of Delaware. Although now teaching in Pennsylvania, Dr. Larsen has had a long association with the West, starting with his youth spent in Wichita, Kansas and completing a Ph.D. at the University of Arizona.

Notonectids, or backswimmers, in the West are primarily still water inhabitants in ponds, pools and stock tanks, and include species principally in two genera, the larger bodied *Notonecta* (11-12mm) and the smaller *Buenoa* (5-8 mm). The differences in the genera also extend to behavior. *Notonecta* species occur primarily at the water surface or on vegetation, feed on terrestrial insects caught on the surface film, and can give a strong bite with their barbed beak. Often *Notonecta* species are highly colored with red, orange and black. *Buenoa* species show neutral buoyancy which allows them to maintain their position anywhere in the water column, and consequently to effectively feed away from the water surface. *Buenoa* species have the first two pairs of legs modified to form a "basket" to grab and hold prey, which often consists of mosquito larvae. Male notonectids can produce sound through two mechanisms: a chirping sound is produced by scraping a tibial comb across striated plates located on the rostral prong on the head, or the femur has a stridulatory area which scrapes against a coxal peg.

Dr. Larsen introduced the audience to the two main pond habitats and their notonectid inhabitants in the Sonoran Desert area where he conducts his research. The mountain canyons contain rock pools called *tinajas* formed by natural scouring by intense, local summer storms, and the surrounding lowlands contain muddy ponds, mostly derived from damming of watercourses by settlers in the last hundred years. (Surprisingly, these lowland ponds are better habitat for notonectids if cattle are present!) Artificial stock tanks can be found in both mountains and valleys. The *tinajas* harbor 4 species of backswimmers, including a Southwest endemic in each genus, while the lowland ponds contain five species distributed among both genera, none of these Southwest endemics. Assemblages of these species are not random with respect to body size in the Southwest as species of similar body size are far less likely to co-occur in the same pool than one would expect by chance. Body-size mediated competition is the leading hypothesis to explain the pattern. Because backswimmers disperse from one habitat to another by flying, Dr. Larsen was interested in why the species found in *tinajas* were rarely found in lowland ponds and vice versa. To test criteria of habitat selection, Dr. Larsen used concrete stock tanks of different sizes in both mountain and valley habitats, and found that *tinaja* species select any size tank as long as it is in the mountains (topographic criteria), while lowland species tend to select the largest size tank no matter where it is located (size criteria). Simply put, choosing the largest size habitat for lowland species decreases the risk of the pond drying out during the two annual drought periods, while selecting a pool based on topography insures a species ends up in a *tinaja* habitat for which it was evolved specifically to exploit. Dr. Larsen demonstrated that habitat selection is far more complex, though; he observed in Organ Pipe National Monument a *tinaja* pool with approximately 50,000 individuals (with a continuous "rain" of backswimmers dropping from the sky at the rate

of about 30/minute) yet surrounding tinaja pools had very low populations!

There were several entomological observations presented at the meeting. Susan Whitney recently returned from Puerto Rico and displayed photographs of termite nests in trees. She also discussed the search for termites for a mark-recapture study to be carried out in Newark, and the finding of an excellent colony for study – unfortunately inhabiting one of the University of Delaware's farmhouses! Roger Fuester noted that the flying females of the Asian Gypsy Moth (flight capable female biotype of *Lymantria dispar*) have been collected in the Wilmington N.C. and Long Island, N.Y. areas, probably introduced from pupae on munitions crates from Germany. He noted the concern that this strain readily disperses due to the flying female stage, but that hybridization between the strain established here and the Asian strain is not successful. Jon Gelhaus reported on crane fly collections made in salt marshes along the Delaware Bay in Cumberland Co. New Jersey. He found three crane fly species common, with two of these newly recorded for the state, and one species, *Limonia gibsoni* Alexander, apparently the most common large insect in this habitat in October and its use as food by swallows and possibly other migrant birds. Approximately 20 members and guests were present.

Jon Gelhaus,  
Corresponding Secretary

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## SOCIETY MEETING OF NOVEMBER 16, 1994

### THE ECOLOGY OF DIABROTICITE CUCUMBER BEETLE PHARMACOPHAGY (COLEOPTERA: CHRYSOMELIDAE)

Dr. Douglas W. Tallamy  
Department of Entomology and Applied Ecology  
University of Delaware, Newark, DE

Cucurbitacins, a class of chemicals found mostly in cucurbit plants such as native gourd species, are some of the most bitter compounds known, even at levels of 1 part per billion. These chemicals are toxic to mammals, causing vomiting and even shrinking tumors, and act as feeding deterrents against insects. Yet, for cucumber beetles, cucurbitacins are strong attractants for both adults and larvae, and individuals will feed on pure cucurbitacins even when it decreases their life span and fecundity! The complexities of this attraction and the various hypotheses to explain the origin of it form the core of Doug Tallamy's research, and he discussed the topic during this Philadelphia meeting of the Society.

Pharmacophagy, the acquisition of a chemical for use other than primary metabolism or recognition of host plants, is well illustrated by *Diabrotica* cucumber beetles. These insects comprise some of our most important agricultural pests including grass specialists (particularly pests of corn) like the Western and Northern Corn Rootworms, pests of cucurbits like the Striped Cucumber Beetle and those with broader host ranges like the Banded and Spotted Cucumber Beetles. All are stimulated to feed by the non-volatile cucurbitacins, even at low concentrations of 1 nanogram/milliliter. The beetles most easily pick up the compounds as adults when feeding on cucurbit pollen. They are easily satiated though, and excrete much of it, detoxifying only a small amount in their haemolymph and cuticle to give them a bitter taste. This feeding comes at a cost for some species, either in reduction of life span or fecundity, and also requires the grass specialists to leave their hosts to seek the compounds. For the Spotted Cucumber Beetle, though, there is little measurable cost in fitness by feeding on and using the cucurbitacins.

Dr. Tallamy discussed competing hypotheses explaining the reasons for this attraction in spite of its cost on fitness. The null hypothesis considers the system of no adaptive advantage, sim-

ply a relictual strategy from a coevolutionary process in which the early ancestors of this tribe of beetles were cucurbit specialists and used the compounds to recognize their hosts. An opposing hypothesis considers the defensive nature of the compounds, with their acquisition giving the beetles protection from invertebrate and vertebrate predators. Dr. Tallamy's research looks at many angles, including investigating the genetic basis of the compound's attraction through crossing sensitive and insensitive individuals, testing predator responses, and examining aposomatic and crypsis coloration. His view is that the evidence at present supports the scenario that adults of this tribe of beetles were first exposed to the compounds as pollen feeders, using them for defense, and did not evolve around the larval feeding habits of cucumber beetles.

There were numerous entomological observations presented at the meeting. Due to the continuing mild weather, President Joseph Sheldon noted the co-occurrence of calling by "winter" birds and "summer" katydids in his yard, and Harold White observed several weeks previous while at 3000 ft in the Shenandoah Mountains that walking sticks and tree crickets were still present even though the trees had dropped their leaves. Ken Frank noted that a recent consumer magazine had rated .5% permethrin more effective than DEET against deer ticks and asked for feedback during the next field season. Roger Fuester remarked on newspaper reports that due to successful IPM programs in commercial table grapes some black widow spiders have been reported in bunches of grapes purchased in stores. Barbara Kirschenstein recounted a recent live trapping of a deer mouse with three emerging bot fly larvae in Allegheny National Forest, prompting Curt Sabrosky to note that he had heard of a deer mouse with 7 *Cuterebra* larvae under the mouth, preventing any feeding by the rodent. Sue Frank made mention of a recent newspaper article concerning Daniel Otte and recent memoirs written by George Poinar and Edward O. Wilson. Mildred Morgan exhibited several photos of her Cape May Point garden during the height of the Monarch Butterfly migration around Labor Day. Approximately 25 members and guests were present.

Jon Gelhaus,  
Corresponding Secretary

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## SOCIETY MEETING OF FEBRUARY 22, 1995

### ENTOMOLOGICAL TREASURES OF THE ACADEMY

Ms. Carol Spawn, Dr. Jon Gelhaus  
Academy of Natural Sciences

The histories of the American Entomological Society and of the Academy of Natural Sciences have been closely linked, commencing with the first meeting of AES in its' new quarters at the Academy in February 1876 (Boyd, 1984, Ent. News 95:131-136). It is only fitting then, that on a February evening, 119 years later, the American Entomological Society and the Friends of the Academy Library met together for a delightful evening examining the entomological history and treasures from the archives and collections of the Academy and AES.

As noted by Carol Spawn, retired Librarian of the Academy, and now the Academy's Archivist, archives constitute the "preservation of non-current records of an organization that are of continuing value." Ms. Spawn selected a variety of archival materials for display, including the bound Society minutes from 1859-1981, the proposal of membership for Lucy Say (Thomas Say's widow), early financial records from as far back as 1859 and the first book of meeting minutes noting, for example, the election of Henry Ulke as a regular member and Baron Osten Sacken as a corresponding member. Beautiful archival items included an album of the only insect paintings created by the 17th century flower painter Alexander Marshall, and P. A. Latreille's personal, two

volume copy of the plates he created for *Encyclopedie Methodique, Insectes*, with his annotations and original drawings. The entomological library has always been a primary interest of the Society, starting with the first meeting in which two books were presented to the Society. By 1867 over 2000 items were in the AES library managed by the first librarian! Although AES has housed its library in the Academy building since 1875, the remarkable agreement guiding the library today was brought about through the guidance of Venia Phillips, librarian at the Academy commencing in 1944, who had a Ph.D. in entomology from Cornell. Today, while the Society retains title, and through its endowments continues to acquire journals and books and bind materials, the Academy catalogs, shelves and makes accessible all the wonderful items in the library and archives.

Jon Gelhaus, Academy curator, exhibited 12 of the nearly 100 Peale butterfly boxes from the Entomology Collection at the Academy. This collection, dating from the 1820's, was developed by Titian R. Peale II (1799-1885), the youngest son of Charles Wilson Peale, and reflected his interests in natural history, scientific illustration and the development of science in a young United States. The boxes were designed to prevent damage to insect specimens by museum beetles and yet allow observation of the specimen from above and below, and the appearance of the specimens some 160 years later confirms the success of his design. Boxes shown at the meeting held specimens from all over the world including some from Peale's explorations in Surinam and Brazil, butterflies and moths from a then more rural Philadelphia and the oldest North American butterfly type described by a North American entomologist (Thomas Say). This latter specimen was illustrated by Peale for Say and then incorporated in Peale's collection.

There were numerous entomological observations presented at the meeting. Dr. Howard Wood, the Friend's President, showed photographic slides of several *Dendrobium* orchid flowers, and solicited any ideas of pollinators from the entomologists. He noted that although the pollinators of many *Dendrobium* species are known or can be surmised by flower morphology, other species have flower characteristics which don't match models for butterfly, moth, bee or bird pollination. Other observations included the early termite swarming noted by Dr. Susan Whitney at Newark, DE, observations by Dale Schweitzer of several species of butterflies and dragonflies in December and January in South Jersey and the incongruity of activity of winter stone flies and box elder bugs during a recent field trip by Joe Sheldon. Mildred Morgan showed a calendar which featured a photo of her Cape May Point garden during the Monarch Butterfly migration. Notice was also made of the newest Academy exhibit on butterflies, which includes a walk-in garden with live butterflies. It was also noted that AES had purchased two chairs for the Library reading room, to complement a Society coffee table which houses the sidewalk stone from the former AES building at 13th and Rodman Streets.

Elections of officers were held. The following individuals were unanimously elected to two year offices by the membership present.

Joseph Sheldon	President
Jon Gelhaus	Vice President
R. Tommy Allen	Corresponding Secretary
Dale Schweitzer	Recording Secretary
Howard Boyd	Treasurer

Approximately 50 members and guests were present.

Jon Gelhaus,  
Corresponding Secretary



## BYLAWS OF THE AMERICAN ENTOMOLOGICAL SOCIETY<sup>1</sup>

Adopted February 23, 1994

CONTENTS:	I. Name	IV. Officers	VII. Funds	X. Meetings	XIII. Amendments
	II. Objective	V. Executive Council	VIII. Publications	XI. Prohibitions	
	III. Members	VI. Standing Committees	IX. Library	XII. Dissolution	

### ARTICLE I – NAME

- Section 1. The name of this Society shall be "The American Entomological Society".
- Section 2. The corporate seal of this Society shall be the title of the Society surrounding the words "Founded 1859, Incorporated 1862", with a figure of *Dynastes tityus* and the motto "Festina lente" (advance deliberately) occupying the center.

### ARTICLE II – OBJECTIVE

- Section 1. The objective of this Society shall be to promote the study and advancement of entomology, by original research, by publication of results, by building and maintaining a library, and by other appropriate means. This Society shall be organized and operated exclusively for scientific and educational purposes.

### ARTICLE III – MEMBERS

- Section 1. Any person interested in entomology, regardless of race, creed, or gender, is eligible for membership in this Society.
- Section 2. This Society shall consist of Regular, Life, Emeritus, Honorary, and Student members.
- Section 3. Regular members are individuals who pay annual dues to the Society.
- Section 4. Life members are Regular members who make a one time contribution equivalent to a total of thirty (30) years of regular annual dues at the current rate. Life members shall be exempt from all further dues.
- Section 5. Emeritus members. Any member 65 years of age or older, who has been a member of this Society for at least fifteen (15) years and who, in the opinion of the Society, by rendering unusual service to the Society, merits special recognition, may be proposed as an Emeritus member. As such, he/she shall be exempt from all further dues and shall be entitled to receive, gratis, any or all of the current issues of the Society's publications. The number of living Emeritus members shall be limited to five.
- Section 6. Honorary members. Any individual who has attained eminent distinction in entomology is eligible for Honorary membership and, upon election, shall be exempt from annual dues. Honorary members shall be entitled to receive, gratis, any of the current serial publications of the Society. The number of Honorary members shall not exceed twenty.
- Section 7. Student members are individuals who are either under 21 years of age or are currently enrolled in a course leading to an academic degree. Annual dues for Student members shall be 50% of Regular membership dues.
- Section 8. All Regular, Life, and Emeritus members are entitled to vote, in person, at all membership meetings of the Society.

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<sup>1</sup> These bylaws, adopted at the membership meeting of this Society on February 23, 1994, are a revision of the Society's bylaws of October 2, 1980. Committee appointed to review previous bylaws and prepare this updated revision: Jon K. Gelhaus, Charles E. Mason, Joseph K. Sheldon, and Howard P. Boyd, Chair.

- Section 9. Regular and Student memberships may be obtained by submitting a written application to the Society. Each application shall include relevant information on the applicant's background.
- Section 10. Nominations for Emeritus and Honorary members shall be made by the Executive Council and submitted to the Society for action. An affirmative vote of at least 3/4ths of the members present shall constitute election.
- Section 11. No individual shall be entitled to the privilege of membership until he/she shall have paid his/her first annual dues, except Honorary members.
- Section 12. All annual dues shall be payable in advance to the Treasurer as of January 1 of each year. The Executive Council may exempt any member from paying all or part of his/her annual dues.

#### ARTICLE IV – OFFICERS

- Section 1. The officers of this Society shall consist of a President, a Vice President, a Corresponding Secretary, a Recording Secretary, and a Treasurer.
- Section 2. Officers shall be elected at the Society's first regular membership meeting in odd-numbered calendar years, to serve a two-year term. Vacancies in office may be filled temporarily by the Executive Council until the next stated membership meeting of the Society at which time an election to fill the vacancy shall take place.
- Section 3. No person is eligible to hold office until he/she shall have been a Regular member of the Society for at least one year prior to election.
- Section 4. The President shall preside at all meetings of the Society and of the Executive Council. He/she shall appoint and discharge all committees, except that such action with respect to standing committees shall be subject to approval by the Executive Council. He/she shall be an ex-officio member of all committees.
- Section 5. The Vice-President, in the absence of, or in the event of the disability of, the President, shall assume his/her duties. At all other times he/she shall assist the President and shall perform such other duties as may be designated by the President and/or by the Executive Council.
- Section 6. The Corresponding Secretary shall undertake such normal correspondence of the Society as is necessary. He/she shall advise the President on matters pertaining to Emeritus and Honorary members. He/she shall inform individuals of their membership status, notify members of their appointment on committees, and keep a list of the members of the Society, their place of residence, date of membership, resignation, or death. He/she shall perform other duties delegated to him/her by the Executive Council.
- Section 7. The Recording Secretary shall record the minutes of the Society and of its Executive Council. He/she shall have charge of the corporate seal of the Society, its historical material, and its archives. He/she shall perform other duties delegated to him/her by the Executive Council.
- Section 8. The Treasurer shall be responsible for the securities and funds of the Society, shall keep accurate accounts thereof, and perform other usual duties of such office. He/she shall attend to the collection of all funds owed to the Society and shall pay only those items that have been included in the Society's current operating budget as approved by the Executive Council. All expenditures of funds must be approved by the individual responsible for same and all payments shall be approved and all checks signed by two authorized members of the Society's Executive Council. The Treasurer shall prepare and submit a balance sheet on the status of each of the Society's financial accounts at least four (4) times each year, and at such other times as may be directed by the Executive Council. The Treasurer and the Office Manager/Secretary shall be bonded.

## ARTICLE V – EXECUTIVE COUNCIL

- Section 1. This Society shall be governed by an Executive Council which, for each two-years term, shall consist of the officers of the Society, the three previous Presidents, and any Past Presidents of the Society who desire to serve as members of the Executive Council.
- Section 2. The Executive Council shall have charge of and is responsible for all business matters and all financial affairs of the Society except those activities specifically delegated to standing committees.
- Section 3. The Executive Council shall meet at such times and places as it may designate, or on call of the President, but not less than four times each year. It shall render a report of its actions at the next stated meeting of the Society, and such reports shall be a part of the business of that meeting. Four members shall constitute a quorum at any meeting of the Executive Council.
- Section 4. The Executive Council may delegate any of its functions to special committees or members of the Society, receiving reports therefrom as the Executive Council may direct.
- Section 5. At a meeting to be held at least sixty days prior to the biennial election meeting of the Society, the President, with the approval of the Executive Council, shall appoint a Nominating Committee consisting of three members whose duty shall be to nominate the officers for the ensuing two years. These names shall be submitted at the last stated meeting of the Society in the calendar year prior to the election meeting. After the Nominating Committee shall have presented its nominations, the presiding officer or the Recording Secretary shall call for additional nominations from the floor.

ARTICLE VI  
STANDING COMMITTEES

- Section 1. There shall be four (4) standing committees: Finance, Publications, Library, and Education. Each committee shall consist of three or more members, including its chairperson who shall be appointed by the President and approved by the Executive Council. Each committee shall function from the time it is approved by the Executive Council until its successor has been appointed and approved, or until it is otherwise relieved by the President and the Executive Council.
- Section 2. The Finance Committee, with the Treasurer, shall be responsible for investing the funds of the Society, shall change any or all investments whenever it may deem it advantageous for the Society to do so, and shall report each change to the Executive Council at its next meeting. This committee also is responsible for the development and administration of the annual operating budget of the Society.
- Section 3. The Publications Committee shall receive all papers for publication, act upon the same, and produce the publications of the Society. It shall have control over the utilization of income from the various publication funds and accounts. This committee may select editors and delegate discretionary powers in various matters to the editors of the respective journals, subject only to committee review.
- Section 4. The Library Committee shall have general supervision of all library matters. It shall have control over the utilization of income from the various funds and accounts assigned to the Society's library. It shall have the power to direct purchases, exchanges, bindings, and other library operations.
- Section 5. The Education Committee shall be responsible for obtaining speakers for membership meetings, selecting the recipients of the Calvert Award, and arranging and conducting the annual Insect Field Day. It shall be responsible for coordinating other Society sponsored educational programs such as teacher workshops and youth projects.

ARTICLE VII  
FUNDS

- Section 1. The fiscal year of this Society shall be September 1 through August 31. Periodical subscriptions and salaries/honoraria shall be on a calendar year basis.
- Section 2. This Society is authorized to accept donations and bequests which shall be used for the purposes outlined in Article II.
- Section 3. The principal of each fund shall be held in the investment portfolio of the Society. Only the income from such funds may be spent for the purposes of the Society, except in an emergency, in which case principal funds may be spent if authorized by at least a 2/3rd majority of the Executive Council.
- Section 4. All income received from the sale of investments of a fund shall be reinvested for that same fund.
- Section 5. Funds of the Society shall be apportioned into separate accounts for convenience in managing the different activities. Special accounts or funds may be created for special purposes. Accounts may be rearranged, combined, or divided upon the recommendation of standing or special committees if approved by at least a 2/3rds majority of the Executive Council. A current balance sheet shall be submitted to the Executive Council by the Treasurer at least four (4) times each year. This statement shall be examined promptly at an Executive Council meeting to make certain all accounts are in good order. There shall be an annual external audit of all financial accounts of the Society.
- Section 6. An annual budget containing anticipated income and expenses shall be prepared, adopted, and followed throughout the fiscal year as a guide to the Executive Council and account managers. A budget shall be prepared for each account by the person responsible (committee chairperson, editor) and this shall be submitted to the Finance Committee not later than the seventh month (March) of the fiscal year. Budgets shall be based upon actual receipts and expenditures, as reported in the audit of the year just completed, with allowances for anticipated changes. The Executive Council may accept a budget as submitted or may require changes before approval. Budgets shall be approved by the Executive Council by the eighth month (April) of the fiscal year and recorded in the minutes of the Executive Council. The total of annual account expenditures may not exceed approved budget limits without the approval of at least a 2/3rds majority vote of the Executive Council, unless the account has a sufficient cash surplus from previous years to cover the increased expenditures. Revisions to a previously approved budget, when necessary, may be submitted for consideration by the Executive Council. No financial obligation against the Society may be contracted by any officer or member except as specified in the annual budget as approved by the Executive Council.
- Section 7. Any property or funds acquired by the Society which are unrestricted as to their use by the donor(s) or by the Society may be used as the Executive Council determines, within guidelines outlined in Section 4 above and in Article II.
- Section 8. The Finance Committee, with the Treasurer, on the advice of the investment advisor, is authorized to buy and sell stocks and bonds in the Society's name, provided that such securities are held in the Society's investment portfolio and that any income received be paid into the investment account for distribution to operating accounts or for reinvestment.

ARTICLE VIII  
PUBLICATIONS

- Section 1. The serial publications of this Society shall be:
- a. *Transactions* of the American Entomological Society
  - b. *Memoirs* of The American Entomological Society
  - c. *Entomological News*
- Section 2. The *Transactions* of the Society shall be published in quarterly numbers except when occasional conditions make it expedient to combine some issues. The *Memoirs* of the Society shall be published as frequently as suitable manuscripts and sufficient funds are available. *Entomological News* shall be published in annual volumes of five numbers except when occasional conditions make it expedient to change the number of issues.
- Section 3. The expense of publishing these journals shall be defrayed by subscriptions, sales, interest from funds bequeathed or apportioned, and donations received for such purposes. The Publications Committee shall direct the utilization and allotment of funds so received, as well as make relevant contracts and assume required obligations.
- Section 4. The Publications Committee may accept for publication and produce such other non-serial publications as are of sufficiently broad usefulness or desirability, are of such character as not to fit readily into regular serials, and for which financial support is available.

ARTICLE IX – LIBRARY

- Section 1. The Library of this Society shall contain books, periodicals, pamphlets, separates, and related bibliographic and biographic materials pertaining to entomology. These Society materials are housed in the library of the Academy of Natural Sciences of Philadelphia and are cared for by their librarians. The Society purchases and binds its publications.

ARTICLE X – MEETINGS

- Section 1. The biennial meeting for the election of officers and for other business shall be held on the first stated Society meeting in odd-numbered calendar years.
- Section 2. Stated meetings of this Society shall be held at such times as may be fixed at the biennial meetings but if any meeting can not be held on the date specified, the President may select the next available date.
- Section 3. Special meetings may be called by the President or at the request, in writing, of three members. Any such request shall state the purpose for which the meeting is to be called. Notification of any special meeting, stating the purpose for which it is being called, must be sent by first class mail, to all members eligible to vote, in time to be received at least one full week in advance of the meeting.
- Section 4. Ten members shall constitute a quorum at any meeting of the Society.
- Section 5. The order of business at meetings of the Society shall include the following:
1. Minutes of the previous meeting
  2. Report from the Executive Council
  3. Reports from officers and committees
  4. Business, deferred and new
  5. Communications, written and verbal
  6. Reports on items of entomological interest
  7. Program for the meeting.

## ARTICLE XI – PROHIBITIONS

- Section 1. No part of the assets of this Society shall, under any circumstances, be used for the benefit of any private individual.
- Section 2. No substantial part of the activities of this Society shall consist of carrying on propaganda, or attempting to influence legislation. This Society shall not participate in, or intervene in, any political campaign on behalf of any candidate for public office; nor shall it publish or distribute statements on behalf of any candidate.
- Section 3. This Society shall not be organized or operated for profit.
- Section 4. This Society shall not transact any business with any officer or member of the Society, or any substantial contributor to the Society, which shall result in gain to that individual, or corporate body, or which shall represent more than a proper consideration for services rendered, or goods or materials sold, to the Society.

## ARTICLES XII – DISSOLUTION

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    - 2nd. Other scientific and non-profit organizations having similar overall interests and objectives as this Society.
 All organizations under 1st and 2nd above shall be organized for scientific and educational purposes within the meaning of, and shall be exempt organizations under, Section 501(c)(3) of the Internal Revenue Code of 1954.

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- Section 1. Every proposal to alter or amend these bylaws shall be submitted in writing, signed by three members of the Society, shall be read at a stated membership meeting of the Society, and then referred to the Executive Council for consideration. At the next stated meeting of the Society, the Executive Council shall present the proposed amendment(s) for action, together with their recommendations. An affirmative vote on the proposed amendment(s) or modifications thereof, by at least 3/4ths of the members present, shall constitute their adoption as part of these bylaws.
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**GENUS *NIPPONONEBRIA***  
**IN THE NEARCTIC REGION, WITH DESCRIPTION**  
**OF A NEW SUBGENUS, *VANCOUVERIA***  
**(COLEOPTERA: CARABIDAE)<sup>1</sup>**

David H. Kavanaugh<sup>2</sup>

**ABSTRACT:** Based on a phylogenetic analysis to be presented elsewhere, three Nearctic species, described and formerly placed in the genus *Nebria* are recognized as the monophyletic adelphotaxon (sister group) of the two Palaearctic species in the genus *Nippononebria*. A new subgenus, *Vancouveria* (type species: *Nebria virescens*) is described for the Nearctic species (*Nippononebria virescens*, *N. alisierae*, and *N. campbelli*). The Palaearctic species (*Nippononebria chaldeola* and *N. pusilla*) represent the nominate subgenus.

*Nippononebria* was first described as a subgenus of *Nebria* Latreille by Uéno (1955:49; see also Uéno, 1952) to include two "remarkably different" Japanese species, *Nebria chaldeola* Bates (1883) and *Nebria pusilla* (Uéno) (1955). In his original description, Uéno cited the apically truncate fourth hind tarsomeres, a scutellar pore puncture on the elytral bases, impunctate metepisterna, and a well developed "sagittal aileron" at the aedeagal base in males as significant distinguishing features of this taxon.

Habu (1958) revised *Nippononebria* and, based on characters of external morphology of adults and larvae, concluded that this taxon should be ranked as a distinct genus. To Uéno's list of distinctive features of adults, Habu added the pubescence on the apical one-third of the third antennomeres. He also suggested that the elongate, projected nasale, reminiscent of that seen in *Leistus* larvae, and the absence of an inner lobe on the maxillary stipes were larval features supporting generic recognition distinct from *Nebria*. In this revision, Habu also described a new species, *Nippononebria kyushuensis* Habu (now considered a subspecies of *N. chaldeola* (Bates); see Nakane, 1963), and a new subspecies, *N. pusilla teres* Habu [later recognized as a junior synonym of *N. pusilla pusilla* (Uéno) (Habu, 1975)]. The only other taxa subsequently included in *Nippononebria* were *N. chaldeola horioi* and *N. pusilla yatsuana*, subspecies described by Nakane (1960).

Prior to my continuing study of Nearctic *Nebria* species and to the present, *Nippononebria* has been considered a strictly eastern Palaearctic taxon, with the geographical distributions of all known species and subspecies restricted to the islands of Honshu and/or Kyushu, Japan. An initial phylogenetic analysis (Kavanaugh, 1978), which included all known Nearctic *Nebria* species, representatives of all described *Nebria* subgenera, and selected Palaearctic

<sup>1</sup> Received March 17, 1995. Accepted April 25, 1995.

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*Nebria* species thought to be closely allied to Nearctic forms, suggested that one Nearctic species, *Nebria virescens* Horn, was closely related to the two *Nippononebria* species (*N. chalceola* and *N. pusilla*). Lindroth (1961) placed *Nebria virescens* in its own species group (the *virescens* group), but suggested no particular affinities for this taxon. In 1984, I described two new species, *Nebria altisierrae* and *Nebria campbelli*, which were apparently very closely related to *N. virescens* (Kavanaugh, 1985) and, therefore, could be included in Lindroth's *virescens* group.

Results of a recently completed and more comprehensive cladistic analysis of the Nearctic nebrine fauna (to be published elsewhere) provide evidence that *Nebria virescens*, *N. altisierrae*, and *N. campbelli* form a monophyletic group and, further, that this group is the adelphotaxon (sister group) of a monophyletic group that includes only the two Palaearctic species of *Nippononebria*. Consequently, I include in *Nippononebria* both the Palaearctic and Nearctic adelphotaxa and rank the putative monophyletic faunal groups as separate subgenera. The purpose of this paper, therefore, is to recognize the congeneric status of Nearctic and Palaearctic species groups, provide a revised diagnosis of the genus *Nippononebria* and a key to its subgenera, and briefly describe both the subgenus *Nippononebria*, as the name is here applied, and a new subgenus for the Nearctic species. More extensive descriptions of all taxa, figures illustrating all features discussed, and a comprehensive presentation of the data and results of the cladistic analysis, upon which this paper is based, will be presented elsewhere, in a revision of the Nearctic nebrine fauna (manuscript in preparation).

### Genus *Nippononebria* Uéno

Type species: *Nebria pusilla* Uéno (1955:47), by original designation.

**Diagnosis.** The following features are postulated as synapomorphies in support of the monophyly of this genus and, in combination, also serve to distinguish its members from those of other nebrine genera:

Antennal scape markedly narrowed basally; paraglossae distinct, dentate and minute, not completely fused with glossal sclerite; epilobe of mentum with tooth long; mesosternum, mesepisternum, metasternum (laterally), and metepisternum smooth, impunctate; tarsomeres with dorsal pubescence present but short and very sparse; male median lobe with mid-shaft moderately narrowed basally and slightly compressed in cross-section, apical orifice (in apical aspect) slightly deflected right; female proctiger (mediotergite IX) short, broad, membranous apically, setae of valvifer (laterotergite IX) medium length, gonocoxa (stylocoxa 1) and gonostylus (stylocoxa 2) fused medially, widely separated by membranous region laterally, sparsely setose ventrally; diameter of distal portion of spermathecal duct extremely narrow.

**Relationships and ranking.** Although several synapomorphies for *Nippononebria* are provided above, most of the features noted by Uéno (1955) as distinctive for *Nippononebria* probably represent symplesiomorphies among the Nebriini and other basal carabid tribes. Such features include the apically truncate fourth hind tarsomeres, a scutellar pore puncture on the elytral bases, and a "sagittal aileron" (a thin, vertical, fin-like sclerite in the dorsal midline) at the base of the median lobe in males. The larval features cited by Habu (1958) in support of a generic distinction between *Nebria* and *Nippononebria* also require reinterpretation and additional comment. Larvae of *Nippononebria virescens*, which I have reared from captive adults but not yet described in publication, also have the nasale elongate and projected, and lack the inner lobe of the maxillary stipes, as in *Nippononebria chaldeola* larvae. However, both of these features are shared also with larvae of genus *Leistus* Frölich and, therefore, cannot be viewed as synapomorphies for *Nippononebria* alone. In fact these larval characteristics, as well as several morphological features of adults (manuscript in preparation), support instead the monophyly of a group including only *Leistus* and *Nippononebria* as adelphotaxa. It is this inferred closer phylogenetic relationship of *Nippononebria* with the highly distinctive genus *Leistus* than with *Nebria*, members of which are superficially more similar, that provides the most compelling argument for recognition of *Nippononebria* as a distinct genus.

**Distribution.** Holarctic (Fig. 2), trans-North Pacific, with species restricted to Honshu and/or Kyushu islands, Japan, in the eastern Palaearctic Region, and to the Pacific coastal area, from southern British Columbia to central California, in the western Nearctic Region.

### Subgenus *Nippononebria* Uéno

Type species: *Nebria pusilla* Uéno (1955:47), by original designation.

**Diagnosis.** The following features are postulated as synapomorphies in support of the monophyly of this subgenus and, in combination, also serve to distinguish its members from those of its adelphotaxon:

Antennomere 3 with moderately dense pubescence on apical one-third; anterior margination of pronotum broad and markedly impressed; elytra moderately convex; male median lobe with preapical shaft faintly deflected right, apex slightly deflected right (in ventral aspect) and bluntly pointed (in lateral aspect); female with basal apodeme of hemisternite VIII emarginate completely to base, bursa copulatrix with spermathecal chamber flat and thin (in lateral aspect), spermathecal duct markedly long.

Although not considered synapomorphies, the following additional features help to distinguish members of subgenus *Nippononebria* from those of subgenus *Vancouveria*:

Elytral microsculpture only faintly impressed; posterior transverse impression of pronotum slightly to markedly deepened and narrow; male with parameres unequal in length, right paramere much longer than left, left paramere broad, short, and narrow basally, right paramere slender and moderately long; female with medial portion of apical margin of hemisternite VIII only moderately setose, valvifer sparsely setose, gonocoxa (stylocere 1) with 3 or 4 medium-length setae in ventral diagonal row, setae in mediodorsal row short or medium length, ventral surface of both gonocoxa and gonostylus (stylocere 2) densely setose medially.

**Distribution.** The geographical range of this subgenus is restricted to Japan. *Nippononebria pusilla* (Uéno) is represented by two subspecies (*N. pusilla* s. str. and *N. pusilla yatsuana* Nakane), both restricted to central Honshu. *Nippononebria chaleola* is represented by two subspecies on Honshu (*N. chaceola* s. str. and *N. chalceola horioi* Nakane) and a single subspecies on Kyushu (*N. chalceola kyushuensis* Habu).

### Subgenus *Vancouveria*, NEW SUBGENUS

Type species: *Nebria virescens* Horn (1870:100), here designated.

**Diagnosis.** The following features are postulated as synapomorphies in support of the monophyly of this subgenus and, in combination, also serve to distinguish its members from those of its adelphotaxon:

Elytral microsculpture very deeply impressed; posterior transverse impression of pronotum slightly shallow and broad; prosternal intercoxal process with margination only in basal one-half; elytra with apex narrowly oblique, laterally displaced from midline, and posteriorly acute, sutural margin angulate at apex; abdominal sterna III to V each with 2 pairs of posterior paramedial setae: male with parameres approximately equal in length, left paramere broad, medium length, and broad basally, right paramere broad and slightly shortened; female with medial portion of apical margin of hemisternite VIII densely setose, valvifer moderately densely setose, gonocoxa (stylocere 1) with 5 or 6 moderately long setae in ventral diagonal row, setae in mediodorsal row moderately long, and medial surface densely setose, gonostylus (stylocere 2) asetose medially.

Although not considered synapomorphies, the following additional features help to distinguish members of subgenus *Vancouveria* from those of subgenus *Nippononebria*:

Antennomere 3 without or with only extremely sparse pubescence on apical one-third; anterior margination of pronotum moderate in width and depth of impression; elytra only slightly convex; male median lobe with preapical shaft and apex straight and symmetrical (in ventral aspect), apex narrow, sharply pointed (in lateral aspect); female with basal apodeme of hemisternite VIII markedly emarginate, but emargination not extended to base, bursa copulatrix with spermathecal chamber flat and thick (in lateral aspect), spermathecal duct only slightly longer than average for nebrines.



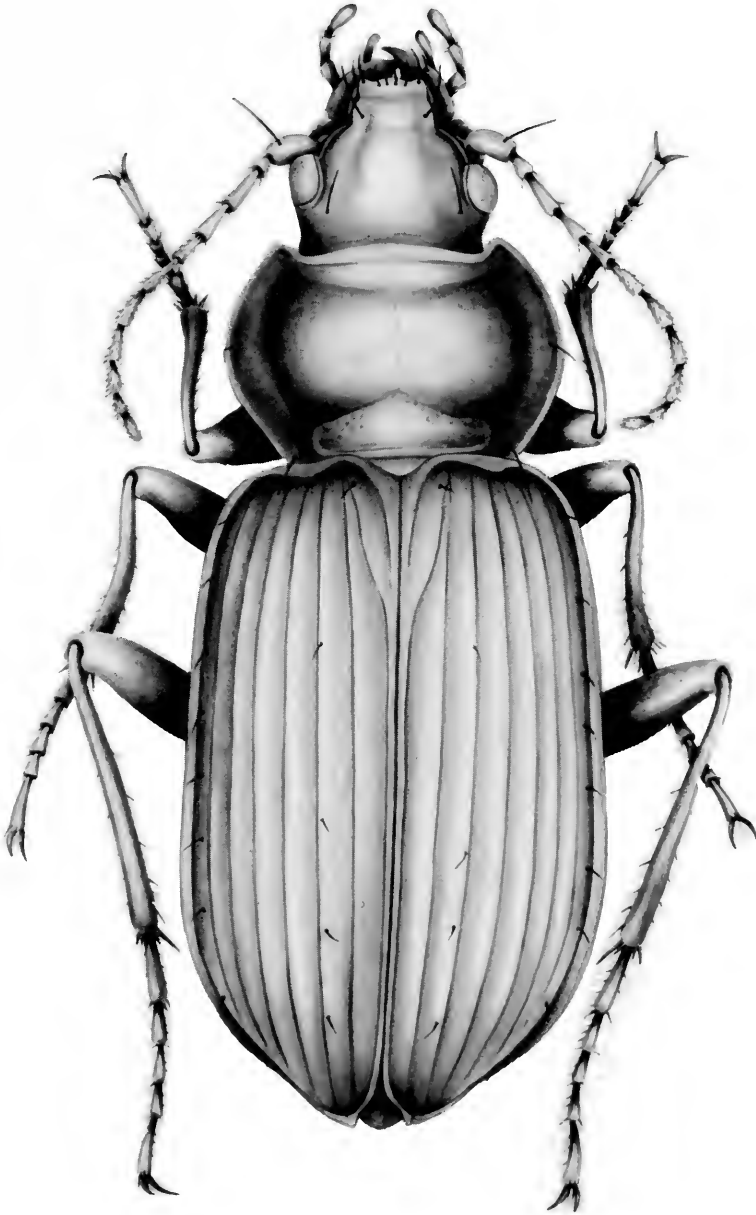


Figure 1. Habitus drawing, *Nippononebria (Vancouveria) virescens* (Horn), adult female from Benton County, Oregon; scale line = 1.0 mm.

**Distribution.** This subgenus is restricted to a portion of the west coast of North America (Fig. 2) [see also Bousquet and Larochelle, 1993]. *Nippononebria virescens* (Horn) is broadly distributed in coastal regions from southwestern British Columbia to northern California, with an eastern extension of its range into the Columbia River Basin to eastern Washington, northwestern Idaho, and northeastern Oregon. *Nippononebria altisierrae* (Kavanaugh) is restricted to the central Sierra Nevada of California, from Tuolumne County south to Sequoia National Park; and *Nippononebria campbelli* (Kavanaugh) is restricted to high montane areas in southcentral British Columbia and north-central Washington.

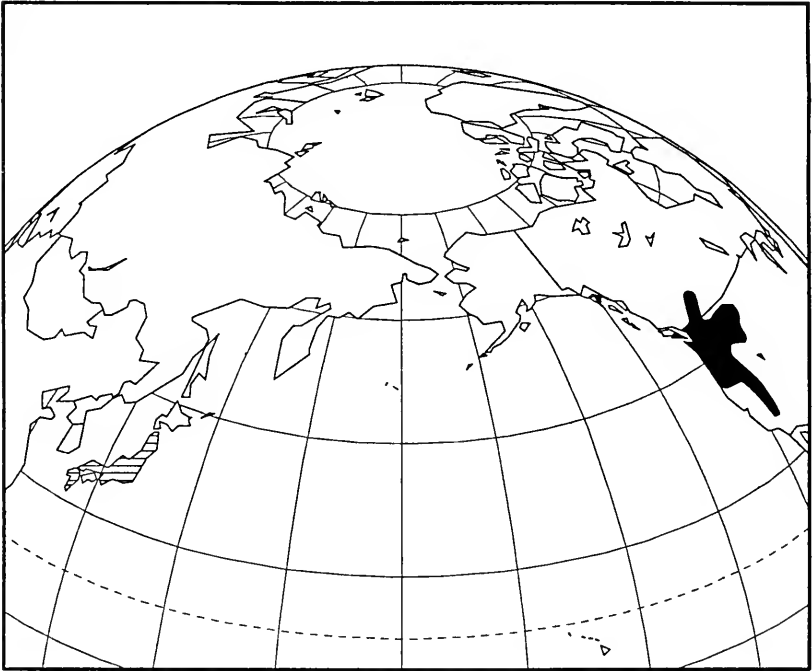


Figure 2. Map illustrating geographical distributions of subgenera of *Nippononebria* Uéno; area with horizontal lines = subgenus *Nippononebria*; area in black = subgenus *Vancouveria* Kavanaugh.

As an aid for identification of specimens to subgenus, I provide the following key.

### Key to Subgenera of *Nippononebria*

- Antennomere 3 with moderately dense pubescence on apical one-third; elytral apex bluntly pointed at midline, sutural margin straight at apex; abdominal sterna III to V each with 1 pair of posterior paramedial setae [specimen from eastern Palaearctic Region (Japan)] . . . . .  
 . . . . . subgenus *Nippononebria*
- Antennomere 3 without or with extremely sparse pubescence on apical one-third; elytral apex narrowly oblique, laterally displaced from midline, and posteriorly acute, sutural margin angulate at apex; abdominal sterna III to V each with 2 pairs of posterior paramedial setae [specimen from western Nearctic Region (Pacific Coast of North America)] . . . . .  
 . . . . . subgenus *Vancouveria*

### Checklist of *Nippononebria* Taxa

Genus *Nippononebria* Uéno

Subgenus *Nippononebria* Uéno

*Nippononebria* (*Nippononebria*) *pusilla* (Uéno)

*Nippononebria* (*Nippononebria*) *pusilla pusilla* (Uéno)

*Nippononebria* (*Nippononebria*) *pusilla yatsuwana* Nakane

*Nippononebria* (*Nippononebria*) *chalceola* (Bates)

*Nippononebria* (*Nippononebria*) *chalceola chalceola* (Bates)

*Nippononebria* (*Nippononebria*) *chalceola horioi* Nakane

*Nippononebria* (*Nippononebria*) *chalceola kyushuensis* Habu

Subgenus *Vancouveria*, new subgenus

*Nippononebria* (*Vancouveria*) *virescens* (Horn), new combination

*Nippononebria* (*Vancouveria*) *altisierrae* (Kavanaugh), new combination

*Nippononebria* (*Vancouveria*) *campbelli* (Kavanaugh), new combination

### ACKNOWLEDGMENTS

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## XX INTERNATIONAL CONGRESS OF ENTOMOLOGY

This great event will be held August 25 - 31, 1996 in Firenze, Italy. Over 140 Section Symposia, Workshops, and Special Interest Group Meetings will be offered in twenty four sections. Abstracts of papers to be considered by the Scientific Committee for presentation must be submitted by January 31, 1996. Registrations fees are set to provide incentives for early registration: by January 31, 1996, or by April 30, 1996, or thereafter. Deadline for registration is July 15, 1996. Further details may be obtained from the Organizing Secretariat, O.I.C., Via A La Marmora 24, 50121 Firenze, Italy.

## BIOLOGY, DEVELOPMENT AND LARVAL CHARACTERS OF *OXYPORUS MAJOR* (COLEOPTERA: STAPHYLINIDAE)<sup>1</sup>

Michael A. Goodrich<sup>2</sup>, Rodney S. Hanley<sup>3</sup>

**ABSTRACT:** Known aspects of the life history and habits of *Oxyporus major* are described, based on material collected in the field and reared in the laboratory. Adults inhabit mature basidiocarps of a variety of fungi, including *Stropharia hardii*, *Lepiota acutaesquamosa*, and *Armillaria* spp. Two cases of oviposition and larval development in *S. hardii* are described. Development of *O. major* is very rapid, with progression from eggs or early larval instars to adults in 13-15 days at 21-23° C. Female protection of oviposition sites is suggested by field observations. The mature larva of *O. major* is described and illustrated.

Species of *Oxyporus* are known to be obligate inhabitants of higher fleshy mushrooms (Ashe 1984, Leschen and Allen 1988, Hanley and Goodrich 1994a, 1994b). The immatures of only six of the 14 species of *Oxyporus* known to occur in North America have been described (Paulian 1941; McCabe and Teale 1981; Leschen and Allen 1988; Hanley and Goodrich 1994a). The purpose of this paper is to describe the larva of a seventh, *Oxyporus major* Gravenhorst, and to describe known aspects of its life history and habits.

Adult *O. major* are large and black, with one or two distinct, ivory-colored longitudinal vittae on each elytron (see Campbell [1969] and Hanley and Goodrich [1994b] for complete diagnostic descriptions). Adults have been collected from Vermont and New Hampshire south to South Carolina and Georgia, and west to Missouri and Arkansas (Hanley and Goodrich 1994b). The larvae of *O. major* are undescribed and adults have not been reared from a host fungus until now.

### METHODS

On 31 July 1994, one of us (MAG) collected one male and two female *O. major* on three widely separated basidiocarps of *Stropharia hardii* Atkinson in Baber Woods Nature Preserve, 4 miles SSE of Kansas, Edgar County, Illinois. Each adult was found in a tunnel (Fig. 14) in the host basidiocarp. The basidiocarps were visually inspected in the field at the time of collection, and a few hours later under a dissecting microscope in the laboratory, but no eggs or lar-

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vae were observed. However, this inspection was carefully performed to avoid damage to the tunnels produced by the beetles and to provide the best chance of development of any offspring that might be present, thus eggs and/or first larval instars could easily have been overlooked.

As the presence of eggs and/or first larval instars was suspected, two of the host basidiocarps (those found with adult females inside) were placed in a rearing chamber made from a 1.1 kg coffee can with a substrate of loose potting soil with a depth of 7.5 cm. A perforated plastic lid served as a cover to retain moisture, while permitting exchange of gases with the atmosphere. The third basidiocarp was preserved until the identity of the host fungus was confirmed.

Twenty-eight to 30 hours after collection, the basidiocarps in the rearing chamber were reexamined. Two large, mature larvae of *Oxyporus* were found. One of these was removed and preserved by killing in boiling water and preservation in 80% ethanol; the other was returned to the rearing chamber with the two basidiocarps. No other larvae were observed at this time, although it should be noted that a non-destructive examination of the basidiocarps was again performed, thus early larval instars could have been missed. The basidiocarps were returned to the rearing chamber and maintained in the laboratory at 21-23°C, with the chamber examined daily for emergence of adult beetles.

After five-six days, the basidiocarps were reduced to a remnant of their original structure. Any larvae present earlier would have had to complete development and crawl into the soil to pupate by this time. On 12 August, 13 days after collection of the specimen, one fully pigmented and sclerotized adult *O. major* was found in the rearing chamber. On 13 August, 13 additional fully pigmented and sclerotized adults of *O. major* were collected in the rearing chamber. The chamber was checked daily for two weeks with no additional emergence of specimens. At this point the soil in the chamber was removed and carefully examined. No additional larvae, pupae, or adult specimens were found.

The chaetotaxy used in the description of the mature larva of *O. major* is based on the system used by Hanley and Goodrich (1994a) in the description of the larvae of *O. stygicus* Say.

## RESULTS AND DISCUSSION

### Description of mature larva of *Oxyporus major* Gravenhorst.

**Length** 3.5 mm. Body elongate, gently curved, parallel-sided, slightly flattened dorsoventrally. Color white with thoracic and abdominal terga brown; head dark yellow to brown. Vestiture length variable, setae simple.

**Head.** Cylindrical to oval; ecdysial lines distinct, lateral arms fork-shaped, complete from back of head to bases of antennae; six pigmented stemmata in two vertical rows on each side (Fig. 1); setal arrangement as in Figs. 1 and 2. Antenna 3-segmented and inserted anterodorsally near stemmata in membranous socket; segment I elongate, asetose, length 4 times width; segment II trisetose, 0.6 times length of segment I, bearing tubercle-like sensory appendage with distinct basal collar, a single, narrow, conical sensory appendage also present; antennomere III 0.5 times length of segment II, bearing inner circle of 3 small, subequal setae at apex, surrounded by outer circle of 3 longer setae (Fig. 3). Labrum fused to frons with anterior margin serrate; chaetotaxy with labral marginal and labral lateral rows of 2 setae each, labral dorsal row of 1 seta (Fig. 4). Adoral surface of labrum (epipharynx) with numerous branched microtrichia and a large median furrow. Mandibles broad, flat, bifid apically, stout basally; margins finely serrate with many fine teeth, lateral margin with 2 small setae, protheca absent (Fig. 5). Maxilla with cardo triangular, fused to stipes and mala, with 1 small seta; mala short, stout, trilobed, inner lobe with 2 non-articulated spines, middle lobe with 1 non-articulated spine, outer lobe with 1 non-articulated and 2 articulated spines dorsally (Fig. 6). Maxillary palpus 3-segmented; segment I asetose, about as long as wide; segment II bisetose, length 1.2 times length of segment III; segment III conical, asetose, minute sensory structure at apex (Fig. 6). Labium with diamond-shaped submentum and trapezoidal mentum, ligula absent; labial palpus 2-segmented, directed ventrally; segment I 0.6 times length of segment II; segment II elongate and conical with 3 very minute setae at apex; palpigers fused to form ventral premental sclerite bearing 3 pairs of setae, no campaniform sensillae present (Fig. 7).

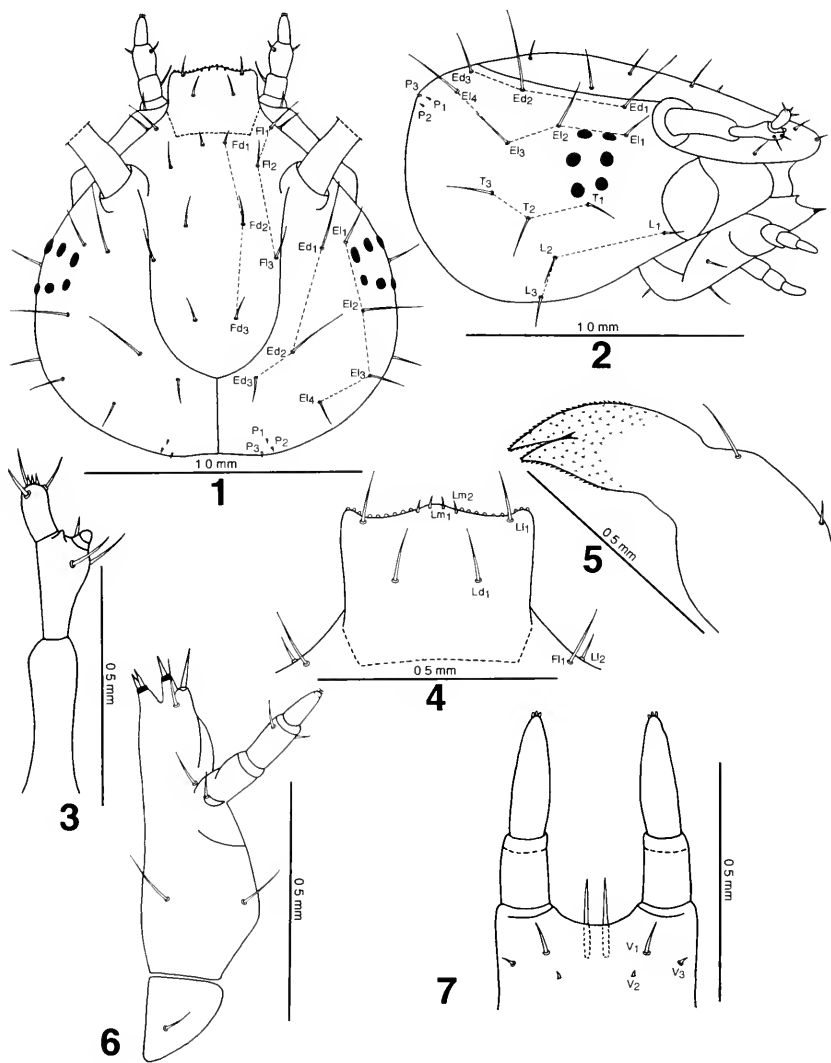
**Thorax.** Pronotum transverse, broadly oval, moderately sclerotized; chaetotaxy with anterior rows of 4 setae, discal and lateral rows of 3 setae each, posterior rows of 8 setae (Fig. 8). Mesonotum transverse, moderately sclerotized; chaetotaxy with anterior rows of 7 setae, posterior rows of 6 setae, lateral rows of 5 setae, membranes with 4 setae ( $M_2$  grouped with  $M_{3,4}$ ) (Fig. 9). Metanotum transverse; chaetotaxy similar to mesonotum, except only 4 setae present in lateral row (Fig. 10). Legs long, each similar in size and configuration; chaetotaxy with 9 setae on coxa, 6 setae on trochanter, 5 setae on tibia, 2 setae on tarsus (Fig. 11).

**Abdomen.** Tergum I transverse, chaetotaxy with anterior and posterior rows of 4 setae each, lateral rows of 3 setae, laterotergites with 3 setae each, no marginal setae present (Fig. 12); tergites and sternites of segments II-VIII similar in setation. Tergite IX with 3 pairs of setae at lateral margins, 1 pair of marginal setae and minute campaniform sensillae on disc (Fig. 13). Urogomphi 2-segmented; basal segments arising from tergum IX, each with 5 setae on apical half; segment II with 1 small ventral seta and 2 small apical setae. Abdominal segment X slightly tapered from base to apex, setation consisting of 12 setae (Fig. 13).

**Diagnosis.** The mature larva of *O. major* is similar to other described species of *Oxyporus*, including *O. vittatus* Gravenhorst (Leschen and Allen 1988) and *O. stygicus* (Hanley and Goodrich 1994a). Diagnostic differences between mature larvae of *O. major* and these species are found in a combination of the following characteristics:

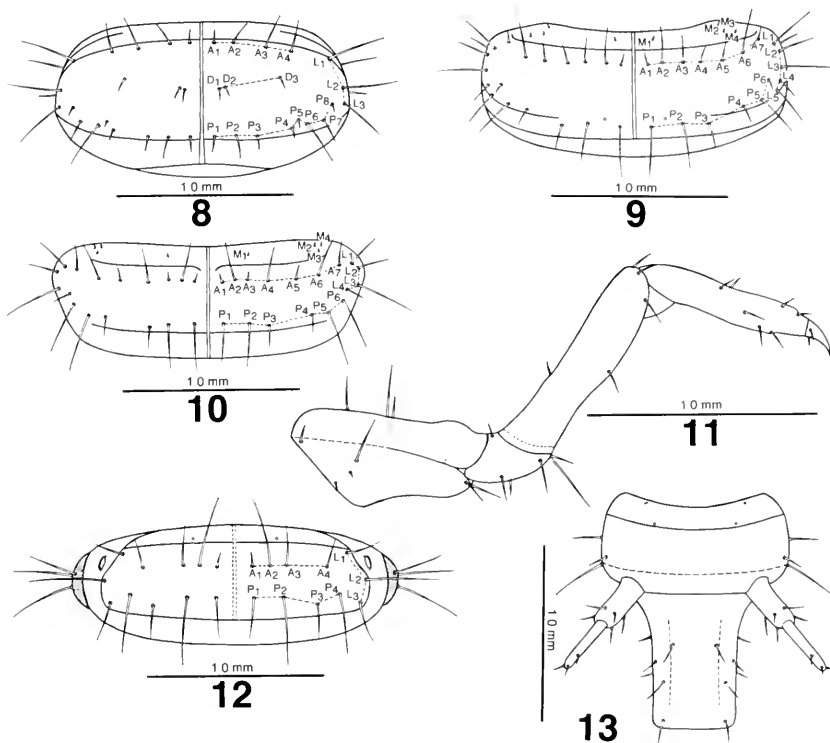
Epicranial seta  $El_1$  located medial to uppermost stemmata; lateral head seta  $L_4$  absent; labral marginal seta  $Lm_3$  absent; 4 setae in anterior and 8 setae in posterior rows of pronotum; 7 setae in anterior, 6 in posterior and 5 in lateral rows of mesonotum; 7 setae in anterior, 6 in posterior and 4 in lateral rows of metanotum; 4 setae in anterior rows and no marginal setae on abdominal tergum I.

**Development.** We have reported the rapid development of larvae in *O. stygicus* (Hanley and Goodrich 1994a). In *O. stygicus* the developmental time



Figs. 1-7. *Oxyporus major* Gravenhorst, mature larva. 1. head, dorsal view. 2. head, lateral view. 3. antenna, ventral view. 4. labrum, dorsal view. 5. mandible, dorsal view. 6. maxilla, dorsal view. 7. labium, ventral view. Abbreviations: Ed, epicranial dorsal row setae; El, epicranial lateral row setae; Fd, frontal dorsal setae; Fl, frontal lateral row setae; L, lateral row setae; Ll, labral lateral setae; Lm, labral marginal setae; P, posterior epicranial setae; T, temporal row setae; V, ventral setae.





Figs. 8-13. *Oxyporus major* Gravenhorst, mature larva. 8. dorsal aspect of thorax, pronotum. 9. mesonotum. 10. metanotum. 11. prothoracic leg, anterior view. 12. abdominal tergum I. 13. abdominal terga IX-X. Abbreviations: A, anterior row setae; D, discal row setae; L, lateral row setae; M, membrane setae; P, posterior row setae.

from egg to adult was 16-18 days, with 7-10 days spent as pupae. In *O. major*, development is even more rapid, with fully pigmented and sclerotized adults emerging 12-13 days after collection of the basidiocarps of the host fungus. At most, the original samples contained eggs or early larval instars. The adult that emerged on 12 August must have been the single larva large enough to be visible on 1 August; the other 13 adults emerging on 13 August were still too small to be detected on 1 August, but clearly were still able to complete larval development and enter the soil to pupate by 5 August. Based on these observations, and our study of *O. stygicus*, we estimate total development time from egg to adult of *O. major* to be 13-15 days.

Rapid development of *Oxyporus* spp. is hypothesized as an adaptation to the ephemeral nature of the host fungi (Hanley and Goodrich, 1995). This has been observed earlier for *Oxyporus* spp. by Leschen and Allen (1988) and Hanley and Goodrich (1994a), other fungus feeding Staphylinidae (Ashe 1981, 1984, 1990; Bruns 1984) and fungus-feeding beetles in other families that develop in ephemeral fungi (Bruns 1984; Goodrich and Skelley 1991, 1993, 1994, 1995; Leschen 1988; Leschen and Carlton 1988).

**Host Relationships.** Nine fungal hosts of *O. major* are reported from six families of fungi (Table 1). Adults have been most frequently collected in *Stropharia hardii*, *Lepiota acutaesquamosa* (Weinm.) Kummer, and *Armillaria* spp. The only known larval host of *O. major* is *S. hardii*.

**Feeding and Tunnel Behavior.** Specimens of *O. major* were found within cylindrical tunnels extending from an opening in the undersurface of the cap into the center of the basidiocarps (Fig. 14). These tunnels likely serve as feed-

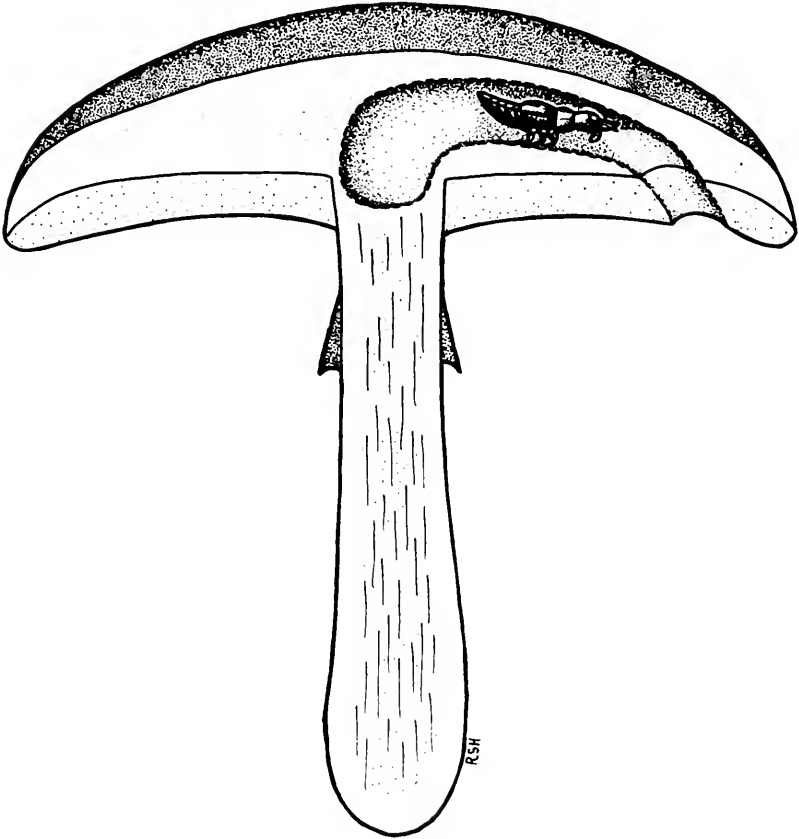


Fig. 14. Tunnel constructed by adult *Oxyporus major* Gravenhorst within host fungus, *Stropharia hardii* Atkinson.

ing chambers for both adults and larvae. The presence of a single female *O. major* in each of the basidiocarps containing eggs and/or larvae suggests guarding of the offspring and their food supply against predators or competing insects, including other individuals of *O. major*. Female egg guarding has also been observed in *O. japonicus* Sharp (Setsuda 1994). We have earlier reported the construction of similar tunnels in host basidiocarps by *O. occipitalis* Fauvel (Hanley and Goodrich 1993) and *O. stygicus* (Hanley and Goodrich 1994a; 1994b), but without observing behavior interpreted as brood chamber guarding.

**Table 1. Known fungal hosts of *Oxyporus major* Gravenhorst.**

Host	Number of Collections	Number of Specimens Taken
<b>Boletaceae</b>		
<i>Boletus</i> sp. <sup>a</sup>	1	1
<b>Cortinariaceae</b>		
<i>Pholiota</i> sp.	1	1
<b>Lepiotaceae</b>		
<i>Lepiota acutaesquamosa</i>	7	15
<b>Russulaceae</b>		
<i>Lactarius</i> sp. <sup>b</sup>	---	---
<i>Russula</i> sp.	3	3
<b>Strophariaceae</b>		
<i>Stropharia hardii</i>	13	33*
<b>Tricholomataceae</b>		
<i>Armillaria gallica</i> (Marxüller and Romagnesi)	2	2
<i>Armillaria mellea</i> (Vahl: Fr.) Kummer	1	1
<i>Armillaria tabescens</i> (Scop.: Fr.) Emel.	1	1

<sup>a</sup> Reported by Newton (1984).

<sup>b</sup> Reported by Campbell (1969) (no collection records given).

\* Includes both adults and larvae.

#### ACKNOWLEDGMENTS

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**TAXONOMIC NOTES AND DISTRIBUTIONAL DATA  
ON NEARCTIC SPECIES OF *CRYPTORHOPALUM*  
(COLEOPTERA: DERMESTIDAE) WITH DESCRIPTION  
OF A NEW SOUTHWESTERN U. S. SPECIES<sup>1</sup>**

R. S. Beal, Jr.<sup>2</sup>

ABSTRACT: *Cryptorhopalum brooksi* from southeastern Arizona and southwestern New Mexico is described as new. *Cryptorhopalum anthrenoides* is considered a valid species, removed from synonymy with *C. pruddeni*, and redescribed. *Cryptorhopalum pruddeni* is redefined. SEM details of female abdominal sternum 5 are provided for *C. brooksi* n. sp., *C. distichia*, *C. pruddeni*, *C. sapindi*, and *C. woolfi*. Range extensions are provided for *C. focale*, *C. haemorrhoidale*, *C. uteanum*, and *C. woolfi*.

The following is an addendum to my taxonomic revision of the Nearctic species of *Cryptorhopalum* (Beal, 1985) based on a study of additional material that has been made available to me.

Measurement in length of specimens is made from the front of the pronotum to the apex of the elytra. Measurement in width is made across the humeri.

*Cryptorhopalum anthrenoides* Casey, 1916, REVISED STATUS

In 1979 I reduced *C. anthrenoides* to synonymy with *C. pruddeni* Casey (1900), an error that was continued in my 1985 revision. Since then I have been able to reexamine the holotype of *C. anthrenoides* and to dissect the terminalia of some specimens virtually identical with the holotype. I found abdominal sternum 8 not only dissimilar to that found in *C. pruddeni* but of a form unknown in any species of the genus thus far studied. Consequently, *C. anthrenoides* must be considered a distinct species and is redescribed as follows.

**Adult male:** Dorsal integument immaculate, yellowish brown to dark reddish brown. Dorsal pubescence consisting of golden brown and white to creamy white hairs. Elytron with whitish hairs forming humeral patch, submedian and subapical bands, and apical patch; bands sometimes sparse and interrupted; whitish basal hairs sometimes present (Fig. 2). Antennal club ovate.

Head with diameter of punctures of frons at middle about 2/3 diameter of facet of eye, punctures becoming larger at sides and equal to 2 times diameter of facet of eye; punctures mostly not contiguous. Pronotum with punctures of disc about equal in diameter to facet of eye and separated by distance equal to 2 or 3 times diameter of puncture. Antennal club reddish brown; ratio of width to length of segment 10 varying from 1:0.9 to 1:1.0; ratio of length of segment 11 to length

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of segment 10 varying from 1:1.3 to 1:1.6; ratio of length of club to length of lateral margin of pronotum varying from 1:1.9. Hypomeron at narrowest point behind antennal fossa as wide as 1 1/6 times width of segments of funicle of antenna. Visible abdominal sternum 1 with 2 oblique striae on each side near middle; striae parallel and extending length of segment. Front tibia widest at middle and tapering slightly to apex.

Sternum of morphological abdominal segment 8 without median cluster of setae at apical margin; lateral lobes digitiform, about as long as 1/2 width of segment; margins of apical 1/2 of each lobe with numerous long and fine setae (Fig. 1). Aedeagus with short, proximally directed, spine-like process on phallosome. Parameres with wide bridge.

Length: 2.1 to 2.6 mm. Ratio of width to length varying from 1:1.40 to 1:1.51.

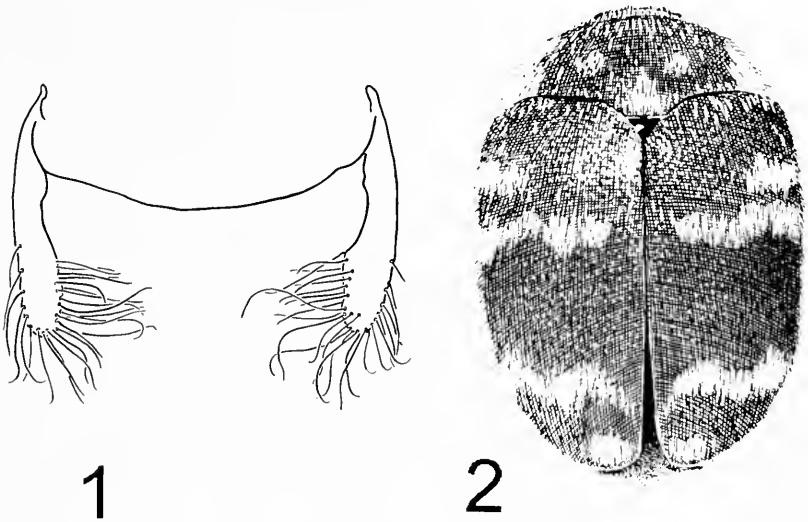
**Adult female:** As males except that antennal club smaller and width of hypomeron behind antennal fossa about 1 1/7 times as wide as greatest width of front tibia. Visible abdominal sternum 5 with 2 transversely oval maculae 5/11 times as long as visible length of sternum, each about 1.7 times as wide as long; maculae bounded by fine, thread-like, unbroken carina. Length: 2.9 mm. Ratio of width to length: 1:1.20.

**Type specimen:** The unique male type in the Casey collection of the U. S. National Museum of Natural History (USNM) (No. 37557) bears the label "Ari" with a line drawn above and a line below the letters. In the original description, the specimen is stated to be from the Santa Catalina Mountains, Arizona. Presumably the specimen was taken in the southern foothills of the mountains, possibly at Sabino Canyon.

**New Records:** ARIZONA: Cochise Co.: Cave Creek Canyon, Chiricahua Mts, 4-VIII-86 (S. M. Fondriest; 1 female, Montana State Univ. coll'n.). Pima Co.: Santa Catalina [Mt.] foothills, 6-IV-68 (K. Stephan, 1 male, Bureau of Entomology, Florida Dept. Agric.); Tucson, 27-IV (Hubbard and Schwarz, 2 males, USNM); *ibid.*, 16-VIII-40 (D. J. and J. N. Knull, 1 male, Ohio State Univ. coll'n.). Yavapai Co.: 2.5 miles upstream from Beaver Creek Ranger Station, 14-VII-69, on mesquite (R. S. Beal, 1 female, Calif. Acad. Sci.). BAJA CALIFORNIA, MEXICO: San Vicente, 8-VII-63 (C. H. Frady, 1 male, Oregon State Univ. coll'n.).

**Discussion:** The shape of the phallus, the presence of 2 stria on each side of visible abdominal sternum 1, and the presence of submedian and subapical bands and an apical patch of light pubescence on the elytron associate *C. anthrenoides* with the *Quadripunctatum* group of species. In other species of this group for which the terminalia have been described, each lateral lobe of abdominal sternum 8 forms a long, slender, sclerotized, gradually-tapering, medially directed apodeme with small setae along the margins and a single, large seta at the apex. In this species the lateral lobes are weakly sclerotized, somewhat fleshy, slightly clavate, and provided with numerous, long, fine setae.

Males will key to couplet 6 in the "Key to Adult Males of the *Quadripunctatum* Group" in my 1985 revision, a couplet that includes *C. woolfi* and *C. pruddeni*. Generally *C. anthrenoides* can be distinguished from these 2 by



Figs. 1-2. *C. anthrenoides*. 1. Posterior margin of morphological sternum 8. 2. Habitus drawing of male from Santa Catalina Mt. foothills, Arizona.

its more rotund shape and by the much thinner and sometimes interrupted submedian and subapical bands of pale pubescence on the elytra. The male antennal club of *C. anthrenoides* is usually relatively longer and narrower than that of *C. woolfi*, although there is a very small overlap in their ranges (ratio of width to length in *C. anthrenoides* 1:1.6 to 1:1.8; in *C. woolfi* 1:1.4 to 1:1.6). The ratio of width to length will separate known specimens of *C. anthrenoides* (ratio 1:1.40 to 1:1.51) from known specimens of *C. pruddeni* (ratio 1:1.55 to 1:1.75). Females of *C. anthrenoides* will key to *C. pruddeni* in the "Key to Adult Females of the Quadripunctatum Group." The transversely oval maculae on abdominal sternum 5 separates them from females of *C. pruddeni*, in which the maculae are more or less round.

### *Cryptorhopalum brooksi* NEW SPECIES

In 1985 I listed a "Form unnamed near *Cryptorhopalum woolfi*." The male terminalia seemed identical with those of *C. woolfi*, and there was no certainty

that the single female, which was manifestly different from females of *C. woolfi*, was conspecific with the males. Since then some associated males and females have been made available for my study along with a number of specimens from other localities. The form clearly represents a distinct species and is described as follows.

**Adult male:** Dorsal pubescence consisting of dark golden brown and silvery white hairs; silvery white hairs on elytron forming basal, subbasal, and subapical bands and apical patch. Dorsal integument with head dark brown, pronotum medium brown, and elytra somewhat light brown. Antennal club ovate.

Head with diameter of punctures of frons at middle about 1 1/2 times diameter of facet of eye and separated by 1 to 1 1/2 times diameter of puncture; punctures becoming larger laterally and separated by about 1/2 times diameter of puncture. Pronotum with silvery white hairs on sides and intermingled dark and silvery white hairs on disc, except patch of all dark hairs at middle and small patch at middle half way from midline to lateral margin; punctures of disc about 1/2 times diameter of facet of eye and separated by 3 to 5 times diameter of single puncture. Elytron with basal band well-developed but interrupted by few dark hairs; subbasal band well-developed, extending anteriorly along suture to meet basal band; diagonal line of hairs over humerus connecting basal and subbasal bands laterally, thus basal and subbasal bands enclosing subbasal patch of dark hairs; subapical band well-developed but interrupted by thin line of dark hairs; apical patch prominent; subbasal and subapical bands and apical patch connected along suture by somewhat sparse line of pale hairs, otherwise pale hairs mostly lacking between bands. Antennal club reddish brown; ratio of width to length of segment 10, 1:1.0; ratio of length of segment 11 to length of segment 10, 1:1.3; ratio of width to length of entire club 1:1.84. Hypomeron behind antennal fossa as wide at narrowest point as 1 1/2 times width of segment 4 of antenna. Prosternum without median carina. Visible abdominal sternum 1 with 2 nearly parallel oblique striae on each side extending length of segment from beneath trochanters. Front tibia widest at middle and tapering slightly toward apex.

Sternum of abdominal segment 8 without median cluster of setae at apical margin; lateral apophysis long; seta inserted at apex about as long as apophysis, evenly curving, somewhat clavate at apex; shaft of apophysis with setae on posterior margin only. Phallus with small, anteriorly-directed, spine-like process on phallosome of aedeagus; parameres with wide bridge.

Length: 2.5 mm; width: 1.5 mm.

**Adult female:** As male except that pronotum with very small sublateral patch of all dark hairs and small, indistinct, median dark spot of intermingled pale and dark hairs. Elytron with few pale hairs along suture between subbasal and subapical bands and with few scattered pale hairs in space lateral to sutural line between subbasal and subapical bands. Antennal club small. Hypomeron at narrowest point behind antennal fossa subequal to greatest width of front tibia. Visible abdominal sternum 5 with 2 large maculae (Figs. 3, 4), each with diameter about 6/9 visible length of sternum; maculae not enclosed by carinae.

Length: 2.6 mm; width: 1.5 mm.

**Range of observed variations:** Pale hairs of dorsum varying from silvery white to pale golden, often silvery white on pronotum becoming more golden toward apex of elytra. Dorsal integument light reddish or yellowish to mahogany brown; pronotum sometimes much darker than elytra. Pronotum with dark hairs forming discal spot and sublateral spot; discal spot large and connected with lateral spots or small and separated from lateral spots; lateral spot consisting of very few dark hairs with intermingled pale hairs or distinct patch of all dark hairs; dark hairs often but not always present on basal margin on either side of basal lobe. Elytron usually without any pale



hairs between submedian and subapical band but when present mostly confined to line along suture; subbasal band usually not interrupted, usually more or less irregular in length but not forming 2 distinct patches. Antennal club of male with ratio of width to length of segment 10 varying from 1:0.8 to 1:1.1; ratio of length of segment 11 to length of segment 10 varying from 1:1.1 to 1:1.5; ratio of width to length of club varying from 1:1.5 to 1:1.9. Hypomeron of male at narrowest point behind antennal fossa 1.5 to 2 times as wide as segment 4 of antenna. Visible abdominal sternum 5 of female with length of maculae 5/9 to 6/9 times visible length of sternum.

Length of males ranging from 1.9 to 2.6 mm; of females from 1.9 to 3.3 mm. Ratio of length to width of males and females varying from 1:1.55 to 1:1.78.

**Types:** Holotype male and allotype female and 5 paratypes: Madera Canyon, Santa Rita Mts., Ariz., 5,400 ft. elev., 18-29-VII 79 (Frank T. Hovore). Additional paratypes as follows: ARI-ZONA: Coconino Co: Oak Creek Canyon, 1-VIII-36 (O. Bryant; 2 females). Cochise Co.: 5 miles SW of Apache, 17-VIII-61 (M. A. Cazier; 1 male); Chiricahua Mts., 4-VIII-86 (M. A. Ivie; 1 female); *ibid.*, 8,000 ft. elev., 7-VIII-55 (G. Butler, Z. Noon; 3 females); *ibid.*, Idlewild Camp, 20-25-VII-80 (R. Turnbow; 1 male, 4 females); *ibid.*, Horseshoe Canyon, 23-VI-75 (S. McCleve, 1 female); Cochise Stronghold, Dragoon Mts., 5-8-VII-70 (R. J. Shaw; 2 males); Huachuca Mts., 9-VI-35 (J. N. Knull; 2 females); *ibid.*, Ramsey Canyon, 5,350 ft. elev., 10-19-VI-66 (F. Werner; 6 males, 1 female); *ibid.*, 13-VII-55 (F. G. Werner & G. D. Butler; 1 male); Palmerlee, 1-VII (H. A. Wenzel; 1 female); *ibid.*, 11-VII (H. A. Wenzel, 1 female). Gila Co.: Pinal Mts., VI (D. K. Duncan). Graham Co.: Ft. Grant, 16-VII (Hubbard & Schwarz; 1 female). Pima Co.: Fraguila Wash, 4 miles S. of Arivaca, 10-VII-77 (S. McCleve; 1 male). Santa Cruz Co.: Atascosa Mts., 19-VIII-50 (R. S. Beal; 1 female); Santa Rita Mts., 16-VI (Hubbard & Schwarz; 2 males); *ibid.*, 31-VIII-65 (C. D. Johnson; 1 male); *ibid.*, 5,000 ft. elev., 18-23-VI-62 (F. Werner; 2 males); Nogales, 17-VIII-06 (F. W. Nunenmacher; 1 female); west slope Patagonia Mts., 7-IX-55 (F. G. Werner & G. D. Butler; 3 females). Yavapai Co.: Lynx Lake, Prescott Nat'l. Forest, 30-VII-69 (G. W. Forster; 2 females). NEW MEXICO: Hidalgo Co., 1706 m, 5-VI-81 (Steve Dobrott; 4 males). Primary types deposited in the U. S. National Museum of Natural History. Paratypes deposited in collections of American Museum of Natural History, Robert J. Brooks, California Academy of Sciences, Colorado State University, Northern Arizona University, Montana State University, Ohio State University, Scott McCleve, Oregon State University, Robert H. Turnbow, U. S. National Museum of Natural History, University of Arizona, University of Mississippi; and R. D. Zhantiev of the M. W. Lomonosov State University of Moscow.

**Diagnosis:** Females are fairly easily distinguished from other known Nearctic species by the large maculae, which are without a distinct, surrounding, thread-like carina on visible abdominal sternum 5 (Fig. 3). Males usually differ from those of *C. woolfi* in having the antennal club longer and narrower, but there is a degree of overlap: the ratio of width to length varies from 1:1.5 to 1:1.9, whereas the ratio on *C. woolfi* varies from 1:1.4 to 1:1.6. Males and females have all light-colored pubescence on the pronotum, whereas both *C. pruddeni* and *C. woolfi* have a number of dark, golden-brown hairs on the pronotum.

**Etymology:** The species is named for Robert J. Brooks, M.D., hematologist and oncologist of Tucson, Arizona, as a tribute to his scholarship, skill, and empathetic concern for his patients.

**Biology and floral information:** The species has been taken on *Chilopsis linearis* (Cav.) Sweet (Bignoniaceae), on *Baccharis glutinosa* Pers. (Com-

positae), and on *Cowania mexicana* D. Don (Rosaceae). Specimens have also been taken at light and in a sugar bait trap. No other information on the biology is available.

*Cryptorhopalum distichia* Beal, 1985

Under a stereoptican dissecting microscope females of this species and *C. aspilon* Beal appear to lack maculae on visible abdominal sternum 5. Maculae on other species in the Quadripunctatum group are formed by clusters of minute pores which presumably serve for the secretion of pheromones. In *C. distichia* a few such pores are nevertheless present on either side of the sternum, as demonstrated by SEM examination (Figs. 7, 9).

*Cryptorhopalum focale* Beal, 1985

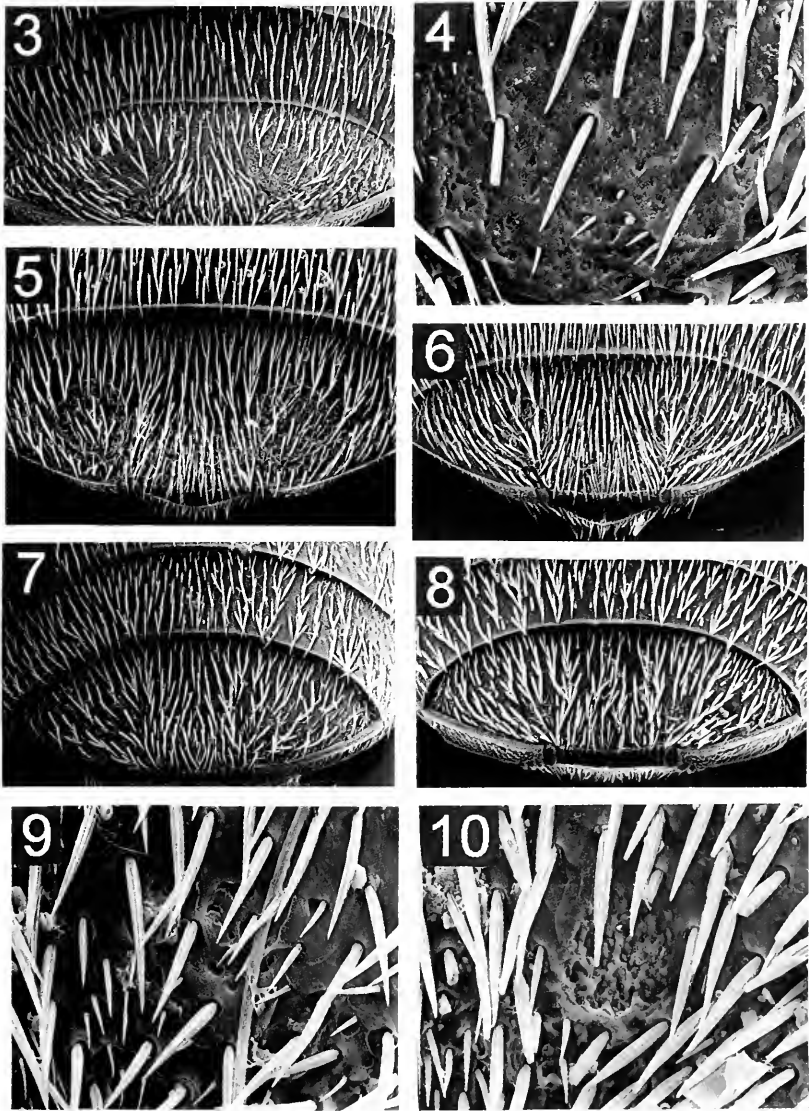
This species was described from 2 specimens taken in the vicinity of Daytona Beach, Florida. The following specimens extend the known range south to Highlands County, Florida. Archbold Biological Station, 3-IV-79 (H. V. Weems, Jr., & Sylvia Halkin; 1 male, USNM; 1 female, Bureau of Entomology, Florida Dept. Agric.); *ibid.*, 10-11-IV-80 (C. L. Smith; 1 female, Univ. Georgia Coll.); 5 miles south of Sebring, 21-III-78 (H. V. Weems, Jr.; 1 male, Bureau of Entomology, Florida Dept. Agric.).

*Cryptorhopalum haemorrhoidale* (LeConte, 1824)

The following is the first recorded occurrence in Canada: Toronto, Ontario (R. J. Crew; 3 specimens, Cornell Univ. Coll.)

*Cryptorhopalum pruddeni* Casey, 1900

Robert H. Turnbow collected a series of 108 unusually small specimens of this species on sugar bait in Idlewild Canyon, Chiricahua Mts. (Cochise Co.), Arizona, 20-25-VII-80. This series makes it possible to place a number of small specimens which previously I could not definitely associate with this species. The length of 62 measurable males ranged from 1.8 mm to 2.7 mm with a median length of 2.0 mm. The length of 38 measurable females ranged from 1.9 mm to 2.8 mm with a median length of 2.3 mm. In external measurements and setal pattern the larger specimens of the series seem unmistakably identical with previously described specimens of the species. Smaller specimens tend to have the subapical elytral band uninterrupted and uniform in length across the elytra. Terminalia of both larger and smaller specimens are



Figs. 3-10. Scanning electron micrographs of visible abdominal sternum 5 of females. 3. *C. brooksi*, x 79. 4. *C. brooksi*, detail of macula x 398. 5. *C. pruddeni*, x 79. 6. *C. sapindi*, x 79. 7. *C. distichia*, x 79. 8. *C. woolfi*, x 79. 9. *C. distichia*, detail of macula, x 398. 10. *C. woolfi*, detail of macula, x 398.

identical, as are the maculae on visible abdominal sternum 5 of the female (Fig. 5).

Revised measurements for the species based on the specimens above and restricted by the removal of specimens now assigned to *C. anthrenoides* are the following: length of males ranging from 1.8 mm to 2.9 mm; length of females from 1.9 mm to 3.5 mm. Ratio of width to length of males varying from 1:1.55 to 1:1.75; females from 1:1.52 to 1:1.75.

*Cryptorhopalum uteanum* Casey, 1914

The known range of the species is extended from Oregon northward to the following localities in the State of Washington: Soap Lake, Grant Co., 21-V-49 (M. R. Hatch; 13 specimens); Vantage, Kittitas Co., 21-v-49 (M. H. Hatch, 1 specimen). The above are deposited in the Oregon State Univ. Coll.

*Cryptorhopalum woolfi* Beal, 1985

The known range of this species is extended from Southern Arizona into Sonora, Mexico, as follows. 10 miles east of Navajoa, 13-VIII-59 (W. L. Nutting & F. G. Werner; 1 male, 1 female); 5 miles east of Alamos, 11-VIII-73 (K. Stephan & D. S. Chandler; 1 female). Above specimens are deposited in the Univ. of Arizona Coll. A new southeastern Arizona locality is Idlewild Canyon, Chiricahua Mts., Cochise Co., 20-25-VII-80 (R. Turnbow; 1 male, Univ. of Georgia Coll.)

Figures 8 and 10 show the structure of the minute macula on each side of visible abdominal sternum 5.

*Cryptorhopalum sapindi* Beal, 1985

Females of this species are similar to females of *C. reversum*. The maculae on visible abdominal sternum 5 of the latter have a diameter 1/3 to 1/2 visible length of segment (essentially similar to maculae of *C. pruddeni*, Fig. 5). In *C. sapindi* the maculae are about 3/10 visible length of the segment but also are positioned near the middle of the segment (Fig. 6).

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For the generous loan of specimens in their care or kind gift of specimens I am indebted to the following: C. D. Johnson, Northern Arizona University; David H. Kavanaugh, California Academy of Sciences; John W. Kingsolver, formerly with the Systematic Entomology Laboratory, U. S. Dept. of Agriculture; Paul K. Lago, University of Mississippi; J. D. Lattin, Oregon State University; James K. Liebherr, Cornell University; Scott McCleve, Douglas, Arizona; Katherine Seibert, Montana State University; Charles A. Triplehorn, Ohio State University; Robert H. Turnbow, Jr., Directorate of Engineering and Housing, Fort Rucker, Alabama; Howard

V. Weems, Jr., Florida State Collection of Arthropods, Florida Dept. of Agriculture; the late Floyd G. Werner, University of Arizona. I am grateful to Norman Grim of Northern Arizona University for the scanning electron micrographs. For a helpful and critical reading of the manuscript I offer my best thanks to C. D. Johnson of Northern Arizona University and Paul K. Lago of the University of Mississippi.

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SCIENTIFIC NOTE  
OVERWINTERING OF *POLLENIA RUDIS*  
(DIPTERA: CALLIPHORIDAE)<sup>1</sup>

Kipling W. Will<sup>2</sup>

Members of the genus *Pollenia* are commonly referred to as cluster flies. Taxonomy of some species groups (Rognes 1987, 1991) and their life history (Thomas & Davies 1973a, 1973b) are well documented. The occurrence of clustering in buildings is referred to in nearly all references to *Pollenia* species. However, outside of manmade structures, the winter habits of adults are not well recorded. In fact, a search of pertinent literature returned only one reference. Dennys (1927) reported overwintering adults of *Pollenia rudis* collected from tunnels of "wood borers".

I collected three live adult *P. rudis* from abandoned galleries of *Bolitotherus cornutus* (Panzer) (Coleoptera: Tenebrionidae) in rotting hoof fungi (*Fomes fomentarius* [L. ex Fr.] Kickx). A larva of *B. cornutus* was also collected in a separate piece of hoof fungus. The hoof fungus was growing approximately one meter above the ground on a rotting hardwood stump. Specimen data as follows: 2♀ ♀, 1♂-USA, New York, Tompkins County, 5 miles S of Danby, 14:1:1995.

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## TAXONOMY OF THE NORTH AND CENTRAL AMERICAN SPECIES OF *CAMELOBAETIDIUS* (EPHEMEROPTERA: BAETIDAE)<sup>1</sup>

C. R. Lugo-Ortiz, W. P. McCafferty<sup>2</sup>

ABSTRACT: Ten nominal species of *Camelobaetidium* (Ephemeroptera: Baetidae) are recognized from North and Central America. Two new species are described from larvae: *Camelobaetidium kondratieffi*, NEW SPECIES, from Guatemala, and *C. similis*, NEW SPECIES, from Guerrero, Mexico. *Camelobaetidium salinus* is synonymized with *C. musseri*. *Camelobaetidium cepheus*, *C. navis*, *C. trivialis*, and *C. zenobia* are synonymized with *C. warreni*. *Camelobaetidium musseri* is newly reported from Costa Rica and New Mexico. *Camelobaetidium warreni* is newly reported from Costa Rica and Honduras. A key to the known larvae of North and Central American species is provided.

Demoulin (1966) erected the genus *Camelobaetidium* (Ephemeroptera: Baetidae) to include *C. leentvaari* Demoulin, a species described from larvae from Suriname. He indicated that the only character that distinguished the genus was the spatulate shape of the tarsal claws. Other characters, according to this author, were doubtfully of generic significance because only *C. leentvaari* was known to him at that time.

Traver and Edmunds (1968) erected the genus *Dactylobaetis* and designated *D. warreni* Traver and Edmunds, a species described from larvae and male and female adults from California, as the type species. According to these authors, the larvae of *Dactylobaetis* could be readily distinguished from other baetid genera, except *Camelobaetidium*, by the presence of spatulate tarsal claws. *Dactylobaetis* was differentiated from *Camelobaetidium* by the length of the terminal filament (less than the length of abdominal segment 10 in *Camelobaetidium*; at least 3/4 the length of the cerci in *Dactylobaetis*) and the presence of a blunt projection on the anterior margin of the forefemora of *Camelobaetidium*. The adults of *Dactylobaetis* were separated from other baetids by the broadly based costal projection and the wide separation of the male genital forceps. Traver and Edmunds (1968) further indicated that the venational characters discussed by Demoulin (1966) and based on the developing fore- and hindwings of the larvae of *C. leentvaari* were unreliable because they could be highly modified during larval growth.

McCafferty and Waltz (1990) studied the types of *Camelobaetidium* and *Dactylobaetis* and concluded that they were of the same genus because there were no autapomorphies that could separate them. Consequently, *Dactylo-*

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*baetis* was placed as a junior synonym of *Camelobaetidius*. These authors also discussed the circumstances surrounding the priority of the name *Camelobaetidius*.

*Camelobaetidius* has a widespread distribution in the Western Hemisphere, being reported from large rivers with silt/clay substrate from Saskatchewan (Lehmkuhl 1976) and Indiana (McCafferty and Klubertanz 1994) to northern Argentina (Traver and Edmunds 1968). McCafferty *et al.* (1992) hypothesized that the genus had a Mesoamerican center of dispersal (but not necessarily center of origin). Two pieces of evidence led to this hypothesis. First, *Camelobaetidius* tends to be arid-favored and warm-water sublimated in southwestern North America, a pattern seen in other genera which clearly have a recent Neotropical center of dispersal (e. g., *Fallceon* Waltz and McCafferty, *Thraulodes* Ulmer, and *Traverella* Edmunds). Second, preliminary phylogenetic data indicated that the most derived species are South American. In addition, demographic data indicated that *Camelobaetidius* has more species in the Mexican and Mesoamerican region than in North and South America. These data also suggest to us the possibility that the genus evolved in the Mexican and Mesoamerican landmass between the Eocene (54-38 mya) and Pliocene (5-2 mya), when South America was isolated, and that it spread to that continent after the emergence of the Panamanian land bridge during the Pliocene.

Although a comprehensive revision of the genus is not yet possible, we here review in alphabetical order those species known to occur in North and Central America, and we include the description of two new species from Mexico and Central America, new synonyms, and new locale data. We also provide a key to differentiate North and Central American species known from the larval stage. Institutions housing the materials used in this study and their acronyms are as follows: Colorado State University (CSU), Fort Collins; Florida A & M University (FAMU), Tallahassee; New Mexico Highlands University (NMHU), Las Vegas; Purdue Entomological Research Collection (PERC), West Lafayette, Indiana; the Universidad Nacional Autónoma de México (UNAM), México, D. F.; and the private collection of J. R. Davis (JRD), Texas Water Commission, Austin.

### *Camelobaetidius* Demoulin

*Camelobaetidius* Demoulin 1966: 9.

*Dactylobaetis* Traver and Edmunds 1968: 629.

**Larva.** Head hypognathus. Forelegs usually longer than mid- and hindlegs. Tarsi bowed (Fig. 7). Tarsal claws spatulate, with 5-45 denticles (Figs. 8, 9). Abdominal gills 1-7 ovate, simple; gills 1 and 7 smaller than gills 2-6.

**Adult.** Forewings with paired marginal intercalaries. Hindwings with two longitudinal veins,

broadly-based costal process, and small undulation beyond costal process (Fig. 2). Male genital forceps 3-segmented, widely separated basally.

**Diagnosis.** Larvae of *Camelobaetidius* can be distinguished by the bowed tarsi (Fig. 7) and the spatulate tarsal claws (Figs. 8, 9). Adults can be provisionally distinguished by the combination of two longitudinal veins, a broadly-based costal process, and a small undulation beyond the costal process in the hindwings (Fig. 2). Male adults of *Camelobaetidius* are similar to those of *Acerpenna* Waltz and McCafferty. However, male adults of *Acerpenna* possess a distinct conical process at the base of the genital forceps and a broad undulation beyond the costal process of the hindwings (see McCafferty and Morihara 1979: Figs. 1 and 2). These differences are based on North American species of *Acerpenna*; adults of Mesoamerican species of this genus remain unknown (Lugo-Ortiz and McCafferty 1994). As is the case with many baetid genera, adult characteristics associated with *Camelobaetidius* are probably not as stable as those of the larvae (Waltz *et al.* 1994).

**Type species.** *Camelobaetidius leentvaari* Demoulin, 1966: 9 (original designation).

**Included North and Central American species.** *Camelobaetidius arriaga* (Traver and Edmunds); *C. chiapas* (Traver and Edmunds); *C. jenseni* (Traver and Edmunds); *C. kondratieffi* Lugo-Ortiz and McCafferty, NEW SPECIES; *C. mexicanus* (Traver and Edmunds); *C. musseri* (Traver and Edmunds); *C. similis* Lugo-Ortiz and McCafferty, NEW SPECIES; *C. sinaloa* (Allen and Murvosh); *C. waltzi* McCafferty; *C. warreni* (Traver and Edmunds).

#### *Camelobaetidius arriaga* (Traver and Edmunds)

*Dactylobaetis arriaga* Traver and Edmunds 1968: 658.

*Camelobaetidius arriaga*: McCafferty and Waltz 1990: 777.

**Diagnosis.** Male adults can be separated from those of other species of *Camelobaetidius* by the elongate basal segment of the genital forceps (Traver and Edmunds 1968: Fig. 60). According to Traver and Edmunds (1968), *C. arriaga* is further differentiated by the purplish posterior margins of terga 1-3, 6, and 10, and the contiguous, large, orange turbinate eyes.

**Remarks.** The type material of *C. arriaga* is in rather poor condition. Only one male of the type series retains complete genitalia. This character agrees with Traver and Edmunds' (1968) description. However, the purplish poste-



rior margins of terga 1-3, 6, and 10 are difficult to discern, and the coloration of the male turbinate eyes is yellowish in all specimens. Moreover, the turbinate eyes are not contiguous; they are separated and diverge anteriorly. This condition is similar to that of *C. jenseni*. Despite these discrepancies, we recognize *C. arriaga* as a valid species on the basis of its particularly elongate basal forceps segment. This species remains unknown in the larval stage.

**Known distribution.** Mexico: Chiapas.

**Material examined.** Paratypes: Four male and one female adults, MEXICO, Chiapas State, VIII-22-1965, P. J. Spangler (PERC).

### *Camelobaetidius chiapas* (Traver and Edmunds)

*Dactylobaetis chiapas* Traver and Edmunds 1968: 659.

*Camelobaetidius chiapas*: McCafferty and Waltz 1990: 777.

**Diagnosis.** Male adults of *C. chiapas* can be separated from those of *C. arriaga* and *C. jenseni* by the relatively small and yellowish turbinate eyes and the uniformly cream abdominal coloration. We found the shape of the male genital forceps not to be of use in separating this species from *C. jenseni*. Male adults of *C. chiapas* are similar to those of *C. mexicanus*. However, in *C. chiapas* the apical segment of the genital forceps (Traver and Edmunds 1968: Fig. 68) is more elongate than in *C. mexicanus* (McCafferty and Provonsha 1993: Fig. 12). The genitalia of *C. chiapas* is also very similar to that of *C. warreni*, but in the latter species the forceps are more widely separated and bowed (Traver and Edmunds 1968: Fig. 4) than in *C. chiapas*.

**Remarks.** The larva of this species is unknown. Turbinate eye color of male adults apparently is useful to distinguish species only in fresh specimens.

**Known distribution.** Mexico: Chiapas.

**Material examined.** Paratypes: 10 male and 12 female adults, MEXICO, Chiapas State, Arriaga, VIII-22-1965, P. J. Spangler (PERC).

### *Camelobaetidius jenseni* (Traver and Edmunds)

*Dactylobaetis jenseni* Traver and Edmunds 1968: 660.

*Camelobaetidius jenseni*: McCafferty and Waltz 1990: 777.

**Diagnosis.** Male adults of this species can be separated from those of *C. arriaga* only by the short basal segment of the genital forceps (Traver and Edmunds 1968: Fig. 62). The coloration, shape, and size of the male turbinate eyes and the abdominal coloration are indistinguishable in these two species (see remarks under *C. arriaga*, above). However, these same characters can be used to separate *C. jenseni* from *C. chiapas*.

**Remarks.** We consider one of Traver and Edmunds' specimens now in the PERC and labeled only as "Holotype" and "*Dactylobaetis* sp." to be the holotype of *C. jenseni*. The locale data of the specimen agrees with that cited by Traver and Edmunds (1968) (see below), and, although in poor condition and taken in the same time and place as *C. arriaga*, its genitalia and purplish markings of the abdomen fit the original description of *C. jenseni*. The larva of this species is not known.

**Known distribution.** Mexico: Chiapas.

**Material examined.** Holotype: Male adult, MEXICO, Chiapas State, Arriaga, VIII-22-1965, P. J. Spangler (PERC). Paratypes: One male and one female adults, same data as holotype (PERC).

### *Camelobaetidius kondratieffi* Lugo-Ortiz and McCafferty, NEW SPECIES

(Figs. 1, 3)

**Larva** (Fig. 1). Body length: 5.5-6.5 mm; caudal filaments: 2.2-3.0 mm. Head: Coloration pale, with areas along coronal and frontal sutures pale brown. Vertex pale brown. Ocelli black. Turbinate eyes of male orange-brown. Antennae pale, with very fine, simple setae on scapes, pedicel, and distally on each segment; ventral porelike sensilla distally on each antennal segment. Labrum (Fig. 3) sclerotized along margin; submedial and five to six submarginal branched setae present; simple intermediate setae minute. Right mandible 3 + 1 + 2 (?) denticles; tuft of simple setae between prosthema and molar (outer denticles appear to be worn in all specimens). Left mandible similar to right mandible, except with long, slender process at base of molar, similar to Fig. 43 in Traver and Edmunds (1968). Maxillae robust; maxillary palps extending almost as far as galealaciniae; palp segment 2 broad distally, similar to Fig. 55 in Traver and Edmunds (1968). Labium robust; palp segment 1 short and robust; segment 2 subequal to 1, with three to four minute setae dorsally, but otherwise similar to Fig. 81 in Traver and Edmunds (1968); segment 3 rounded, with numerous fine, simple setae; glossae with seven to eight simple setae medially, two to three simple setae dorsally, and seven to eight simple setae laterally; paraglossae with three to four simple setae dorsally and 15-17 laterally. Thorax: Nota with complex and distinct color pattern. Sterna cream. Legs cream; femora with pale brown submedian area and numerous fine, long, simple setae dorsally, distal ends rounded and sclerotized; distal end of tibiae with short, simple setae ventrally; tarsi with four short, simple and three long, simple setae ventrally; tarsal claws with 40-45 sclerotized denticles. Abdomen: Color pale brown; terga 1-10 with pale submedian line; tergum 1 variable, almost always with dark brown posterior margin and dashlike anteromedian marks, in some individuals with broad light to dark brown anterior margin, or completely pale except for posterior dark brown margin; terga 2-7 with dark brown posterior margins and two pairs of anteromedian marks; first pair oblique, sometimes fusing with second pair; oblique diffuse brown marks arising almost submedially on anterior margin and reaching base of gills; terga 8-9 usually with same pattern as terga 2-7, but without submedian oblique marks reaching gills; tergum 8, especially in male, somewhat pale; tergum 10 with brown submedian marks running along pale submedian line and bifurcating anteriorly, giving appearance of small Y. Sterna cream, usually with brown sublateral marks on middle and posterior segments; sterna 7-9 with pair of brown submedian dots; dots on sternum 7 usually present, although somewhat faded in some individuals; dots on sterna 8-9 present or absent. Gills on segments 1 and 7 small, with very little or no tracheation; those on segments 2-6 similar to Fig. 6 in Traver and Edmunds (1968). Paraprocts with four to five relatively long spines. Caudal filaments pale to pale brown.

**Adult.** Unknown.

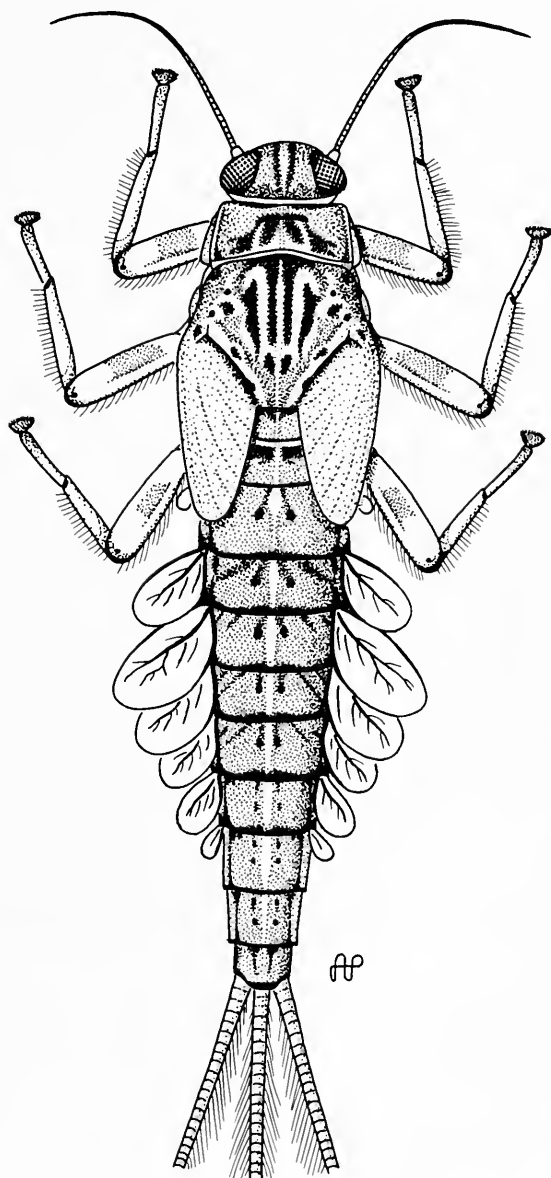


Fig. 1. *Camelobaetidius kondratieffi*, NEW SPECIES, larva, dorsal view.

**Diagnosis.** *Camelobaetidius kondratieffi* differs from *C. musseri* in the number of denticles on the tarsal claws (30-35 in *C. musseri* vs. 40-45 in *C. kondratieffi*), general body coloration (Fig. 1), the presence of weakly pectinate setae on the anterior margin of the dorsal surface of the labrum (Fig. 3), and the extreme reduction of abdominal gills 1 and 7 (Fig. 1).

**Known distribution.** Guatemala.

**Material examined.** Holotype: Female larva, GUATEMALA, Izabal Province, small stream [tributary of?] in Río Cahabón, nr Cahaboncito, I-4-1989, B. C. Kondratieff (PERC). Paratypes: Two female and two male larvae, same data as holotype (PERC).

**Etymology.** The species is named after Boris C. Kondratieff, for his many collections and much appreciated donations of Mexican and Central American mayflies, among which was *C. kondratieffi*.

### *Camelobaetidius mexicanus* (Traver and Edmunds)

(Figs. 2, 4)

*Dactylobaetis mexicanus* Traver and Edmunds 1968: 662.

*Camelobaetidius mexicanus*: McCafferty and Waltz 1990: 777; McCafferty and Provonsha 1993: 66 (male adult).

**Diagnosis.** Larvae of *C. mexicanus* are very similar to those of *C. warreni*. We found, however, two characters which can help to separate them. First, the setation of the labrum is different in the two species. *Camelobaetidius warreni* has one intermediary and two to three lateral setae, whereas *C. mexicanus* has no intermediary and two lateral setae (Fig. 4). Secondly, the tarsal claws of *C. warreni* have seven to nine denticles, but *C. mexicanus* has five to six. Traver and Edmunds (1968) pointed out that the larvae of *C. mexicanus* also tend to be smaller than those of *C. warreni*. We have not found consistent differences to confidently separate male adults of *C. mexicanus* and *C. warreni*. The male adults of *C. mexicanus*, however, appear to differ from *C. chiapas* by their shorter apical segment of the genital forceps, and they can be separated from *C. arriaga* and *C. jenseni* by the absence of purplish markings on the abdominal terga.

**Remarks.** Although *C. mexicanus* and *C. chiapas* are very similar (see remarks under *C. chiapas*, above), we do not know if the larvae of the two species are similar because the larva of *C. chiapas* is not known. We therefore provisionally continue to recognize both species, based on the fact that *C. mexicanus* is also similar as adults to *C. warreni* but distinct from that species in the larval stage.

**Known distribution.** Mexico: Chiapas, Guerrero, Jalisco, Morelos, Nuevo León, Oaxaca, Sinaloa, Sonora, Tamaulipas, Veracruz, Zacatecas; USA: Kansas, Texas.

**Material examined.** MEXICO, Nuevo León State, Santiago, XII-23-1939, L. Berner, larvae (PERC); Río Santa Lucía, Linares, XII-28-1947, L. Berner, larvae (PERC); Tamaulipas State, Arroyo del Meco, XII-26-1939, L. Berner, larvae (PERC); Río Frío, III-14-16-1939, L. Berner, larvae (PERC).

*Camelobaetidius musseri* (Traver and Edmunds)

(Fig. 8)

*Dactylobaetis musseri* Traver and Edmunds 1968: 663.

*Dactylobaetis salinus* Allen and Chao 1978: 302. NEW SYNONYM.

*Camelobaetidius musseri*: McCafferty and Waltz 1990: 777.

*Camelobaetidius salinus*: McCafferty and Waltz 1990: 777. NEW SYNONYM.

**Diagnosis.** Larvae of *C. musseri* closely resemble those of *C. kondratieffi*, but are different in having fewer denticles on the tarsal claws (30-35) (Fig. 8) and lacking the weakly pectinate setae on the dorsal surface of the labrum. The larvae also resemble those of *C. sinaloa*, but can be separated by the absence of dark posterior margins on terga 1-9 in *C. musseri*.

**Remarks.** We consider *C. salinus* to be equivalent to *C. musseri* because the larval differences indicated by Allen and Chao (1978) reflect intraspecific variability. Traver and Edmunds (1968) discussed the presence of larval "allies of *D. musseri*" in Costa Rica and Honduras. Our examination of part of those specimens indicated that they are variants of *C. musseri*. Adults of *C. musseri* are unknown.

**Known distribution.** Costa Rica; El Salvador; Guatemala; Honduras; Mexico: Chiapas, Guerrero, Jalisco, Morelos, Nuevo León, Oaxaca, San Luis Potosí, Veracruz; USA: Arizona, Nevada, New Mexico. The records from Nevada, Costa Rica, and New Mexico are new (see below).

**Material examined.** COSTA RICA, Cartago Province, Río Platanillo, 2.2 km E of Tayutic, 730 m, 9.82°N/83.55°W, I-30-1986, Holzenthal, Morse, and Fasth, larvae (FAMU); Guanacaste Province, Río Tenorio at Finca La Pacífica, E of Panamerican Hwy, II-2-1969, W. P. McCafferty, larvae (PERC); same data, II-8-11-1969; same data, II-8-1969; Heredia Province, Río Sarapiquí, Puerto Viejo, 90 m, VII-10-1962, G. G. Musser, larvae (PERC); Puntarenas Province, Quebrada Pita, nr 3 km (air) W of Golfito, 15 m, 8.642°N/83.193°W, II-15-1986, Holzenthal, Morse, and Fasth, larva (FAMU); San José Province, San José, 1160 m, VIII-9-1962, G. G. Musser, larvae (PERC). USA, Nevada, Clark County, Warm Springs, Moapa Valley, IV-21-1989, G. F. Edmunds, Jr., larvae (PERC); New Mexico, Catron County, San Francisco R, at Reserve, VIII-4-1993, R. Durfee, larva (CSU); Catron County, N of Silver City, W fork Gila R. Gila National Monument, 1.5 mi above jct with Middle Fork, 5600 ft. VII-29-1969, R. and D. Koss, larva (PERC); North of Silver City, Gila R at jct with Little Cr, VII-9-1969, R. W. Koss, W. P. McCafferty, and A. V. Provonsha, larvae (PERC); Grant County, Grant Canyon, 6700 ft. above Gila, X-12-1993, P. Stewart, larva (NMHU); E Fork of Gila R, nr Graperine, 6400 ft. X-12-1993, P. Stewart, larva (NMHU).

*Camelobaetidius similis* Lugo-Ortiz and McCafferty, NEW SPECIES

(Fig. 5)

**Larva.** Body length: 4.7-5.0mm; caudal filaments: unknown. Head: Coloration pale, with area along coronal and frontal sutures pale brown. Vertex pale brown. Ocelli black. Turbinate eyes yellowish. Antennae pale, with very fine, simple setae on scapes, pedicel, and distally on each segment; sensilla absent. Labrum (Fig. 5) sclerotized posteriorly along margin, with submedial and four to five submarginal simple setae arranged almost linearly; intermediate simple setae present. Right mandible 3 + 1 + 3 denticles; distal two denticles appearing fused; tuft of simple setae between prosthema and molar. Left mandible 3 + 3 denticles, with short, robust process at base of molar. Maxillae robust; maxillary palps extending as far as galealacinae; palp segment 2 broad distally similar to Fig. 55 in Traver and Edmunds (1968). Labium somewhat elongate and robust; palp segment 1 long, segment 2 shorter than 1, with five simple setae dorsally and round distal projection; segment 3 almost conical, with numerous fine, simple setae; glossae with 11-12 simple setae medially, five to six dorsally, and four to five laterally; paraglossae with five to six simple setae dorsally and 17-20 simple setae laterally. Thorax: Color pale to dark brown, with no distinct pattern. Sterna pale. Forecoxal osmobranchia present. Legs pale; femora rounded distally, with numerous fine, long, simple setae dorsally; distal end of tibiae with five to seven robust, simple setae ventrally; tarsi with 12 robust, simple setae ventrally, last three longer than preceding nine; tarsal claws with five to six denticles. Abdomen: Color pale brown. Tergal color pattern as in Figs. 11-12 in Traver and Edmunds (1968). Sterna pale brown. Gills on segments 1 and 7 small and with very little or no tracheation; those on segments 2-6 similar to Fig. 6 of Traver and Edmunds (1968). Paraprocts with five to six spines. Caudal filaments pale to pale brown.

**Adult.** Unknown.

**Diagnosis.** Differences separating the larvae of *C. similis* and *C. warreni* are the setation on the labrum (shown respectively in Figs. 5 and 6) and the presence of forecoxal gills in *C. similis*.

**Known distribution.** Mexico: Guerrero.

**Material Examined.** Holotype: Male larva, MEXICO, Guerrero State, km 15 carretera Bejucos, nr Ciudad Altamirano, XI-22-1984, Brailovsky *et al.* (UNAM). Paratype: Female larva, same data as holotype (PERC).

**Etymology.** The specific epithet is a Latin word meaning alike. It is in reference to the general similarity of this species and *C. warreni*.

*Camelobaetidius sinaloa* (Allen and Murvosh)

*Dactylobaetis sinaloa* Allen and Murvosh 1987: 1099.

*Camelobaetidius sinaloa*: McCafferty and Waltz 1990: 778.

**Diagnosis.** According to Allen and Murvosh (1987), larvae of *C. sinaloa* have 30-35 denticles in the tarsal claws. This matches the number of denticles found in *C. musseri*; however, larvae of *C. sinaloa* apparently differ from the larvae of *C. musseri* in having a pale abdomen as depicted in Figure 1 of Allen and Murvosh (1987).

**Remarks.** The adults of this species have not been described.

**Known distribution.** Mexico: Sinaloa.

**Material examined.** Our study of this species is based entirely on the literature since we have been unable to locate the type material (the only material known of the species).

*Camelobaetidium waltzi* McCafferty

(Figs. 7, 9, 10)

*Camelobaetidium waltzi* McCafferty, in McCafferty and Klubertanz 1994: 38.

**Diagnosis.** This species can be readily separated from other species of *Camelobaetidium* in North and Central America by the unique combination of a pointed second segment of the labial palps (Fig. 10) and the small number of denticles (6-7) in the tarsal claws (Fig.1).

**Remarks.** The pointed second segment of the labial palps of *C. waltzi* is similar to that found in the South American species *C. anubis* (Traver and Edmunds) and *C. penai* (Traver and Edmunds). However, as pointed out by McCafferty and Klubertanz (1994), *C. waltzi* is similar to *C. mexicanus* with respect to mandibular morphology, labral setation, small number of denticles on the tarsal claws, and gill pigmentation, and thus the labial palps of *C. waltzi* probably represent an anomaly. The adults of *C. waltzi* remain to be discovered.

**Known distribution.** USA: Indiana, Iowa.

**Material examined.** Holotype: Female larva, USA, Indiana, Posey County, Wabash R. at Old Dam nr Harmony, VII-20-1977, W. P. McCafferty and A. V. Provonsha (PERC). Paratypes: Eight larvae, USA, Iowa, Van Buren County, Des Moines R, at Lacy Keosauqua State Park, VIII-29-1992, T. H. Klubertanz (PERC).

*Camelobaetidium warreni* (Traver and Edmunds)

(Fig. 6)

*Dactylobaetis warreni* Traver and Edmunds 1968: 642.

*Dactylobaetis cepheus* Traver and Edmunds 1968: 648. NEW SYNONYM.

*Dactylobaetis zenobia* Traver and Edmunds 1968: 651. NEW SYNONYM.

*Dactylobaetis navis* Allen and Chao 1978: 300. NEW SYNONYM.

*Dactylobaetis trivialis* Allen and Chao 1978: 302. NEW SYNONYM.

*Camelobaetidium cepheus*: McCafferty and Waltz 1990: 777. NEW SYNONYM.

*Camelobaetidium navis*: McCafferty and Waltz 1990: 777. NEW SYNONYM.

*Camelobaetidium trivialis*: McCafferty and Waltz 1990: 778. NEW SYNONYM.

*Camelobaetidium warreni*: McCafferty and Waltz 1990: 778.

*Camelobaetidium zenobia*: McCafferty and Waltz 1990: 778. NEW SYNONYM.

**Diagnosis.** Larvae of *C. warreni* could be confused with those of *C. mexicanus*. However, the tarsal claws of *C. warreni* have more denticles (7-9) and

the labrum (Fig. 6) has intermediary setae. In addition, the larvae of *C. warreni* tend to be larger than those of *C. mexicanus*.

**Remarks.** Larvae named *C. cepheus*, *C. navis*, *C. trivialis*, *C. warreni*, and *C. zenobia* show only intraspecific variability in morphology and coloration. Mouthpart morphology cannot be used to distinguish them because the labra, mandibles, maxillae, and labia of all of them are of similar type (see Traver and Edmunds 1968). According to Traver and Edmunds (1968), only *C. zenobia* has a different left mandible, categorized as Grade II denticulation (i.e., outer incisor almost or wholly fused, inner incisor with distinct denticles; see Traver and Edmunds 1968: Fig. 87). Our examination of the paratype material of *C. zenobia*, however, revealed that the mandibular denticles were worn at the time of being slide mounted, thus artificially giving the appearance of a Grade II denticulation. Tarsal claw denticulation varies between seven to nine denticles in all of the above larvae. In addition, adults assigned to *C. cepheus*, *C. warreni*, and *C. zenobia* are impossible to separate using the characterization provided by Traver and Edmunds (1968). The genitalia, for example, are nearly identical, and we regard them as variations of the *C. warreni* type. Differences in coloration can also be attributed to variation among populations.

**Distribution.** Costa Rica; Honduras; Mexico: Baja California Sur, Chiapas, Chihuahua, Guerrero, Oaxaca, Sonora; USA: Arizona, California, Colorado, Idaho, New Mexico, Utah. The records from Costa Rica and Honduras are new (see below).

**Material examined.** COSTA RICA, Cartago Province, Río Platanillo, 2.2 km E of Tayutic, 9.82°N/83.55°W, 730 m, I-30-1986, Holzenthal, Morse, and Fasth, larvae (FAMU); Guanacaste Province, Río Tenorio at Finca La Pacífica, E of Panamerican Hwy., II-2-1969, W. P. McCafferty, larvae (PERC); same data, II-8-II-1969; Puntarenas Province, Río Sinigri, nr 2 km (air) S of Finca Helechales, 9.057°N/83.082°W, 720 m, II-21-1986, Holzenthal, Morse, and Fasth, larva (FAMU); Río Guineal, nr 1 km (air) E of Finca Helechales, 9.076°N/83.092°W, 840 m, II-22-1986, Holzenthal, Morse, and Fasth, larva (FAMU); San José Province, San José, 1160 m, VIII-9-1962, G. G. Musser, larvae (PERC). HONDURAS, Comayagua Province, Río Selguapa, at bridge nr Comayagua, on Hwy 1, X-17-1964, J. S. Packer, larvae (PERC); El Rosario, Río Humuya, X-20-1964, J. S. Packer, larvae (PERC); Choluteca Province, Marcovia, X-10-1964, J. S. Packer, larva (PERC); El Paraíso Province, tributary of Río Guayamabre, at jct Hwy 4, 50 km 1R of Danlí, IX-3-1964, J. S. Packer, larvae (PERC); Santa María, small stream, IX-3-1964, J. S. Packer, larvae (PERC); Escuela Agrícola Panamericana, X-26-1964, J. S. Packer, larvae (PERC); 3 km E of Danlí, small stream, VIII-29-1964, J. S. Packer, larvae (PERC); Olancho Province, 1.6 mi W of Campamento Galera turn-off (at bridge), on Hwy 3, XI-7-1964, J. S. Packer, larvae (PERC). MEXICO, Chiapas State, Ocosingo Valley, tributary of Río Santa Cruz, VII-1-7-1950, Goodnight and Stannard, larva (PERC); Chihuahua State, Río Gavalón, Gavalón Ranch, VIII-26-1986, B. C. Kondratieff, male adult (PERC); Guerrero State, Km 15 carretera Bejucos, nr Ciudad Altamirano, XI-22-1984, Brailovsky *et al.*, larvae (UNAM); Oaxaca State, Dominguillo, III-8-1978, H. Zapién, larvae (UNAM); Sonora State, Hwy 11, SW of Tezopuco, I-18-1988, B. C. Kondratieff and R. W. Baumann, larvae (PERC); Río Yaqui, nr Tonichi, IV-25-1982, D.A. and J. T. Polhemus, larvae (PERC). USA, Utah, Washington Co., Virgin R at St. George, V-20-1971, W. P. McCafferty, larva (PERC); Uintah Co., White R. 2 mi S Curay, X-12-1974, B. Stark and T. Wolff, larvae (PERC).



*Camelobaetidius* sp. 1 McCafferty and Davis

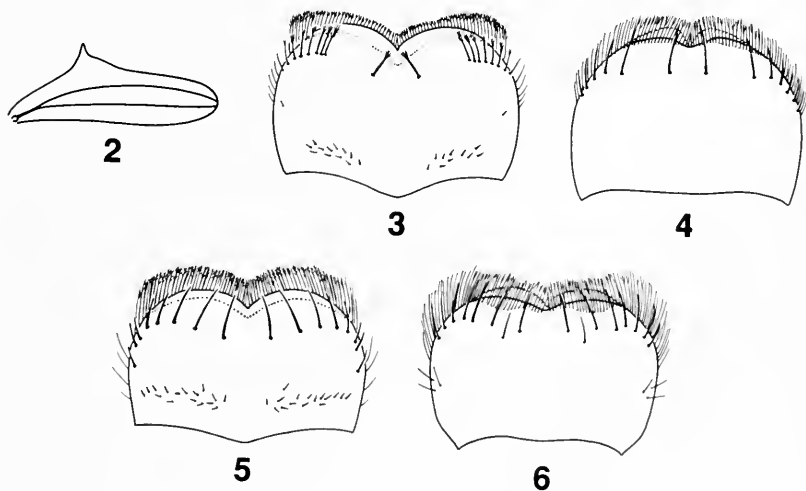
*Camelobaetidius* sp. 1 McCafferty and Davis 1992: 207.

**Diagnosis.** This species can be separated from other representatives of the genus in North and Central America by the presence of 16-18 denticles in the tarsal claws.

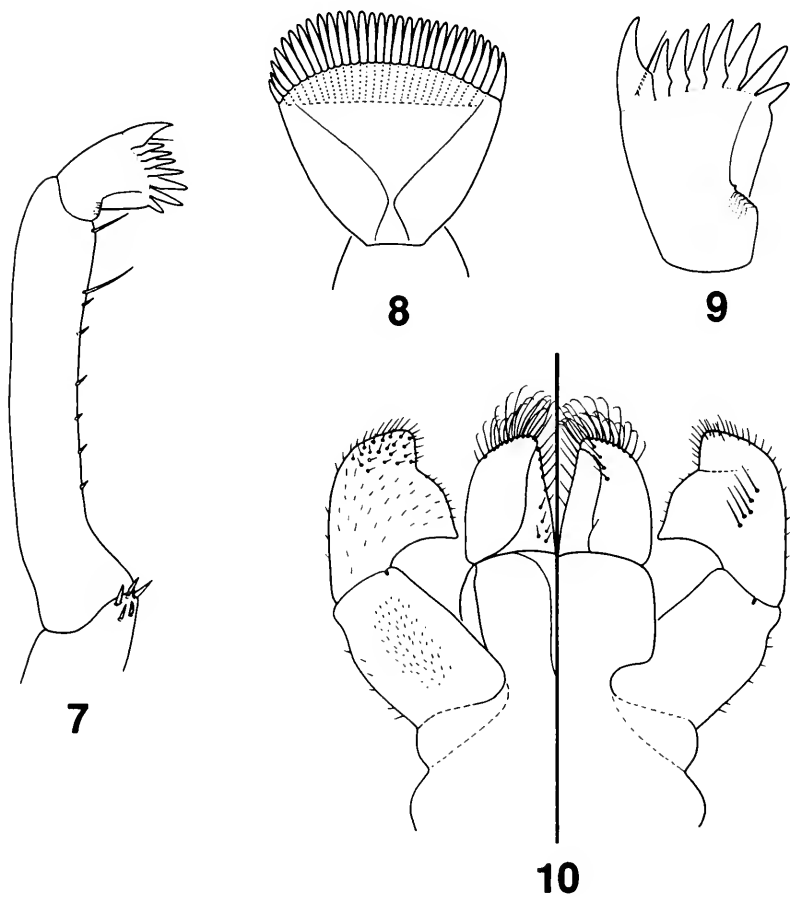
**Remarks.** As indicated by McCafferty and Davis (1992) and McCafferty *et al.* (1993), this species appears to be a distinct representative of *Camelobaetidius* in North America because of the unique number of denticles in the tarsal claws (16-18). We do not give a formal name to this species because the material examined consists of early instar larvae and we do not know yet if mouthpart characters and the number of denticles in the tarsal claws will be affected with growth. However, we have not observed significant changes in mouthpart morphology and tarsal claw denticulation in species series including different aged larvae of *Camelobaetidius* that we have studied thus far, and there remains a strong possibility that *C. sp. 1* is a distinct species.

**Distribution.** USA: Colorado, Texas.

**Material examined.** USA, Texas, Brewster County, Río Grande at Santa Elena Canyon, IX-28-1977, J. R. Davis, larvae (JRD); Presidio County, Río Grande 13 mi downstream from Presidio, VI-28-1977, J. R. Davis, larvae (JRD); Val Verde County, Río Grande at Foster Ranch nr Langtry, V-2-1977, larvae (JRD); Colorado, Moffat County, Yampa R. Echo Park, Dinosaur National Monument, VII-16-1981, larvae (CSU).



Figs. 2-6. *Camelobaetidius* spp.: Hind wing: 2. *C. mexicanus*. Labra: 3. *C. kondratieffi*. 4. *C. mexicanus*. 5. *C. similis*. 6. *C. warreni*.



Figs. 7-10. *Camelobaetidius* spp.: Tarsus: 7. *C. waltzi*. Tarsal claws: 8. *C. musseri*. 9. *C. waltzi*. Labium: 10. *C. waltzi*.

## Key to the known North and Central American larvae of *Camelobaetidius*

- |  |                     |
|--|---------------------|
| 1. Tarsal claws with 5-10 denticles (Fig. 9) .....                                   | 2                   |
| Tarsal claws with 16-45 denticles (Fig. 8) .....                                     | 5                   |
| 2. Forecoxal gills present .....   | <i>similis</i>      |
| Forecoxal gills absent .....   | 3                   |
| 3. Second segment of labial palps pointed (Fig. 10) .....                            | <i>waltzi</i>       |
| Second segment of labial palps round .....   | 4                   |
| 4. Tarsal claws with 5-6 denticles; labrum without intermediary setae (Fig. 4) ..... | <i>mexicanus</i>    |
| Tarsal claws with 7-9 denticles; labrum with intermediary setae (Fig. 6) .....       | <i>warrenii</i>     |
| 5. Tarsal claws with 16-18 denticles .....   | sp. 1               |
| Tarsal claws with 30-45 denticles .....  | 6                   |
| 6. Tarsal claws with 40-45 denticles; labrum with branched setae (Fig. 3) .....      | <i>kondratieffi</i> |
| Tarsal claws with 30-35 denticles (Fig. 8); labrum with simple setae .....           | 7                   |
| 7. Posterior margins of terga 1-9 pale .....   | <i>musseri</i>      |
| Posterior margins of terga 1-9 blackish .....  | <i>sinaloa</i>      |

### ACKNOWLEDGMENTS

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## SCIENTIFIC NOTE

REPORT OF *CHRYSOMYA MEGACEPHALA*  
(DIPTERA: CALLIPHORIDAE)  
IN NORTHERN NEW MEXICO<sup>1</sup>

Grant D. De Jong<sup>2, 3</sup>

The blowfly *Chrysomya megacephala* (Fabricius) has spread dramatically through South and Central America from its introduction to southern Brazil around 1975, probably from southern Africa (Baumgartner and Greenberg 1984), and is a recent invader of the continental United States. It has been reported from the southern regions of California (Greenberg 1988) and Texas (Wells 1991) and southern and central areas of Florida (Baumgartner 1993.)

On 19 October 1994, a single female specimen of *C. megacephala* was collected in association with a dead raccoon (*Procyon lotor* Linnaeus) in northern New Mexico (Mora Co., 12 mi SE of Wagon Mound). The collection of a single specimen does not confirm establishment of this species in New Mexico; however it can indicate the possibility of such an establishment. This record is new to the state and is substantially further north than previous records in North America.

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<sup>1</sup> Received March 17, 1995. Accepted March 30, 1995

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## SPECIFIC ASSIGNMENTS IN *EPHEMERELLINA* AND *VIETNAMELLA* (EPHEMEROPTERA: EPHEMERELLIDAE)<sup>1</sup>

T.-Q. Wang, W. P. McCafferty<sup>2</sup>

ABSTRACT: The presence in alate stages of vestiges of distinguishing larval cephalic horns indicates that Oriental species previously assigned to *Ephemerellina* and known only from alate stages belong to the genus *Vietnamella*. The species thus transferred include *V. ornata*, n. comb. and *V. sinensis*, n. comb. *Ephemerellina* presently is known only from temperate southern Africa.

In revising the higher classification of the pannota mayflies, certain problems with respect to correct generic assignment of species have come to our attention. Such problems often result from the fact that taxa are based on either only alate stages or only larvae, or from the fact that life stages have been incorrectly associated. This note deals with the resolution of a problem exemplifying the former situation. It is prerequisite to conducting accurate cladistics and biogeographic analyses at the species group level.

*Ephemerellina* was erected by Lestage (1924) and was the first recorded genus of Ephemerellidae from southern Africa. The genus was for many years known only from temperate South Africa, where McCafferty and deMoor (1995) have recognized three species. Allen and Edmunds (1963) transferred *Ephemerella sinensis* Hsu, a species known from adults only from Kiangsi Province, China, to *Ephemerellina*. Later, Tshernova (1972) described two subimagos from Yunnan Province, China as *Ephemerellina ornata* Tshernova, based on its similarity to *E. sinensis*. We have new evidence, however, that neither of these Oriental species belong to *Ephemerellina*.

Tshernova (1972) described the genus *Vietnamella* from Vietnam based on a single species, *V. thani* Tshernova. Although adults were unknown to her, the larvae of this genus were shown to be most unusual by their possession of many unique characteristics, including a pair of long cephalic frontal horns [illustrated by Tshernova (1972): Fig. 4]. *Vietnamella dabiesshanensis* You and Su (1987) from China has been the only other species that has been described in this genus. You and Su (1987) provided the first adult description of the genus (the species was based on both larvae and adults).

Recent research on the pannota mayflies has indicated that many larval characters, especially prominent and well-sclerotized armature, are often

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retained as vestiges in the alate stages (see Provonsha 1990, McCafferty and Wang 1994). Tshernova (1972:610) described prominent vestiges of frontal cephalic horns in the subimago of *E. ornata*. These vestiges, however, are precisely where we would have predicted them to be in alate forms of *Vietnamella*, and there are no larval structures in *Ephemerellina* (see, for example the larvae of the type species of *Ephemerellina*: *E. barnardi* Lestage) that would have resulted in such vestiges.

Based primarily on the evidence expressed by the presence of vestigial larval character in the alate stages, we herein recognize *Ephemerellina ornata* Tshernova as *Vietnamella ornata* (Tshernova), n. comb. In addition, on the basis of the close similarity of this species with *E. sinensis* we also recognize *Ephemerellina sinensis* (Hsu) as *Vietnamella sinensis* (Hsu), n. comb.

Some larvae of the ephemerellid genus *Drunella* possess cephalic processes. However, we do not believe it is possible that *V. ornata* and *V. sinensis* belong to *Drunella*, because processes in *Drunella* larvae are much smaller than those of *Vietnamella* and therefore also appear as much smaller vestiges in alate stages. In addition, the male genital forceps of *V. ornata* and *V. sinensis* and other *Vietnamella* are entirely different than those of *Drunella* (and *Ephemerella*, where *sinensis* was first described), being in fundamental agreement with the male genitalia recently described for *V. dabiesshanensis* by You and Su (1987).

#### ACKNOWLEDGMENTS

We thank George Edmunds, Salt Lake City, for the donation of *Vietnamella* material, and we thank Ferdy deMoor for the loan of certain South African material. This paper has been assigned Purdue Experiment Station Journal Number 14613.

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***PEDETONTUS GERSHNERI*, A NEW SPECIES OF  
MACHILIDAE FROM THE INTERIOR HIGHLANDS OF  
NORTH AMERICA (INSECTA: MICROCORYPHIA)<sup>1</sup>**

Robert T. Allen<sup>2</sup>

ABSTRACT: *Pedetontus gershneri*, a new species of Microcoryphia, is described from Magazine Mountain, Logan County, Arkansas. The new species was found in leaf litter in dense deciduous forest. The presence of 2 pairs of exsertile vesicles on urosternites II-V indicates a close relationship with *Pedetontus* species in western North America. Labial and maxillary palpi characters distinguish *P. gershneri* from its western relatives. *Machiloides banksi*, recorded for the first time from Arkansas, is found in more xeric habitats under rocks on the south facing slope of the mountain.

The Microcoryphia (jumping bristletails), along with the Protura, Collembola, Diplura and Thysanura, are the most ancient orders of the class Insecta (Boudreaux, 1979). Characterized by the absence of wings and the retention of other plesiomorphic characters such as abdominal styli and exsertile vesicles on some abdominal segments, Microcoryphia are an important link in understanding the early evolution and subsequent radiation of the entire class Insecta. However, few workers have studied these insects in North America. The most recent papers on the North American fauna are by Ferguson (1990) and Wygodzinsky and Schmidt (1980).

Ferguson (1990) has provided a valuable key to the higher taxa, genera and some species in the Microcoryphia and the Thysanura. These two groups are closely related and were, prior to the work of Remington (1954), both included in the order Thysanura. Ferguson's key makes it possible to readily identify the genera found in North America. Wygodzinsky and Schmidt (1980) provided keys, detailed descriptions and distribution records for four species of Microcoryphia occurring in the northeastern states and adjacent Canadian provinces.

In addition to their general comments on the Microcoryphia, Wygodzinsky and Schmidt (1980) described *Pedetontus saltator*, a new species found in Connecticut, Massachusetts, New Jersey, New York and Pennsylvania. Silvestri (1911) had first reported the genus *Pedetontus* from North America and described five new species from California, Oregon, and Colorado. In considering these species Wygodzinsky and Schmidt (1980) noted that three western species (*P. submutans*, *P. persquamosus*, *P. calcaratus*) possessed "two pairs

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of exsertile vesicles on urosternites II-V, whereas the remaining two western species (*P. californicus* and *P. superior*)” and the eastern *P. saltator* have two pairs of vesicles on urosternites II-VI. The new species described here, in regard to exsertile vesicles has two pairs on urosternites II-V. In this regard it is similar to the western species. The new species does differ from the western species in several respects.

### *Pedetontus gershneri* NEW SPECIES

(Figures 1 a-l o)

**Description.** Color of body uniformly dark, almost black when first collected (except where scales have been removed or intersegmental membranes are exposed); total body length 14-15 mm. Head large, median dark area extending from beneath compound eyes to 1/2-3/4 length of frontal area (Fig. 1a). Ocelli dark, soule-shaped, and, in freshly collected specimens, surrounded by a narrow, distinct pale margin (Fig. 1a). Antennal scape, segment 2 and basal segments of the palpi uniformly dark, without color pattern and densely covered with scales (Fig. 1g); antennal flagellum dark in basal one-fourth and distal one-half, the second one-fourth lighter in color. Last two segments of labial palpi lighter in color than basal segments (Fig. 1d). Apical segments of maxillary and labial palpi without strong spines. Basal segment of maxillary palpi without a lateral lobe. Length of antenna and flagellum 7.75 mm. Legs uniformly dark, tarsal claws white. Stylets of the urosternites white, those of abdominal segment 9 shorter than coxites. Exsertile vesicles on urosternites II-VII, two pairs on segments II-V. Ovipositor surpassing apex of abdominal segment 9, pale. Gonapophyses of the primary type consisting of 55-60 articles. Cerci 5.5 mm in length, one apical claw; caudal filament 11-12 mm in length.

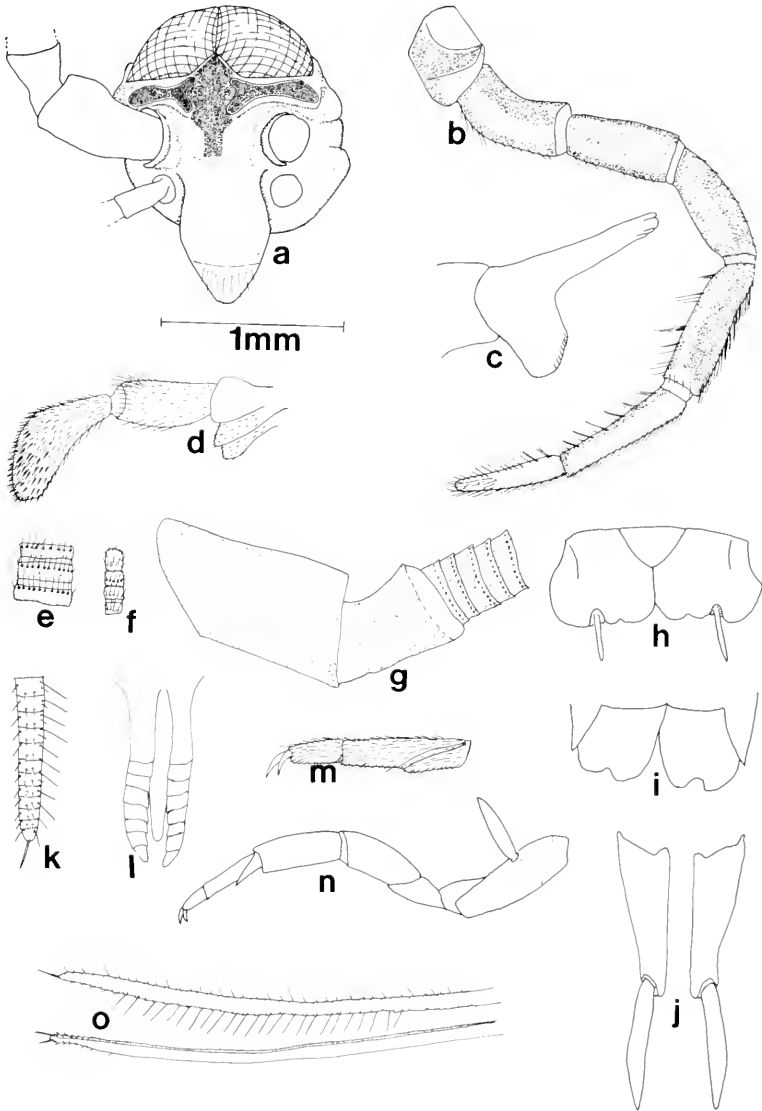
**Holotype.** Female, Mossback Ridge, Magazine Mountain (near Paris), Logan County, Arkansas; June, 1990, pitfall trap; collector J. Dacus. Deposited in the American Museum of Natural History, New York, NY.

**Paratypes.** All material is from different areas on Magazine Mountain, Arkansas, Logan Co., near Paris. Mossback Ridge, June 1989, pitfall trap, R. T. Allen collector, 2 immatures; South Rim, West Cabin Site, R. T. Allen collector, 17 June 1989, pitfall trap 2D, 1♂, 1♀; South Rim, West Cabin Site, R. T. Allen collector, 17 June 1989, pitfall trap 2B, 1♂, 2♀; Mossback Ridge, 16 June 1990, pitfall trap, B. Leary collector, 2♂♂, 3♀♀; Mossback Ridge, June 1990, pitfall trap, J. Dacus collector, 2♂♂, 5♀♀; East End Log Road, 3rd stream crossing, 21 April 1991, R. T. Allen collector, in leaf debris, elev. 1700 ft. 1♀, 1 immature; Dripping Springs, R. T. Allen, June, 1992, R. T. Allen collector, in leaf debris, 1♀, 3 immatures.

**Etymology.** This species is named in honor of Caroline and Larry Gershner of DeValls Bluff, Arkansas. The Gershners have worked diligently to instill an appreciation of the natural sciences in hundreds of high school students.

**Diagnosis.** *Pedetontus gershneri* appears to belong to the western group of *Pedetontus* species with 2 pairs of exsertile vesicles on urosternites II-V. It may be separated from those species using characters associated with the labial and maxillary palpi.





**Fig 1**

Figure 1. *Pedetontus gershneri*: a, frontal view of head, 75X; b, maxillary palp, 37.5X; c, mandible, 150X; d, labial palp, 50X; e, antennal segments, 100X; f, terminal antennal segments, 100X; g, basal antennal segments, 75X; h, sternites of abdominal segment IV, 75X; i, sternites of abdominal segment VIII, 75X; j, coxites of 9th segment, 75X; k, apex of anterior gonopophysis, 150X; l, male genital area, 150X; m, tarsi and claws of hind leg, 150X; n, hind leg, 37.5X; o, anterior and posterior gonapophysis, 75X.

## DISCUSSION

The presence of only one pair of exsertile vesicles on urosternite 6 places the new species with the 3 western *Pedetontus* species. The absence of strong spines on the apical segments of the maxillary and labial segments separate the new species from *P. persquamoas* and *P. calcaratus*. *Pedetontus submutans* has strong spines on the apical segment of the labial palpi and the new species does not. Both *P. submutans* and *P. calcaratus* have distinct lobes and long setae on the basal segments of the maxillary palps.

While most species of *Pedetontus* are found in rather dry rock outcrops *P. gershneri* is found on the moist forest floor or among deciduous leaves or sometimes among coniferous pine needles mixed with deciduous leaves. This habitat is strikingly different from the xeric rock ledges inhabited by *Machiloides banksi*, the other species of Microcoryphia found on Magazine Mountain. Wygodzinsky (1967) noted that members of the genus *Neomachillellus* (Meinertellidae) have "adapted ... to an existence far removed from stony outcrops, many species being found on and under bark of trees, on leaves, and on the soil."

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# FAUNAL COMPOSITION AND FLIGHT ACTIVITY OF SOME TUMBLING FLOWER BEETLES (COLEOPTERA: MORDELLIDAE) IN SOUTHERN QUEBEC (CANADA)<sup>1</sup>

Claire Levesque, Gilles-Yvon Levesque<sup>2</sup>

**ABSTRACT:** One hundred and fifty seven adults of 13 Mordellidae species were collected with flight intercept traps during 1987-1989 at four sites in southern Québec. The five most abundant species were *Mordella* prob. *atrata*, *Mordellistena scapularis*, *Mordellistena* sp., *Tomoxia borealis* and *T. serval*. They flew mainly in mid-summer probably during their reproduction period.

Seventy species and subspecies of mordellids have been recorded in Canada (McNamara 1991). Liljeblad (1945) revised the North American species of Mordellidae and Jackman (1991) discussed recently some nomenclatural changes. Nevertheless, a modern revision would be useful. Members of Anaspini, which used to be included within Mordellidae, are now in the family Scaptiidae (McNamara 1991).

Several species are linked with weedy vegetation. Adults are commonly found on flowers on which they feed (McNamara 1991). Mordellid larvae are represented in entomological complexes of phytobionts and xylobionts, being destructors of living and dying vegetative organic matter (Odnosum 1992).

Little is known about the faunal composition and seasonal activity of adult Mordellidae. We found many individuals of this family in flight intercept traps during a study of beetles in a raspberry (*Rubus idaeus* L.) plantation and adjacent sites in southern Québec. We present results on the faunal composition of mordellids from four sites adjacent to a raspberry plantation, and also the seasonal flight activity of some abundant species, over a three-year period (1987-1989).

## MATERIALS AND METHODS

Beetles were collected from early May through late October on a monocultural raspberry farm at Johnville, near Sherbrooke, in southern Québec, Canada. We studied beetles flying close to the ground with flight intercept traps at four sites: 1) an open site near the center of the plantation (Table 1, A), about 20 m from old plants; 2) an open site near a pond (Table 1, B), about

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5 m from young raspberry plants; 3) a pine woods-raspberry field boundary (Table 1, C); and 4) an adjacent pine woods (Table 1, D) dominated by eastern white pine, *Pinus strobus* L. These traps were not located between rows of raspberry plants because of grower's activities and public access during harvest. Flight intercept traps were modified from the large-area "window" trap design promoted by Peck and Davies (1980). Each consisted of a gray 1.5 mm mesh window screen (1.22 m height, 1.52 m width, about 1.85m<sup>2</sup> of surface) fastened to a wooden frame. The frame itself was suspended by two lateral triangular wooden supports (1.83 m at the base, 1.25 m height), 2-4 cm over a set of two galvanized metal pans (25 by 61 cm at the top, 7.5 cm deep) which were placed directly on the ground. The insects were caught in the pans partially filled with 2% formalin into which a few drops of detergent were added. We installed one intercept flight trap at each site; however, the pine woods trap (Table 1, D) was only operated in 1988 and 1989. Samples were collected twice a week. Levesque and Levesque (1992) presented detailed information about the sampling method and study sites, including a sketch-map of the raspberry farm and the description of plant communities.

Table 1. Mordellidae species captured in flight intercept traps at Johnville, Québec (1987-1989).

Species	Open site near center (A)	Open site near pond (B)	Boundary (C)	Pine woods <sup>a</sup> (D)	Total
<i>Mordella</i> prob. <i>atrata</i> Melsh.	15	15	1	0	31
<i>Mordellistena andreae andreae</i> LeC.	0	1	0	0	1
<i>Mordellistena frosti</i> Liljeblad	0	0	1	0	1
<i>Mordellistena marginalis</i> (Say)	0	1	0	0	1
<i>Mordellistena nigricans</i> (Melsh.)	2	4	0	0	6
<i>Mordellistena</i> prob. <i>picalabris</i> Helmuth	0	1	1	0	2
<i>Mordellistena quadrinotata</i> Liljeblad	0	1	0	0	1
<i>Mordellistena scapularis</i> (Say)	0	0	9	2	11
<i>Mordellistena</i> sp.	16	37	0	0	53
<i>Mordellistena trifasciata</i> (Say)	0	2	0	0	2
<i>Tomoxia borealis</i> (LeC.)	5	2	2	4	13
<i>Tomoxia inclusa</i> LeC.	1	1	0	0	2
<i>Tomoxia serval</i> (Say)	12	3	12	6	33
Total	51	68	26	12	157
Number of species	6	11	6	3	13

<sup>a</sup> not sampled in 1987.

## RESULTS AND DISCUSSION

We collected 157 adults of 13 mordellid species mainly in the open sites near the raspberry plants (Table 1). The maximal diversity occurred in the open site near a pond (11 species), and the minimal diversity in the pine woods (3 species). *Mordella* prob. *atrata* Melsh. and *Mordellistena* sp. [near *M. aspersa* (Melsh.)] flew almost entirely in the two open sites (A and B), *Tomoxia borealis* (LeC.) and *T. serval* (Say) were captured in all four sites, whereas *Mordellistena scapularis* (Say) flew at the woods-field boundary and in the pine woods (Table 1). Brimley (1951) collected 31 mordellid species in Prince Edward County (Ontario), including nine species also caught at Johnville.

The 13 mordellid species from Johnville all flew during the summer (June-September), and we collected 11 species or 58% of the individuals in July. In comparison, for all beetle families together the flight activity was maximal in May-June (60% of total captured individuals) and decreased thereafter; only 17% of beetles flew in July.

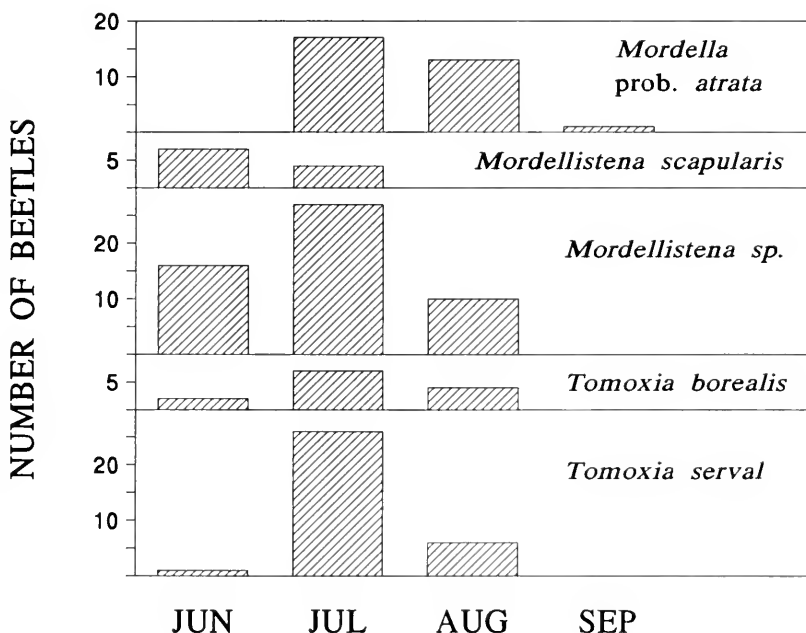


Fig. 1. Seasonal abundance of *Mordella* prob. *atrata*, *Mordellistena scapularis*, *Mordellistena* sp., *Tomoxia borealis* and *Tomoxia serval* in flight intercept traps at Johnville, Québec (1987-1989).

The flight activity of *M. prob. atrata* occurred from July to September, and that of *M. scapularis* in June-July (Fig. 1). We observed the flight of *Mordellistena* sp., *T. borealis* and *T. serval* from June to August, but mainly in July. The period of raspberry flowering occurred in June, whereas we observed during mid-summer flowers of abundant weeds: buttercup (*Ranunculus acris* L.), clovers (*Trifolium pratense* L., *T. repens* L.), ox-eye daisy (*Chrysanthemum leucanthemum* L.), common milkweed (*Asclepias syriaca* L.) and vetch (*Vicia cracca* L.). We suspect that several southern Canadian mordellid species fly during their aestival reproduction period, and that their larvae feed on weeds and overwinter.

#### ACKNOWLEDGMENTS

We appreciate the help of Mrs. J. McNamara (Centre for Land and Biological Resources Research, Agriculture Canada, Ottawa, Ontario) for identifications and confirmations of species collected in this study. Voucher specimens of some species are deposited in the Canadian National Collection (Agriculture Canada, Ottawa). We are grateful to two anonymous reviewers for their helpful comments on this manuscript. We thank Michel Couture and Lucie Labrecque, owners of "La Framboisière de l'Estric, enr." at Johnville (Québec). This study was partially supported by the Fonds F.C.A.R. (Québec).

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## BIOLOGICAL NOTES ON *OOSTERNUM ATTACOMIS* (COLEOPTERA: HYDROPHILIDAE), FROM MORELOS STATE, MEXICO<sup>1</sup>

Juan Márquez-Luna<sup>2</sup>, José Luis Navarrete-Heredia<sup>3, 4</sup>

**ABSTRACT:** *Oosternum atacomis* was collected from two localities from Morelos State, Mexico, in refuse dumps of the leaf-cutting ants *Atta mexicana*. Higher abundance was detected at refuse dumps with lower temperature variation and high humidity. This is the first record of the species from Mexico.

The genus *Oosternum* includes nine species in the World. Two are distributed in the New World: *O. costatum* Sharp and *O. atacomis* Spangler (1962). The first one is widely distributed in America. The second one has been recorded only from Louisiana (U.S.A) and El Salvador, always associated with refuse dumps of the leaf-cutting ants *Atta*: *A. texana* (Buckley) and *A. mexicana* (F. Smith) (Smetana, 1978).

Ants of the genus *Atta* are widely distributed in the New World, from southern United States to South America (Pescador, 1980). Three species have been recorded from Mexico: *A. mexicana* has been recorded in 19 states; *A. texana* distributed in the northern part of the country and *A. cephalotes* (L) primarily in the tropical areas of southeastern Mexico (Smith, 1963). *A. mexicana* is distinguished from the other two Mexican species because the ant debris produced in the fungus gardens is carried out of the colony to form external refuse dumps; while *A. texana* and *A. cephalotes* store their debris in special underground chambers (Rojas, 1986, 1988; Deloya, 1988).

The goal of this paper is to provide biological notes on *O. atacomis*, a coleopterous insect inhabitant of refuse dumps of *A. mexicana* and to record it for the first time from Mexico.

### MATERIAL AND METHODS

Adults of *Oosternum atacomis* were collected in refuse dumps of the leaf cutting ant *A. mexicana*. Three refuse dumps in northern Morelos state were sampled at three month intervals between January 1992 and January 1993.

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Specimens were collected directly. Length, width and depth of the refuse dumps were measured in order to determine their volume. Temperature and humidity were also recorded.

One refuse dump designated as M-1 is near San Jose de los Laureles in a disturbed cloud forest. M-2 and M-3 are in Tlayacapan where temporary crops are found (Secretaría de Programación y Presupuesto, 1981) (Fig. 1).

## RESULTS AND DISCUSSION

*Oosternum attacomis* is recorded for the first time from Mexico.

Specimens examined are labelled: "MEXICO: Morelos, Tlayacapan, San José de los Laureles, 30-I-1992, ex detritos de *Atta mexicana*, J. Márquez col. (3 specimens)"; same data except for: "19-VII-1992, (22)"; same data except for: "24-x-1992, (153)"; same data except for: "8-IX-1990, J.L. Navarrete y G.A. Quiroz cols. (3)". "MEXICO: Morelos, Tlayacapan, 24-IV-1992, ex detritos de *Atta mexicana*, J. Márquez col. (1)"; same data except for: "20-VII-92, (2)"; same data except for: "25-X-1992, (2)". Additional specimen from Las Pilas, Morelos is labelled: MEXICO: Morelos, Las Pilas, 10-IV-1992, ex detritos de *Atta mexicana*, J.L. Navarrete y G.A. Quiroz cols.(1)".

The specimens are deposited in the following collections: Field Museum of Natural History, Chicago (FMNH); Canadian National Collection, Ottawa (CNC); Instituto de Biología, Universidad Nacional Autónoma de México, Cd. de México (IBUNAM); Museo de Historia Natural Cd. de México, Cd. de México (MHNCM); Centro de Zoología, Universidad de Guadalajara, Zapopan (CZUG); and in our entomological collections: Juan Márquez-Luna, Cd. de México (JML) and J.L. Navarrete, Zapopan (JLN).

M-1 and M-2 refuse dumps have similar debris volume, but M-1 has a lower temperature variation and high humidity. Temperatures of M-2 and M-3 are both higher than the environment, but the humidity of M-2 is intermediate between M-1 and M-3. M-3 is the smallest and driest refuse dump and presents the highest human perturbation.

Adults of *O. attacomis* seem to prefer the most humid and more stable temperature conditions of the M-1 refuse dump, since 178 specimens were collected there during the study. There is apparently less preference for the M-2 conditions, because only 5 specimens were collected there. Refuse dumps as disturbed and dry as M-3 seem not to offer appropriate conditions for this species. No specimens were collected there (Fig. 2).

Adults were most abundant during the rainy season (July and October samples) (Fig. 2).

Based on these observations and in the classifications provided by Rojas (1986) for the fauna associated with ant refuse dumps, we conclude that *O. attacomis* is a permanent inhabitant of ant refuse dumps. Permanent species are characterized because they spend all their life cycle in this microhabitat, which is richer in nutrients and facilitates the colonization of a higher diversity of insects.



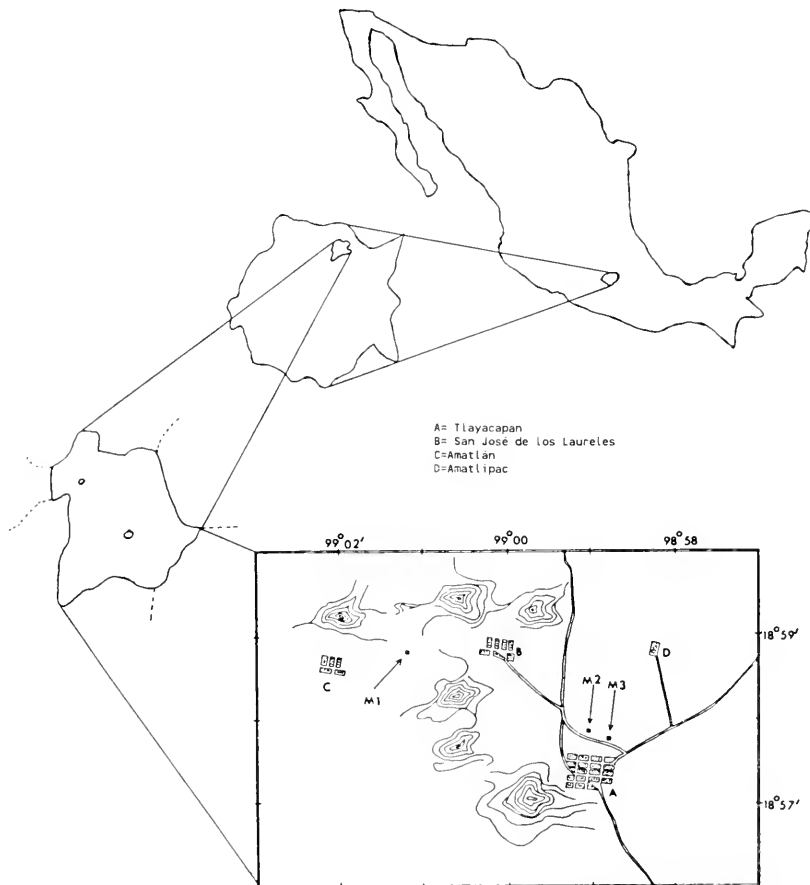


Figure 1. Location of study sites. (Map modified after Cartas Topográficas INEGI, 1991: Cuernavaca E-14-A-53 and Cuautla E14B51).

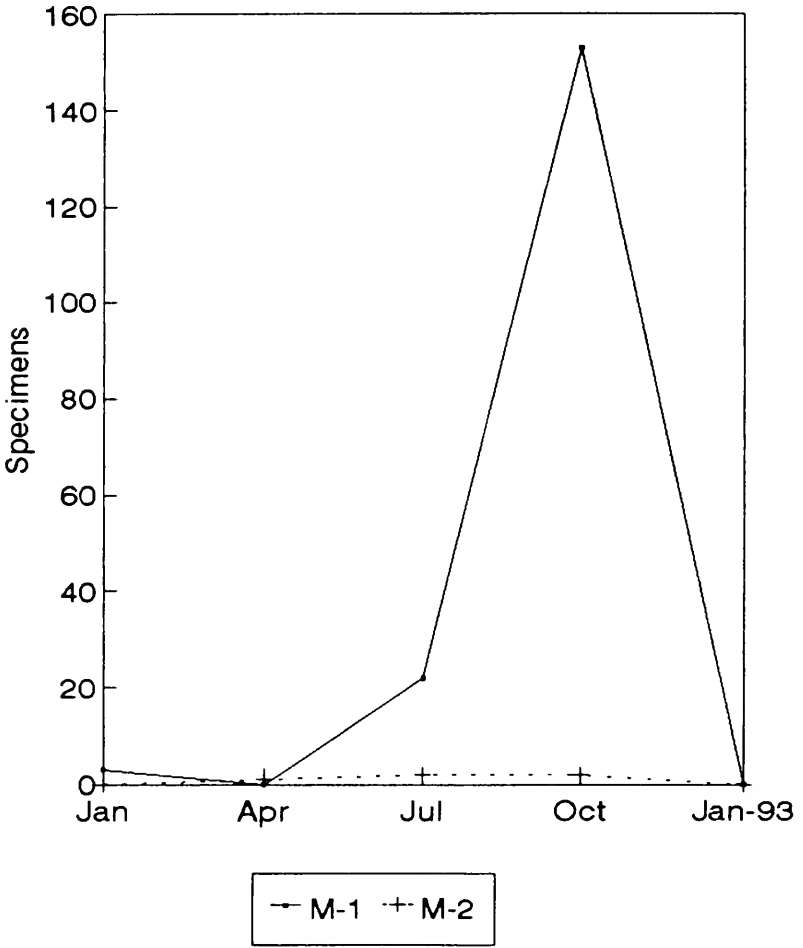


Figure 2. Abundance of *Oosternum attacomis* in two ant refuse dumps.

Márquez-Luna (1994) reported 22 permanent species of beetles that coexist with *O. attacomis* in this microhabitat. These are included in Table 1.

Table 1. Permanent species collected in three ant refuse dumps from northern Morelos, Mexico.\*

FAMILY	SPECIES	FAMILY	SPECIES
Alleculidae	<i>Hymenopus</i> sp.	Scydmaenidae	<i>Ascydmyus</i> sp. <i>Euconnus</i> sp. <i>Neladius</i> sp. 1 <i>Neladius</i> sp. 2
Cerylonidae	<i>Laphetus</i> sp.	Staphylinidae	<i>Falagonia mexicana</i> <i>Glenus</i> sp. aff. <i>flohri</i> <i>Glenus setosus</i> <i>Philonthus alius</i> <i>Platydracus fulvomaculatus</i>
Histeridae	<i>Epiglyptus costatus</i> <i>Hister</i> sp. <i>Phelister</i> sp. <i>Pseudister rufulus</i> <i>Xestipyge multistriatum</i>	Tenebrionidae	<i>Bycrea villosa</i>
Passalidae	<i>Ptichopus angulatus</i>	Undetermined	<i>Coleoptera</i> sp.
Scarabaeidae	<i>Ataenius holopubescens</i> <i>Aphodius dugesi</i> <i>Cloeotus nassutus</i> <i>Onthophagus rufescens</i>		

\**O. attacomis* is excluded. Relative abundance per refuse dump and for each sampling date are presented in Márquez-Luna (1994). Groups are in alphabetical order.

Faunal studies of ant debris have been carried out primarily in the external refuse dumps of *A. mexicana* possibly because they are easily detected. It is very possible that the distribution of this species in Mexico is similar to that of *A. mexicana* since other permanent inhabitants have such a pattern of distribution. However, this hydrophilid beetle seems to prefer refuse dumps with higher humidity and constant temperature in relation to the environment. This preference is reported for other permanent species of beetles (Márquez-Luna, 1994).

#### ACKNOWLEDGMENTS

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## 1995 CALVERT AWARD

Since its inception in 1987, the annual presentation of the Calvert Award has become the centerpiece of the Society's April membership meeting. Coinciding with the explosion of springtime on the Delaware Valley, the event has a refreshing festive air in celebration of excellence by budding young entomologists. Attendance at this year's April meeting, as in the recent past, was the highest of the year. Members and guests arrived early to visit the exhibit, "Butterflies Live & in Color!," at the Academy of Natural Sciences and to look at the insect related science projects displayed by this year's Calvert Award winner and other recognized students.

Lisa Patrick, a ninth grade student at Central High School in Philadelphia, received the 1995 Calvert Award for her project on the "Effects of chlorine-treated wastewater on benthic invertebrates." Both the judges who evaluated the project at the Delaware Valley Science Fairs on April 5 and the Society membership at the April 26 membership meeting were tremendously impressed by Lisa and her project. It culminated four years of research on water quality and showed a sophisticated understanding of the interrelation of water chemistry, pollution control issues, and the biology of aquatic insects.

The first runnerup this year was Joshua Rufe, a seventh grade student at Pennridge Central Junior High School in Perkasio, PA. Joshua's project on preying mantises revealed his unusual sensitivity for the care of these insects, excellent observational skills, and an intense curiosity about the insect's behavior.

In keeping with the practice of honoring projects dealing with local insects and natural settings, honorable mention went to Galeet Cohen who, having never knowingly seen a gypsy moth, did a science project on gypsy moths. She compared the growth of oak trees and tulip poplar trees, as revealed in their annual growth rings, to see the differential effects of gypsy moth defoliation in the early 1980's of oaks, but not tulip trees, in the same woodlots. Galeet is a tenth grade student at Central High School in Philadelphia.

Philip P. Calvert, for whom the Award is named, was himself a student at Central High School more than 100 years ago. [See ENT. NEWS 95(4): 155 - 162 (1984)]. Thus it seems fitting that this year and in past years that a disproportionately large number of insect-related projects recognized by the Society have come from this high school. All of those projects have been sponsored by a single teacher, Mr. Dennis Erlick. Recognizing the importance of teachers and mentors in cultivating the scientific interests of students, the Society presented a certificate to Mr. Erlick in special appreciation for his dedication to young people and his sponsorship of so many excellent projects.

Following the awards ceremony, the audience was treated to a beautifully illustrated talk on the Butterflies in Valley Forge National Park by Jane Ruffin, a member of the Society and a volunteer in the Entomology Department at the Academy of Natural Sciences.

Harold B. White  
Chair, AES Education Committee

## NEW HOMONYM, SYNONYM, AND COMBINATIONS IN THE CHINESE CICADELLIDAE (HOMOPTERA: AUCHENORRHYNCHA)<sup>1</sup>

Ai-Ping Liang<sup>2</sup>

ABSTRACT: One species of Evacanthinae, *Evacanthus uncinatus* Kuoh, a preoccupied name, is renamed *Evacanthus kuohi*, new name. The hylicine *Wania membracioidea* Liu is synonymized with *Balala fulviventris* (Walker). In Nirvaninae, two new combinations, *Sophonia alba* (Kuoh), (*Pseudonirvana*) and *Sophonia nigrifrons* (Kuoh), (*Pseudonirvana*) are reported.

During the preparation of a checklist of Cicadellidae found in China, it became evident that several nomenclatorial changes in the subfamilies Evacanthinae, Hylicinae, and Nirvaninae are necessary. In this paper, I offer replacement name for one homonym, propose one new synonym, and transfer two species to the correct genus.

### EVACANTHINAE

#### *Evacanthus kuohi* Liang, NEW NAME

*Evacanthus uncinatus* Kuoh, 1992: 259, 308, fig. 18 (preoccupied by *Evacanthus uncinatus* Li, 1989: 337, 339, figs. 1-5).

Kuoh (1992) described *Evacanthus uncinatus* from a male and a female collected in Yunnan Province of southwestern China. Because the name *E. uncinatus* is preoccupied, I am here proposing the replacement name *kuohi*, in honor of the Prof. C.L. Kuoh for his extensive work on the Chinese Cicadellidae.

<sup>1</sup> Received January 25, 1995. Accepted February 29, 1995

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## HYLICINAE

*Balala fulviventris* (Walker)

*Penthimia fulviventris* Walker, 1851: 841.

*Balala fulviventris* (Walker); Distant, 1908: 251, fig. 159; Evans, 1946a: 59, fig. 23; Metcalf, 1962: 14.

*Wania membracioidea* Liu, 1939: 297, 3 figs. **New synonymy.**

*Balala membracioidea* (Liu); China, 1941: 255; Evans, 1946b: 46; Metcalf, 1962: 14.

Liu (1939) described *Wania membracioidea* as a new genus and species from Anhui Province of eastern China from a single female in the Héude Museum, Shanghai, China which is now held in the Insect Collection of the Institute of Zoology, Academia Sinica, Beijing, China. China (1941) synonymized *Wania* Liu with *Balala* Distant and established the new combination *Balala membracioidea* (Liu). *Balala fulviventris* (Walker) is a widespread species ranging from India, east to Burma, Tonkin, Indo-China, southern and central China, Taiwan, Sumatra, Borneo. I have compared the female holotype of *membracioidea* to material of *fulviventris* from the southern and eastern China and find them indistinguishable.

## NIRVANINAE

*Sophonia alba* (Kuoh), NEW COMBINATION

*Pseudonirvana alba* Kuoh, 1992: 293, 314, fig. 52.

Kuoh (1992) described *alba* in the genus *Pseudonirvana* from a single male taken at Dali, Yunnan of southwestern China. *Pseudonirvana* Baker was suppressed as a junior synonym of *Sophonia* Walker by Evans (1947) and has been accepted by most authors (Viraktamath & Wesley, 1988). I have studied the holotype of *alba* which is held in the Insect Collection of the Institute of Zoology, Academia Sinica, Beijing and find that this leafhopper belongs in the genus *Sophonia*.

*Sophonia nigrifrons* (Kuoh), NEW COMBINATION

*Pseudonirvana nigrifrons* Kuoh, 1992-292: 314, fig. 51.

*Pseudonirvana nigrifrons* was described from a single male taken at Markam of Xizang [Tibet] (Kuoh, 1992). I have examined the holotype of this species which is held in the Insect Collection of the Institute of Zoology, Academia Sinica, Beijing and am here also transferring it to the genus *Sophonia*.

## ACKNOWLEDGMENTS

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## BOOK REVIEW

HOST-PLANT SELECTION BY PHYTOPHAGOUS INSECTS. E. A. Bernays and R. E. Chapman. 1994. Chapman and Hall. 312 pp.

A primary reason entomology holds the status it does today as a biological science is because of insects which are associated with plants of importance to humans, particularly those insects causing economic losses. When the interactions of plants with phytophagous insects and those with entomophagous insect natural enemies associated with herbivorous prey are combined, the majority of the insects are linked with some form of plant relationship. Much progress has been made as a result of applied and theoretical research on the interaction between insects and plants. However, much more can be accomplished. Bernays and Chapman offer new insight into host plant selection, particularly at the behavioral level. With insect pest management moving more toward reduction in use of chemical insecticides, more emphasis is being placed on development of environmentally rational alternatives. The relatively untapped use of behavior modifying techniques associated with host-plant selection holds a great deal of promise for manipulating insects in future insect control strategies to sustain agricultural and natural plant resources. Phytophagous insects select host plants either for food directly for themselves or as ovipositional sites which result in food being available for their young. Since this selection has a profound impact on the fitness and survival of their offspring, host-plant selection has a tremendous influence on the evolution of phytophagous species.

*Host-Plant Selection by Phytophagous Insects* is a well written synthesis of knowledge on various aspects underlying how phytophagous insects select host plants. The authors justify writing this book, on a topic they recognize as having much written on it before, because of their desire to draw attention to the behavioral role in host-plant selection. Since approximately half of the text is on behavior, it would have been more informative if the title would have included behavior. Although the book is on plant selection by phytophagous insects, much of the information can be applied also to entomophagous insects seeking plants (tritrophic interactions). The book begins with a look at the range of host-plant use by phytophagous insects. This includes the various degrees of specialization across taxa and on plant parts. The next chapter covers the different kinds of chemicals encountered by phytophagous insects. These include volatiles first encountered, surface compounds, and chemicals within the plant. The latter category comprises 92 percent of the chapter which suggests that much is yet to be learned about the chemicals encountered before reaching the plant and those encountered at the plant surface. Chapter 3 contains structure and function of insect sensory systems as applied to phytophagous insects. Several examples of sensory response to taste and smell are included. The next three chapters (47 percent of the book) include behavior of host-plant selection. The first portion is on the basic behavior associated with finding and accepting a host-plant, followed by how environmental and physiological factors can influence these basic behavioral processes. The last of these three chapters discusses the effects of experience based on behavioral characteristics. The final two chapters of the book cover genetic variation in host selection and evolution of host range. This treatment of genetics and evolution provides the basis for a discussion on development of specialization in herbivorous insects. Genetics of host-selection behavior is identified as an area in need of much research.

Overall, the book is easy to read and follows a logical sequence of presenting the subject areas associated with host-plant selection. The authors have chosen to leave reference citations out of the text. This approach makes the book an excellent candidate for a college text in courses relating to this topic. At the end of each chapter, references are organized by chapter subdivisions making it easy to link the examples in the text with the appropriate references. A list of books and chapters suggesting further reading is also given at the end of each chapter. The book includes a glossary with over 160 entries, and a separate taxonomic index as well as a subject index. In addition to use as a student text, this book is recommended for researchers and professionals with an interest in insect behavior, ecology and evolution.

Charles E. Mason,  
Dep't. of Entomology,  
University of Delaware



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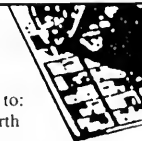
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## NEW SPECIES OF *SMICRIDEA* (*RHYACOPHYLAX*) (TRICHOPTERA: HYDROPSYCHIDAE) FROM COSTA RICA<sup>1</sup>

Ralph W. Holzenthal, Roger J. Blahnik<sup>2</sup>

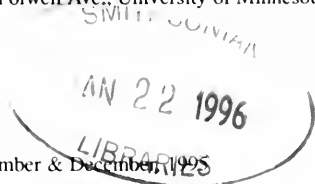
**ABSTRACT:** Three new species in the caddisfly genus *Smicridea*, subgenus *Rhyacophylax*, are described from Costa Rica and 25 additional species in the two recognized subgenera are recorded from the country. Illustrations of the male and female genitalia and wing coloration are provided for each of the new species along with a map of their distributions. Two of the new species, *S. singri* and *S. nemorosa*, are in the *signata* species group, and the third, *S. tapanti*, is a member of the *peruana* species group.

Since 1986, the authors have been involved in a nationwide inventory of the Trichoptera of Costa Rica. Not surprisingly, during the course of this survey, many previously undescribed species have been discovered, including three in the genus *Smicridea*, subgenus *Rhyacophylax* Müller. Concurrently with our survey, John K. Jackson and Bernard Sweeney, Stroud Water Research Center, Avondale, Pennsylvania, have been investigating the ecology of the aquatic insects of Guanacaste National Park, in the northwestern corner of Costa Rica. A *Smicridea* species encountered in the aquatic insect rearing program of Jackson and Sweeney is the same as one of the new species captured during our inventory. We are taking this opportunity to describe this new species, along with the two others, so that binomens are available for use by ecologists and others interested in the caddisfly fauna of Costa Rica.

The genus *Smicridea* is diverse and abundant throughout the Neotropical realm, ranging from the southwestern United States to extreme southern South America; it is also found through the Antilles. Important papers on the taxonomy and diversity of the genus include those of Blahnik (1995), Flint (1968, 1974a, 1974b, 1981, and 1989), and Flint and Denning (1989). Wiggins (1977) provided a detailed account of the larval morphology, yet little is known about larval biology. Larvae we observed in Costa Rica constructed typical hydropsychid retreats and capture nets which they undoubtedly use to filter organic matter suspended in the water. Two subgenera are recognized, *Smicridea* Mac Lachlan and *Rhyacophylax* Müller, containing 92 and 57 species, respectively. With the description below of three new species, 28 are now known from Costa Rica. The 25 previously described Costa Rican *Smi-*

<sup>1</sup> Received March 19, 1995. Accepted April 11, 1995.

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*cridea* include, in *Rhyacophylax*: *acuminata* Flint 1974, *bifurcata* Flint 1974, *murina* Mac Lachlan 1871, *radula* Flint 1974, *signata* (Banks) 1903, and *talamanca* Flint 1974, and in *Smicridea*: *aries* Blahnik 1995, *bivittata* (Hagen) 1861, *breviuncata* Flint 1974, *catherinae* Blahnik 1995, *fasciatella* Mac Lachlan 1871, *filicata* Flint and Denning 1989, *gemina* Blahnik 1995, *gomezi* Blahnik 1995, *gomphotheria* Blahnik 1995, *holzenthali* Flint and Denning 1989, *hybrida* Blahnik 1995, *matagalpa* Flint 1974, *mirama* Flint and Denning 1989, *multidens* Flint and Denning 1989, *polyfasciata* Martynov 1912, *sirena* Bueno 1986, *turrialbana* Flint 1974, *ulva* Flint 1974, and *varia* (Banks) 1913.

### *Smicridea (Rhyacophylax) nemorosa*, NEW SPECIES

Figs. 1, 4, 8, 10

This new species is closest *S. (R.) salta*, with which it shares the sharp spur on the ventral margin of tergum X and the long thin retractile structures of the phallus. It differs from *salta* in that the apex of the phallus has a pair of ventrolateral lobes and a single, pointed mesoventral lobe; in *salta* the ventrolateral lobes are not present and the mesoventral lobe is rounded apically.

**Adult:** Forewing length 4.5 mm. Color overall pale stramineous; forewing (Fig. 8) with dark marks along chord and over radial and thyridial nygmata, apex of wing with darker setae and light subterminal band, bordered basally by slightly darker setae. Sternum V in male with anterolateral glandular process almost twice as long as sternum; about half length of sternum in female. **Male genitalia:** Segment IX with anterolateral margin produced into a pointed, upturned lobe. Tergum X, in lateral aspect, with tip rounded, not upturned, bearing tiny setae; apicodorsally with wart bearing 4-6 long setae; ventrolateral margin of X bearing single, mesal, spinelike projection; apex of X divided to full length of tergum. Inferior appendages two-segmented; basal segment long, slightly inflated preapically, covered with setae, apicodorsal setae long; apical segment short, apex rounded in dorsal and lateral aspects. Phallic apparatus tubular, basal section enlarged and meeting apical section at about 130°; apex of phallus with paired ventrolateral, slightly upturned lobes and pointed mesoventral lobe; apically with retractile structure composed of two very slender, slightly sinuate, sclerotized rods and single, long, keel-like structure. Dorsal periphallial membranes very small, indistinct. **Female genitalia:** Sternum IX divided, each sternal plate very acute posteriorly, setose, adjacent pleural membrane setose. Internal plate (*sensu* Flint 1974), in ventral aspect, elongate, lyre-shaped, in caudal aspect U-shaped. Vaginal apparatus with anterior bar narrow; anteromesally without sclerotized plates, this region highly membranous.

**Holotype.** ♂: COSTA RICA: *Alajuela*: Reserva Forestal San Ramón, Río San Lorencito and tribs., 10.216°N, 84.607°W, el. 980 m, 6-10.iii.1990, Holzenthal, Muñoz, Huisman (NMNH).

**Paratypes:** COSTA RICA: *Alajuela*: Quebrada Latas, 8.9 km NE Bajos del Toro, 10.269°N, 84.260°W, el. 1030m, 6.ix.1990, Holzenthal, Blahnik, Huisman; 10 ♂, 8 ♀ (UMSP); same data as holotype, except 30.iii-1.iv.1987, Holzenthal, Hamilton, Heyn, 1 ♂ (UMSP); same, except 28-30.vii.1990, Holzenthal, Blahnik, Muñoz, 1 ♂, 5 ♀ (UMSP); same, except 6-10.iii.1990, Holzenthal, Muñoz, Huisman, 5 ♂, 2 ♀ (UMSP); Río Sarapiquí, ca. 2 km SE Cariblanco, 10.299°N, 82.172°W, el. 710 m, 22.vi.1986, Holzenthal, Heyn, Armitage, 3 ♂ (INBIO); *Guanacaste*: Par-

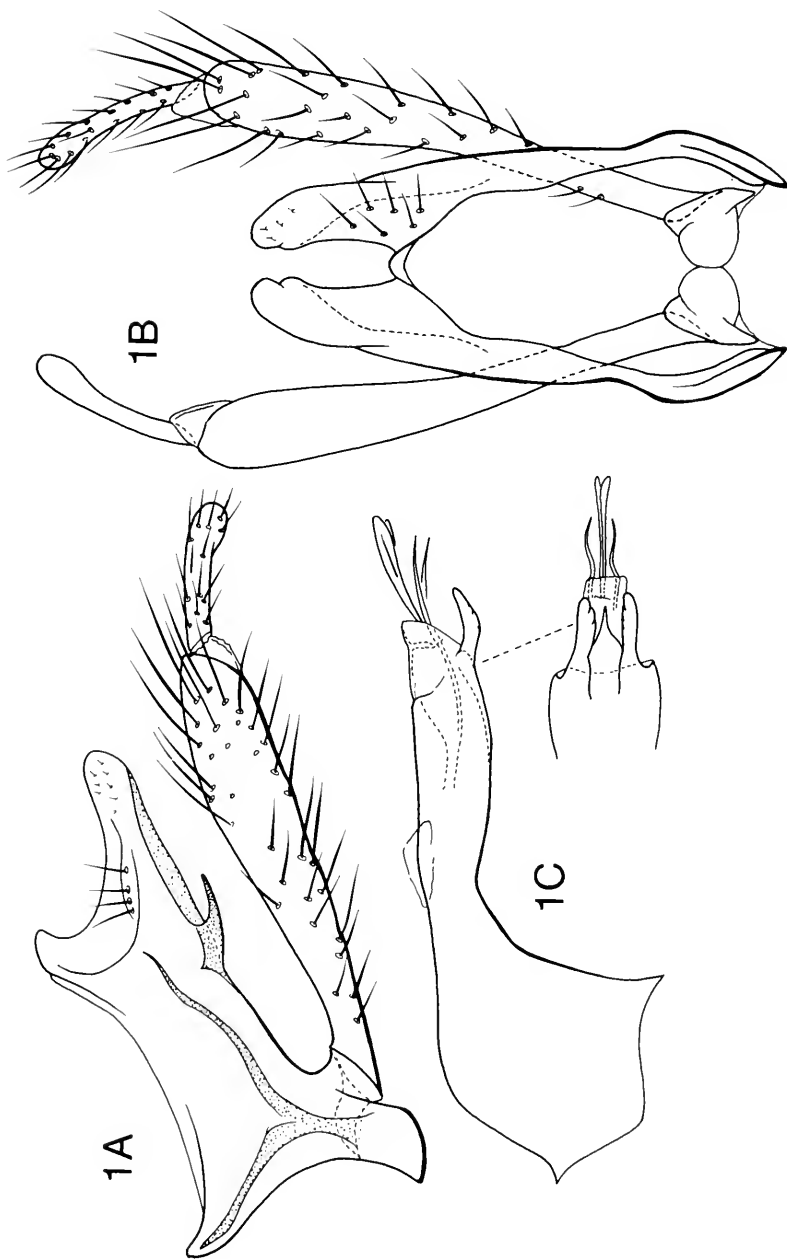


Fig. 1. *Smicridea (Rhyacophylax) nemorosa*, new species, male genitalia: A, segments IX, X, lateral; B, same, dorsal; C, phallic apparatus, lateral (inset, apex of same, ventral).

que Nacional Guanacaste, Maritza. Río Tempisquito, 10.958°N, 85.497°W, el. 550 m, 19-20.vii.1987, Holzenthal, Morse, Clausen, 20 ♂, 15 ♀(UMSP); same, except 30-31.viii.1990, Huisman, Blahnik, Quesada, 24 ♂, 8 ♀(UMSP); *Heredia*: P[arque] N[acional] Braulio Carrillo, Est[ación] El Ceibo, Río Peje, 10.327°N, 84.078°W, el. 480 m, 29-31.v.1990, Holzenthal, Blahnik, Muñoz, 11 ♂, 4 ♀(UMSP); same, except Est[ación] Magsasay, Río Peje, 10.402°N, 84.050°W, el. 130 m, 25-26.viii.1990, Holzenthal, Blahnik, Huisman, 1 ♂, 4 ♀(UMSP); *Limón*: Parque Nacional Braulio Carrillo, Quebrada Gonzalez, 10.160°N, 83.939°W, el. 480, 12-14.v.1990, Holzenthal & Blahnik, 22 ♂, 1 ♀(UMSP); *Puntarenas*: Río Guineal, ca. 1 km (air) E Finca Helechales, 9.076°N, 83.092°W, el. 840 m, 22 ii.1986, Holzenthal, Morse, Fasth, 8 ♂, 2 ♀(NMNH); same, except 4.viii.1987, Holzenthal, Morse, Clausen, 3 ♂, 8 ♀(UMSP); *San José*: P[arque] N[acional] Braulio Carrillo, Est[ación] Carrillo, Q[uebrada] Sanguijuela, 10.160°N, 83.963°W, el. 800 m, 27.iii.1987, Holzenthal, Hamilton, Heyn, 3 ♂, 6 ♀(UMSP).

**Etymology.** From the Latin, meaning full of woods, woody, or shaded, and in reference to the forested streams where the species was collected.

### *Smicridea (Rhyacophylax) singri*, NEW SPECIES

Figs. 2, 5, 9, 10

This species appears to be a member of the *signata* group, where it is close to both *S. (R.) signata* and *S. (R.) bidactyla* Flint and Reyes. It shares with *bidactyla* the spinose ventrolateral margin of segment X of the male genitalia. However, in the new species these spines are of a different arrangement. With *signata* the new species shares serrate lateral lobes and the slightly sinuate, tongue-like apicoventral lobe of the phallus, although in the new species the serrate lateral lobes are preapical, not midlateral as in *signata*.

**Adult:** Forewing length 4.5 mm. Color overall pale stramineous; forewing (Fig. 9) with dark marks along chord and over radial and thyridial nygmata, apex of wing with darker setae and dark subterminal band, bordered basally by a band of light setae and another of slightly darker setae. Sternum V of male with anterolateral glandular process almost twice as long as sternum; about half length of sternum in female. **Male genitalia:** Segment IX with anterolateral margin straight. Tergum X, in lateral aspect, with tip narrowly produced into a rounded, slightly upturned lobe, bearing tiny setae; apicodorsally with wart bearing 4-6 long setae; ventrolateral margin of X bearing preapical series of 4 sclerotized, spinelike projections, one more basal than the other three; in dorsal aspect, apex of X divided to about half length of tergum. Inferior appendages two-segmented; basal segment long, slightly inflated mesally (when viewed laterally), covered with setae, apicodorsal setae especially long; apical segment short; apex rounded in dorsal and lateral aspects. Phallic apparatus tubular, basal section enlarged and meeting apical section at about 130°; with preapical, serrate, lateral lobes; apex sclerous, with projecting ventral lobe and emergent, apparently retractile, semimembranous, tubular projection, with elongate tapered, mesal, tongue-like projection, and paired basolateral, tapering, anteriorly directed projections. Dorsal periphallal membranes prominent. **Female genitalia:** Sternum IX divided, each sternal plate acute posteriorly, setose. Internal plate (*sensu* Flint 1974) in ventral aspect narrow; in caudal aspect V-shaped, with projecting apex. Vaginal apparatus with anterior bar narrow; anteromesally with pair of elongate, lightly sclerotized plates.



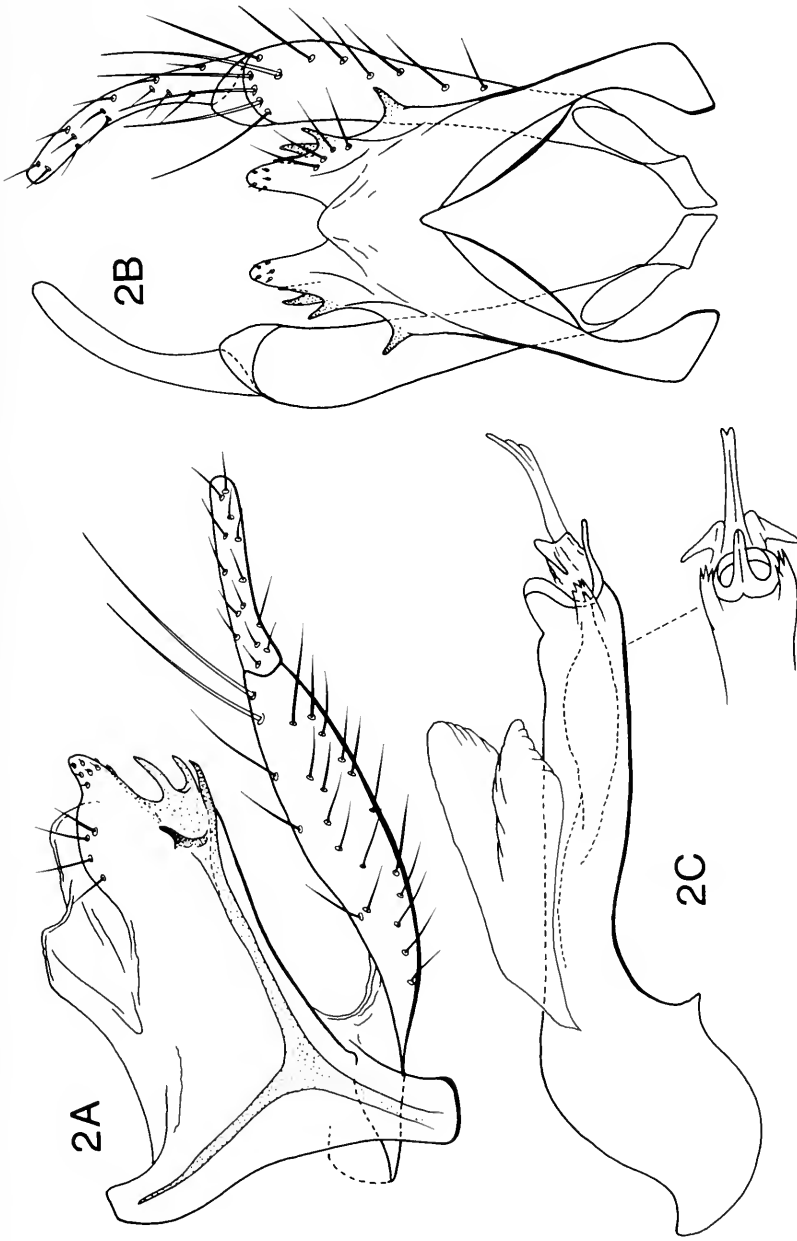


Fig. 2. *Smicridea (Rhyacophylax) singri*, new species, male genitalia; A, segments IX, X lateral; B, Same, dorsal; C, phallic apparatus, lateral (inset apex of same, ventral).

**Holotype.** ♂: COSTA RICA: *Puntarenas* Río Singrí, ca. 2 km (air) S Finca Helechales, 9.057°N, 83.082°W, el. 720 m, 21.ii.1986, Holzenthal, Morse, Fasth (NMNH).

**Paratypes.** Same data as holotype, 18 ♂, 3 ♀ (UMSP), 1 ♂, 1 ♀ (INBIO), 1 ♂, 1 ♀ (NMNH).

**Etymology.** Named for the type locality, in Costa Rica's Talamanca mountain range.

### *Smicridea (Rhyacophylax) tapanti* NEW SPECIES

Figs. 3, 6, 7, 10

This new member of the *peruana* group is similar to *S. (R.) talamanca* and *S. (R.) acuminata*, perhaps being most closely related to the latter. The new species differs from *acuminata* in the shape of the phallic apparatus, being broader basally in the new species. The apex of the phallus also differs in its structural details between the species; in particular, *tapanti* lacks the spiculate sac found in *acuminata*.

**Adult:** Forewing length 7.5 mm (males), 9.0 mm (females). Color overall pale stramineous; male forewing (Fig. 7B) with dark marks along chord and over radial and thyridial nygmata, apex of wing with darker setae and light subterminal band, bordered basally by slightly darker setae; female wing with same pattern of coloration, but much darker overall (Fig. 7A). Sternum V of male with anterolateral glandular process almost twice as long as sternum; about half length of sternum in female. **Male genitalia:** Segment IX with anterolateral margin only moderately produced, highly membranous anterodorsally, with sclerous, dorsomesal prominence. Tergum X, in lateral aspect, with tip pointed, not upturned, apicodorsally with well defined wart bearing ~12 short setae; ventrolateral margin of X strongly sclerotized, but without spine-like projections; apex of X narrowly divided to about half length of tergum. Inferior appendages two-segmented; basal segment long, parallel sided, covered with setae, apical setae longest; apical segment short, apex rounded in dorsal and lateral aspects. Phallic apparatus tubular, basal section very enlarged and meeting apical section at about 100°; apex of phallus with paired ventrolateral, upturned lobes bearing tiny spicules, spicules also present middorsally; apex, in ventral aspect, with dorsomesal, lightly sclerotized lobe; internally, in lateral view, with slender, slightly sinuate, internal process, in ventral aspect widened preapically. Dorsal periphallial membranes absent. **Female genitalia:** Sternum IX divided, each sternal plate truncate posteriorly. Internal plate (*sensu* Flint 1974), in ventral aspect, broad, lyre-shaped, in caudal aspect  $\pi$ -shaped. Vaginal apparatus with anterior bar very broad, with lateral edges crenulate; anteromesally with heavily sclerotized, elongate dorsal plates; ventrolaterally with lightly sclerotized mesal and lateral areas.

**Holotype:** ♂: COSTA RICA: *Cartago*: Reserva Tapantí, Quebrada Palmitos and falls, 9.72°N, 83.78°W, el. 1400 m, 24-25.iii.1991, Holzenthal, Muñoz, Huisman (NMNH).

**Paratypes:** COSTA RICA: *Cartago*: Reserva Tapantí, Río Grande de Orosi 9.686°N, 83.756°W, el. 1650 m, 8-9.vii.1986, Holzenthal, Heyn, Armitage, 3 ♂, 2 ♀ (UMSP), same data as holotype, except Holzenthal, Blahnik, Muñoz, 2-3.vi.1990, 3 ♂, 2 ♀ (UMSP), 1 ♂, 1 ♀ (INBIO); same, except 24-25.iii.1991, Holzenthal, Muñoz, Huisman, 2 ♂, 5 ♀ (UMSP).

**Etymology:** Named for Costa Rica's densely forested, very wet Tapantí National Wildlife Reserve, site of the type locality.

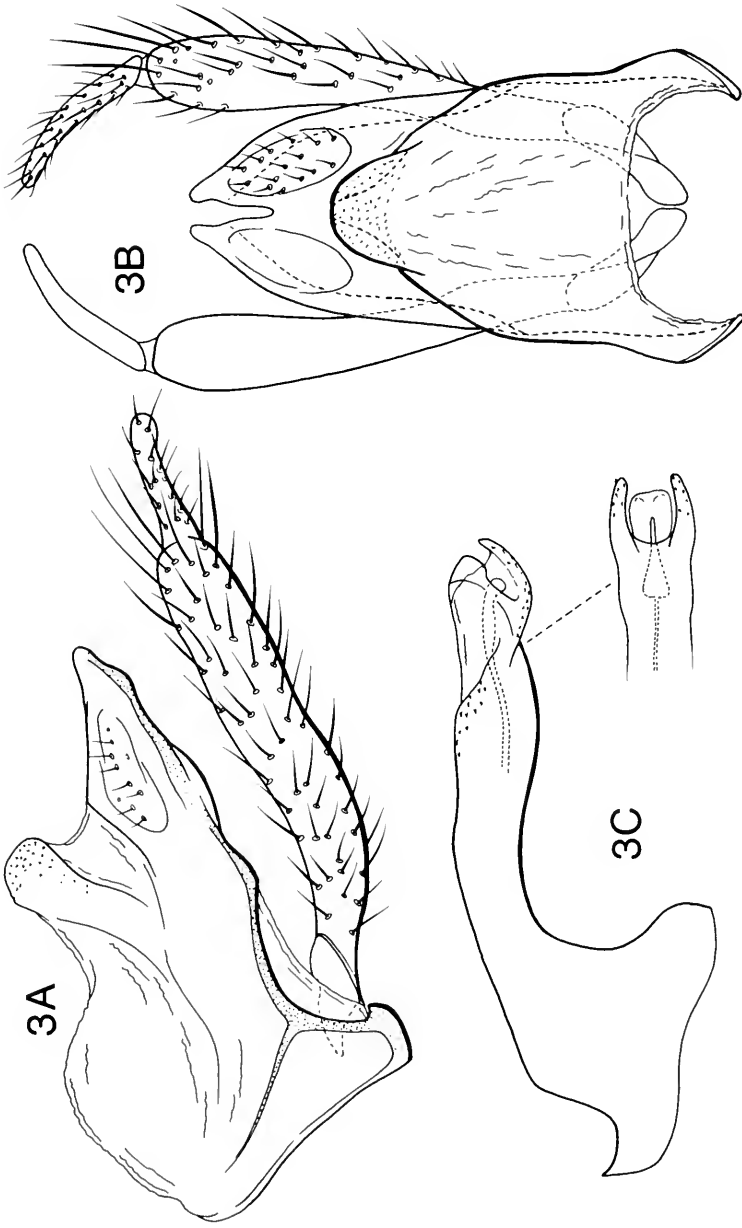
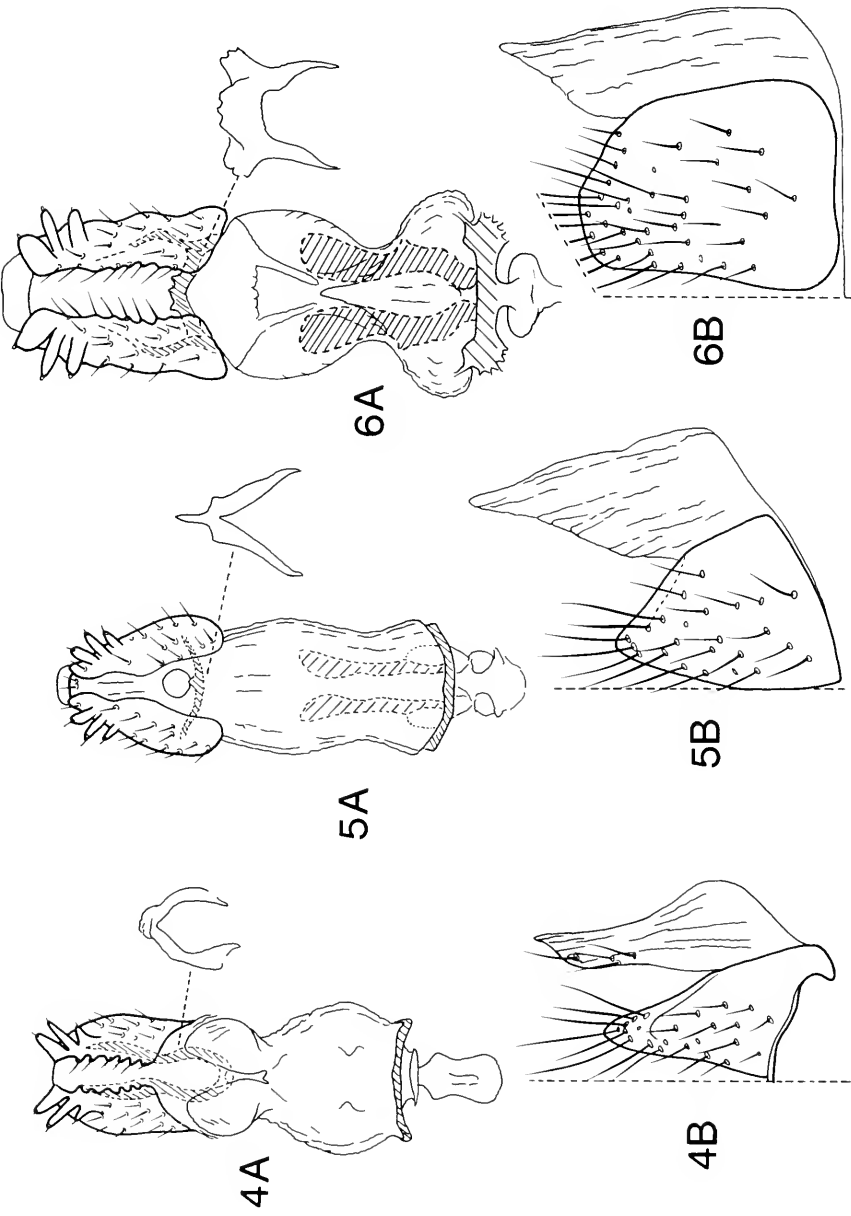
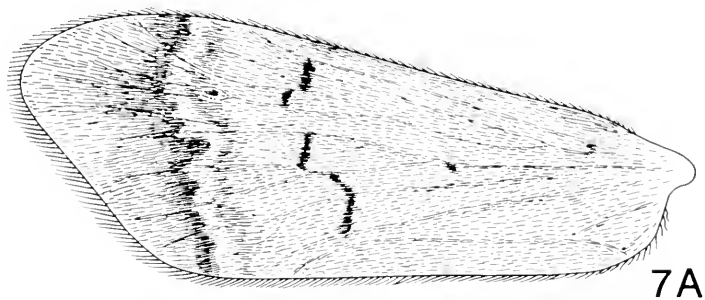


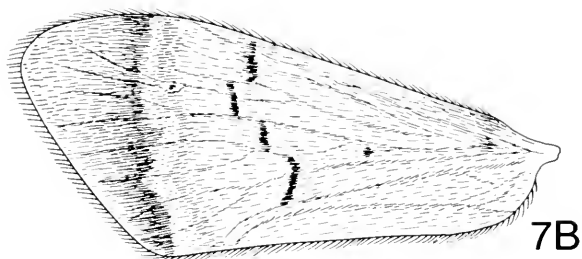
Fig. 3. *Smicridea (Rhyacophylax) tapaniti*, new species, male genitalia: A, segments IX, X, lateral; B, same, dorsal; C, phallic apparatus, lateral (inset, apex of same, ventral).



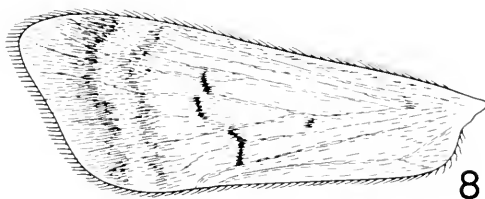
Figs. 4-6. *Smicridea* (*Rhyacophylax*) new species, female genitalia, segments IX, X: A, vaginal apparatus, ventral. (inset internal plate, caudal); B, right sternite and adjacent pleural membrane, ventral. Fig. 4. *S. (R.) nemorosa*, new species. Fig. 5. *S. (R.) sirgri*, new species. Fig. 6. *S. (R.) rapanti*, new species.



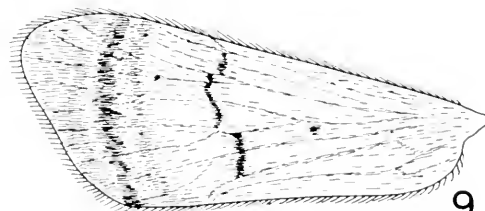
7A



7B



8



9

Figs. 7-9. *Smicridea (Rhyacophylax)* new species, forewings. Fig. 7. *S. (R.) tapanti*, new species. A, female, B, male. Fig. 8. *S. (R.) nemorosa*, new species, male. Fig. 9. *S. (R.) singri*, new species, male. Wing outlines in Figs. 8, 9 same scale as in Fig. 7B.

## COSTA RICA



Fig. 10. *Smicridea* (*Rhyacophylax*) new species, distribution.

## ACKNOWLEDGMENTS

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## FACTORS AFFECTING THE DISTRIBUTION OF PAVEMENT ANTS (HYMENOPTERA: FORMICIDAE) IN ATLANTIC COAST URBAN FIELDS<sup>1</sup>

Thomas G. King<sup>2</sup>, Stanley C. Green<sup>3</sup>

**ABSTRACT:** This study shows that disturbance allows the pavement ant to thrive on the Atlantic Coast. Disturbance creates open, dry habitats similar to the habitats occupied by the pavement ant in its native Eurasia. Disturbance tends to minimize competition by creating habitats too harsh or transient for native species. While the pavement ant can encounter competition in these harsh conditions, we note that the pavement ant competes well in urban fields that are abundant in food resources.

The pavement ant, *Tetramorium caespitum* (L.), inhabits open, dry areas throughout much of temperate, mesic Eurasia (Abe, 1971; Brian, 1979; Baroni-Urbani, 1970; Tarzinskii, 1991; Woyciechowski, 1985). The species typically occurs in species-poor habitats, where its large colonies collect a high percentage of available food resources (Abe, 1971; Brian, 1979).

Two hundred years after its probable introduction into North America (Brown, 1957; Weber, 1965), *T. caespitum* is among the most abundant ant species in urban and highly developed suburban areas along the Atlantic Coast (Bruder and Gupta, 1972; Nuhn and Wright, 1979). Despite its prevalence, no study has examined the ecology of this species in North American urban ecosystems.

This study attempts to understand how *T. caespitum* fits into the ecology of urban ecosystems on the Atlantic Coast. To accomplish this, the authors correlated its distribution with physical and biological parameters, observed its ability to compete with native species for large food finds, and followed the progress of thirty-one colonies in a large, minimally disturbed field.

### MATERIALS AND METHODS

Data were collected from several fields scattered throughout the northeastern section of Philadelphia, Pa.

#### Competition for large food finds

In June, 1993, twenty-four cracker baits were placed in vegetation less than 50 cm tall; sixteen in small clearings (<1M<sup>2</sup>) in vegetation higher than 50 cm; and nineteen in continuous vegetation higher than 50 cm. Each bait was checked

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at half hour intervals from 4:00 PM (placement) to 6:30 PM (finish), with the species on each bait noted. Sundown occurred at 8:30 PM.

In May, 1995, the process was repeated in low vegetation using twenty-one beef cat food baits. Sundown occurred at 8:00 PM.

### **Variables affecting soil moisture and temperature**

**Vegetation:** At two hundred thirty-nine random points in ten open fields, the vegetation was measured to determine if it was high (>50 cm), low (< 50 cm), dense (> 50% shade) or bare (< 50% shade). The ant species foraging at each site and the expanse of similar conditions were also noted. All observations were made between 4:00 PM and 8:00 PM in late June, 1993.

**Inclination of soil:** At 216 of the 239 sites in the above vegetation study, a protractor was used to measure the inclination of the ground to the horizontal.

**Soil texture:** At eighty sites in areas of low vegetation, surface soil samples were taken to approximate percentages of sand, silt, and clay using the methods described by Stevenson and Talbot (1975). Notes were taken as to the activity of *T. caespitum* at each point where a soil sample was collected.

### **Tracking of thirty-one *Tetramorium caespitum* colonies**

The progress of thirty-one colonies of *T. caespitum* living in a two-plus hectare field was qualitatively followed from the summer of 1991 to the spring of 1995. This was done to add perspective to the other data.

## **RESULTS**

### **Competition for large food finds**

Of the species that foraged on bare ground or in low vegetation, *T. caespitum* and *Monomorium emarginatum* Dubois were clearly dominant. This dominance was as impressive in 1995 as it was in 1993. Combining the data, the two species discovered or co-discovered the forty-five baits a total of forty-three times. Although nine other species competed for baits in low vegetation, *T. caespitum* (with twenty baits) and *M. emarginatum* (with eighteen baits) exclusively controlled eighty-four percent of baits two hours after placement. The two species overwhelmed the competition by finding the baits quickly, and rapidly recruiting dozens to hundreds of foragers to the bait site.

Despite its success in low vegetation, *T. caespitum* was not present at any baits placed in higher vegetation.

### **Vegetation**

Chi squared analysis showed that *T. caespitum* was not randomly foraging in the study fields ( $p < .005$ , d.f. = 11). Instead, while the species was absent in the dense/high vegetation, it was foraging in 57% of the bare/low sites, 45%

of the bare/high sites, and 34% of the dense low sites. Further chi squared analysis showed that *T. caespitum* preferred sites where the vegetation remained unchanged for thirty or more square meters ( $p > .995$ , d.f. = 2).

### **Inclination of soil**

*T. caespitum* most commonly nested in level soil. The species did, however, show a statistically greater tendency to nest on inclined soil than would have occurred if their distribution was random ( $p > .995$ , d.f. = 3).

### **Soil texture**

*T. caespitum* did not prefer specific surface soil textures within our eighty samples. The soils were mostly sandy loam, with organic matter rare or absent. These results were consistent with the Urban Land and Urban Land - Howell Complex Soils found in the study fields (USDA, 1975).

### **Species present with *Tetramorium caespitum***

When *T. caespitum* foraged with other species, *Lasius neoniger* Emery was the most common (28% of *T. caespitum* containing sites). *M. emarginatum* was next (27%), followed by *Paratrechina faisonensis* (Forel) (21%), *Tapinoma sessile* (Say) (17%), and *Formica* species (15%). Eighteen species cohabited at least once with *T. caespitum*.

In sites that contained *T. caespitum*, thirty percent had *T. caespitum* as the sole species. This made *T. caespitum* the most likely to forage without competition. When foraging with competition present, *T. caespitum* was the most likely to compete against only one species.

### **Tracking of thirty-one *Tetramorium caespitum* colonies**

Of the thirty-one colonies mapped in 1991, twenty-one continued to exist in 1995. Nine of the ten "lost" colonies had vegetation schemes shift from bare/low to dense/high. Three other colonies moved their location approximately five meters when the original site changed from bare/low to dense/high vegetation. The new site was bare/low in all three cases.

Colonies that survived typically inhabited "islands" of year-round sparse vegetation measuring thirty or more square meters in area. The presence of large, flat rocks appeared to correlate with healthier colonies. Colony death routinely occurred when vegetation grew too high and dense.

## **DISCUSSION**

As in Eurasia, *T. caespitum* inhabited the hottest, driest soils found in an otherwise mesic habitat. The species was found in large areas of sparse or low vegetation, where sunlight and wind heat and dry the soil. The species selected

inclined soil when available, as inclined soil dries quickly due to run-off and thin vegetation. The soils sampled were "urban", with much fine sand but little organic matter or clay. While these soils are fertile, the combination of sparse vegetation, often inclined ground, and urban soils created relatively xeric conditions in an area that normally is mesic and richly vegetated (Akin, 1991; Godfrey, 1980).

Disturbance often creates species-poor habitats. This occurs because many species either cannot survive the disturbed conditions, or they cannot find these areas before regeneration occurs. As *T. caespitum* finds newly disturbed areas quickly, the species can maintain its large colonies by monopolizing resources due to the absent or minimal competition. The data show that minimal competition is very common for *T. caespitum* in Philadelphia, and this minimal competition resembles the ecosystems *T. caespitum* occupies in Eurasia.

Despite its success in areas of minimal competition, much data show *T. caespitum* competing well in areas of diverse competition. *T. caespitum* had overlapping territories with eighteen species, and twenty-six percent of *T. caespitum* colonies competed against two or more native species. In competition for baits, *T. caespitum* extirpated nine species to gain control of forty-four percent of baits placed in sparse vegetation. *T. caespitum* was a prominent species in a high percentage of areas with sparse vegetation, and species competition did not appear to affect *T. caespitum* while vegetation remained sparse.

We suspect, however, that the result of species competition varies with the amount of food in a habitat. Areas rich in food should favor the large colonies of *T. caespitum*; areas with limited food supplies should favor the much smaller colonies of native competition. Urban fields should possess abundant food supplies, as they contain both human trash and numerous insects killed by pedestrians, passing cars, lawn-mowers, and streetlights. We speculate that both sparse vegetation and adequate resources are needed by *T. caespitum*, but vegetation becomes the active limiting factor in resource-abundant urban areas.

In many ways human disturbance provides acceptable conditions for *T. caespitum*. We have seen that disturbance creates large open, dry areas needed by the species. We have seen that *T. caespitum* finds many disturbed habitats where it competes against little or no native competition. We even speculate that disturbance provides abundant food supplies that should favor the very large colonies of *T. caespitum*. Disturbed areas fill a substantial fraction of *T. caespitum*'s Atlantic Coast range (Boston to Charlotte), and these areas continue to grow in size. This implies that *T. caespitum* may become an increasingly common species in this region of the country.

#### ACKNOWLEDGMENTS

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# ROBBER FLY AND TROUT PREDATION ON ADULT DRAGONFLIES (ANISOPTERA: AESHNIDAE) AND FIRST RECORDS OF *AESHNA UMBROSA* FROM WYOMING<sup>1</sup>

A. P. Platt<sup>2</sup>, S. J. Harrison<sup>3, 4</sup>

**ABSTRACT:** Two instances of predation on large adult dragonflies (Anisoptera: Aeshnidae) are recorded from the foothills of the Big Horn Mountains in north-central Wyoming. A medium sized robber fly, *Stenopogon inquinatus* (Asilidae), was photographed and captured while taking a male *Aeshna umbrosa*. The dramatic size differential between the robber fly predator and its larger aeshnid prey is unusual. This note includes the first published records of *A. umbrosa* from Wyoming, as well as the first record of *S. inquinatus* capturing an aeshnid. Also, a male *Aeshna eremita*, and a female *Aeshna* sp. were recovered among the stomach contents of two brook trout, *Salvelinus fontinalis*, taken in the same general area.

Adult aeshnid dragonflies are usually considered top aerial insect predators. They are, in turn, occasionally preyed on by other upper-level consumers. Dunkle & Bellwood (1982) reported bats as odonate predators. McCafferty (1981) listed frogs and birds, and Howard (1905) kingbirds, as predators of adult Odonata. Wright (1946) and Belle (1994) referred to human consumption of adult odonates. In more comprehensive listings, Wilson (1917-1918), Garman (1927), McAtee (1932), Laroche (1976; 1978), and Westfall (1984) included fishes, amphibians, turtles, birds, spiders, tiger beetles, ants, wasps, and other dragonflies as predatory on adult odonates. Even horses are known to be an indirect cause of mortality in Anisoptera by inadvertently consuming and trampling emerging naiads, while grazing around ponds (Thompson *et al.* 1985).

There are relatively few records of asilids preying on adult Odonata (Poulton 1906; Lavigne 1976). Hobby (1935) observed that robber flies were not important predators of adult odonates, because most asilids occur in much drier habitats than do many dragonflies and damselflies. Borrer *et al.* (1976) listed dragonflies as prey of robber flies. Breland (1942) and Corbet (1962) gave several references of asilid predation on adult odonates. Furthermore, Corbet (*loc. cit.*) stated that asilids are probably some of the most frequent predators of perched dragonflies but added that such perching insects are well concealed by

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their postures, cryptic coloration, and choices of resting sites. However, few others writing about dragonfly biology include the Asilidae among adult dragonfly predators.

Although fish are well-known predators of larval Odonata (Wright 1943; Morin 1984; Fong 1985; Heads 1985), there is little published evidence that they prey on adults. Neither Needham (1969) nor Westfall (1984) include them in their lists. However, Wilson (1917-1918) and Garman (1927) observed that adult odonates are taken by fish, and Valley (1993) recently noted that many rainbow trout in Grande Ronde Lake in the Elkhorn Mountains of Oregon feed principally on adult dragonflies, including *Somatochlora* and *Aeshna* spp. (see below). This paper reports two observations in which large adult aeshnids have become prey for other top-level insectivores while the insects were either active or were perching in the natural environment. In one case the predator was a smaller robber fly; in the other, two adult dragonflies were found among the stomach contents of two brook trout, both caught in August.

These observations were made in north-central Wyoming on the South Fork of Rock Creek approximately 2 km SW of Saddlestring (Johnson Co.) [lat. 44° 27'N; long. 106° 54'W; elev. 1739 m; 10 km UTM Zone 13T grid square: CV 30]. This area is a typical dry sagebrush habitat located in the foothills of the Big Horn Mountains. The stream width varies from 6-18 m, and the depth from 0.15-1.8 m at this time of year.

## OBSERVATIONS AND DISCUSSION

**Predation by Robber Fly.** On 12 August 1979, A. P. P. was hiking along a riding trail beside the creek at 10:30 a.m. MDT. The weather was seasonably sunny and cool. His attention was attracted to a loud buzzing noise coming from several feet in front of him on the horse trail. Investigation revealed that a medium-sized, female robber fly, *Stenopogon inquinatus* (Loew), had caught and pierced the dorsal thorax of a large male shadow darter, *Aeshna umbrosa* (Walker), with its proboscis. The buzzing sound was made by the dragonfly's wings as it attempted to escape. Both insects were in worn condition, and seemed to have been on the wing for several weeks.

The two insects remained on the trail long enough to be photographed (Fig. 1) before being collected with a hand-net. The size difference between the dipteran predator and its aeshnid prey is noteworthy; the dragonfly is approximately three times larger than the robber fly (Table 1). The specimens have been placed in the insect collection, Department of Biological Sciences at UMBC.

R. Lavigne, Dept. of Plant, Soils, and Insect Sciences (P.S.I.S.), Univ. of Wyoming (pers. comm.) reports that the entomology collection in the Rocky Mountain Systematic Entomology Laboratory contains one other specimen of *A. umbrosa*, collected near Laramie on July 26, 1937, and identified by D. R.

Molnar. Also, O. Flint of the U.S.N.M.N.H., Smithsonian Institution, Wash., D.C. (pers. comm.) reports that the odonate collection there contains no *A. umbrosa* from Wyoming. Neither Williamson (1900), Molnar (1977), nor Molnar and Lavigne (1979) include this species in their discussions of Wyoming dragonflies. As far as we can ascertain, these two specimens represent the first published records of this dragonfly species from Wyoming.

Lavigne (1976; pers. comm.) recorded 20 species (including three families and 14 genera) of Anisoptera, along with 15 species (including three families and nine genera) of Zygoptera as prey of asilids. He noted that these records involve 53 species of robber flies. Among these, 24 species of asilids (representing 14 genera) attacked anisopterans, whereas 29 species (in 19 genera) captured zygopterans. This thorough review contains many single incidents, but also involves multiple occurrences between the same predator and prey species (up to 43 times for one central European species pair). In several cases, adult aeshnids, gomphids, and libellulids even caught asilids, as well! Bullington (1978), likewise, contributed several additional records of asilids preying on adult dragonflies (see also Table 1). Altogether, Lavigne (1976) and Bullington (1978) documented 38 species of odonates as prey of 56 different species of asilids.

For aeshnids (and gomphids), Lavigne's (1976) review includes the following predation records (listed chronologically, by genera):

1) *Aeshna grandis* (L.), taken by *Satanas gigas* Eversm. in Kiev Province, Russia (Federov, 1925).

Table 1. Body length (BL) and Wing length (WL-tip to mid-line) measurements (mm) and ratios of various robber fly predators and their odonate prey.

Diptera: (Asilidae)			Odonata: (Families as listed)			(Predator/Prey ratios)	
Species	BL	WL	Species	BL	WL	BL	WL
1) <sup>1</sup> <i>Promachus rufipes</i> Fabr.	33	24	<i>Pachydiplax longipennis</i> Burmeister (Libellulidae) ♂	38	35	0.87	0.69
2) <sup>1</sup> <i>Efferia aestuans</i> L.	22	15	<i>Ischnura posita</i> Hagen (Coenagrionidae) ♀	27	16	0.81	0.94
3) <sup>2</sup> <i>Stenopogon inquinatus</i> Loew	24	19	<i>Aeshna umbrosa</i> Walker (Aeshnidae) ♂	65	46	0.37	0.41

<sup>1</sup>Data modified from Bullington (1978)

<sup>2</sup>Data from this study.

2) *A. tuberculata* (Walker), caught by *Proctacanthus milbertii* (Macquart), in Michigan (Bromley, 1949).

3) *Anax* sp. killed by *Eccoctopus longitarsis* (Macquart), in Egypt (Efflatoun Bey, 1934).

4) *Caliaeshna* sp., preyed upon by *Trichomachismus paludicola* (Lehr) in Kocakhstan, U.S.S.R., [with the dragonflies caught while flying, and accounting for 24.1% of its prey, with some individuals being up to six times longer than the fly itself (Lehr, 1967)], and

5) *Gomphus* sp. female, caught by *Proctacanthus longus* (Weidemann), in Texas (Bromley, 1934).

**Predation by Brook Trout.** A. P. P. has, for the past 24 years, collected and preserved the viscera of three species of trout [brook trout, *Salvelinus fontinalis* (Mitchell); brown trout, *Salmo trutta* (L.); and rainbow trout, *Oncorhynchus mykiss* (Walbaum)] taken from this region while dry fly fishing during late July and August (1968-1992). The viscera of between 20 and 80 fish have been collected annually. All fish were caught in the North or South Forks of Rock Creek. The trout stomach contents have been used to make ecological comparisons of the feeding habits and niche dimensions of the three trout species which compete as top carnivores in the stream both inter- and intraspecifically.

Among the samples were two large brook trout, one female and one male (estimated lengths 25-36 cm), taken from the South Fork of Rock Creek in August, 1978. Among the stomach contents of the female trout was a male lake darner, *Aeshna eremita* (Scudder). The condition of the dragonfly indicated that it had only recently been eaten and that it likely was alive and active when taken by the fish. *Aeshna eremita* is listed as a Wyoming species by Bick & Hornuff (1972), Molnar (1977), and Molnar & Lavigne (1979); it has not been reported from Johnson County. A second specimen (female) of *Aeshna* sp. was found among the stomach contents of the male trout. The partially digested condition of this insect prevented positive specific identification, although possible species include: 1) *A. umbrosa*; 2) *A. eremita*; 3) the darner paddle-tail, *A. palmata* (Hagen); and 4) the variable darner, *A. interrupta interna* (Walker). R. L. Orr (pers. comm.) of the USDA, who identified the specimen, noted that her abdominal appendages (paddles) are elevated at a 90° angle to her abdomen, as if she had been ovipositing when taken by the trout. Both aeshnids were of standard size for their species, wing lengths: *A. eremita* = 41 mm; *Aeshna* sp. = 45 mm, and body-lengths: *A. eremita* = 54 mm; *Aeshna* sp. = 55 mm. These are rather large insects to be taken by trout of these sizes, although some Orthoptera eaten by these trout also approach this size.

Over the years, the trout stomach contents reveal that some fish are generalists, *i.e.* non-selective feeders, whereas others specialize on particular kinds of



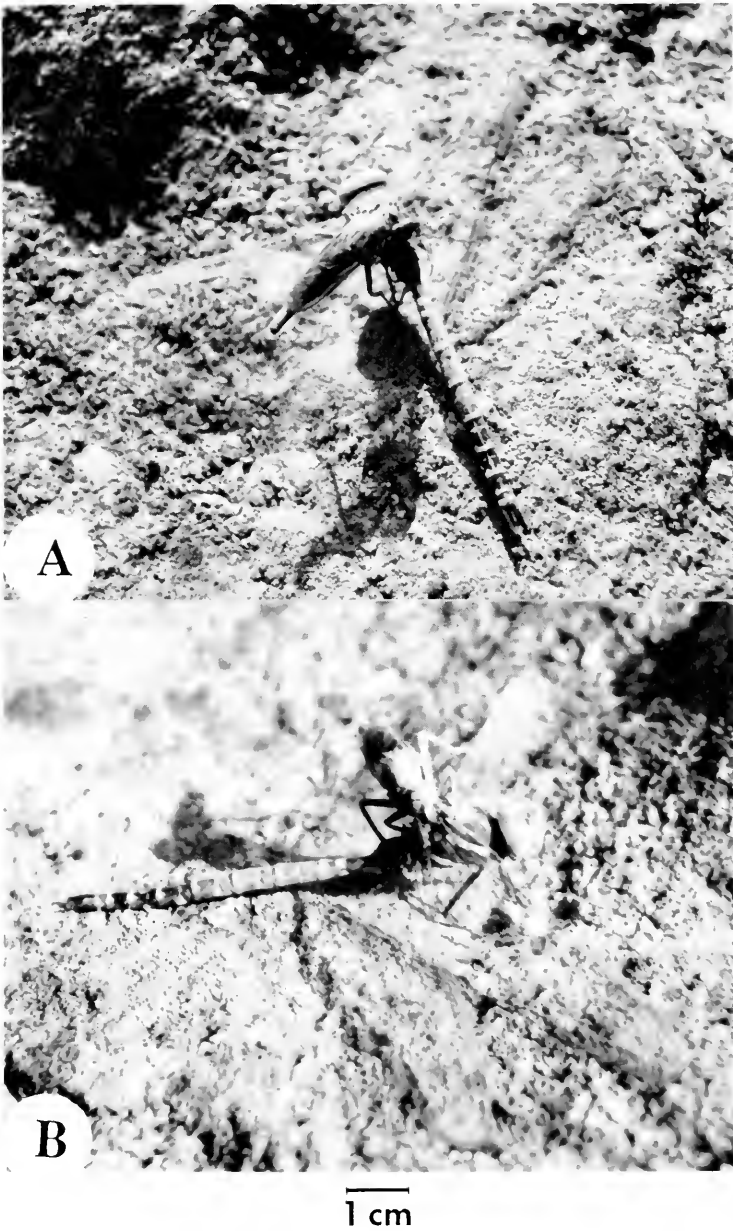


Fig. 1 — A. Dorsal view of the robber fly *Stenopogon inquinatus* attacking the dragonfly *Aeshna umbrosa* in Wyoming; B. Lateral view of the same.

insects such as Hymenoptera, Coleoptera, or Orthoptera. During late July and August, when the streams are low and clear, the trout feed heavily on terrestrial insects such as the orders mentioned above along with Homoptera, occasional larval and adult Lepidoptera, and arachnids.

The rare occurrences of these trout taking adult dragonflies is demonstrated by the fact that these are the only two instances found among the hundreds of trout stomachs examined from this locality. The only other evidence of predation on adult Odonata was the recovery of a single zygopteran wing (Lestidae) from another brook trout. As the actual captures were not witnessed, it is unknown for certain whether the dragonflies were hovering near the stream surface or resting on low foliage or rocks when taken by the fish. Fong (1985) noted that trout will congregate at the shoreline where naiads have moved prior to emerging. As such, the dragonfly prey near the shore may have been teneral adults which were unable to escape the fish. However, these aeshnids develop mainly in shallow ponds (Walker, 1912; Kennedy, 1915; Pennak, 1953), rather than in the primarily lotic environment Rock Creek represents. Other possibilities are that the prey were occupied with mate guarding, territorial defensive activities and/or egg laying, which sometimes occurs underwater (Fincke 1986), and so did not see the trout in time to escape them.

Valley (1993), likewise, reported that rainbow trout in Grande Ronde Lake (Union Co. Ore.) in the Elkhorn Mountains [about 70 mi. (112 km) northeast of John Day in Oregon] seemed to be feeding "exclusively on adult dragonflies" in late July, 1991. Some trout were observed jumping "a foot or more out of water to take ovipositing *Somatochlora* spp.". His wife, Robin, caught some of these rainbows, using an artificial dry fly imitation of a dragonfly, retrieved "fluttering" on the lake's surface. When dissected, the stomachs of these trout contained "only dragonflies, including some aeshnas". Species listed as abundant in Grande Ronde Lake (a small subalpine lake containing lily pads) include *Somatochlora albicincta*, *S. semicircularis* (Selys), *Cordulia shurtleffi* (Scudder), *Libellula quadrimaculata*, *Aeshna palmata* (Hagen), *A. umbrosa*, *A. interrupta*, and *A. juncea* (L.). Valley (1993) also reported that the blue and yellow phases of *A. juncea* were present in about equal numbers, and that "several male *A. interrupta* (were found) in tandem with female *A. juncea*!" at this site.

Finally, W. R. Lamberson (pers. comm.) reported observing a ten in. (25.4 cm) cutthroat trout [*Onchorhynchus clarki lewisi* (Girard)] jumping near the thin end branches of a partly submerged dead tree, apparently catching active (hovering or resting) blue colored damselflies (*Lestes* sp.) near the surface of Klickitat Lake in the Coastal Range of the Cascades (elev. approximately 1220 m) in Lincoln Co., Ore. on a warm sunny afternoon in July, 1981. When caught on a dry fly moments later, this trout's stomach contained either complete specimens or portions of at least five of these damselflies.

Keys used to identify the specimens were: Needham & Westfall (1955), Westfall (1984), and Walker (1958). Common names of the dragonflies are from Borrer (1963) and Paulson & Dunkle (1985 unpubl. ms). Our dragonfly identifications were verified by R. Orr of the USDA, Hyattsville, Md.

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We are grateful to A. G. Scarbrough of Towson State University for identifying the robber fly. A. Carter of UMBC dissected and sorted the contents of the trout stomachs. D. Flaim of UMBC and R. L. Orr of the USDA assisted with the identification of the dragonflies. We are grateful to R. Lavigne, P.S.I.S., University of Wyoming for many valuable comments on the manuscript, and for providing specimen data from the University of Wyoming Entomology Collection. O. Flint kindly searched the U.S.N.H.M. collection for Wyoming records of *A. umbrosa*, and corresponded with us regarding this report. We thank W. R. Lamberson, University of Missouri, for the information he provided about trout feeding on damselflies. G. C. Ford, Jr. and R. Gehrman of UMBC developed and printed the photographs from color slides taken by the senior author. F. W. Baldwin and C. L. Wilkens of UMBC prepared the Table.

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**RHADINOCERAEA N. SP.**  
**(HYMENOPTERA: TENTHREDINIDAE)**  
**FROM WEST VIRGINIA, A SECOND SPECIES**  
**ON ZIGADENUS (LILIACEAE)<sup>1</sup>**

David R. Smith<sup>2</sup>, Edward M. Barrows<sup>3</sup>

ABSTRACT: *Rhadinoceraea sodsensis*, n. sp., is described from West Virginia. Its larvae feed on inflorescences of *Zigadenus leimanthoides* (Liliaceae). This species is separated from the closely related *R. zigadenusae* from coastal Mississippi by reproductive isolation, phenology, and wing morphology. *Rhadinoceraea sodsensis* is univoltine. Adults fly in mid-July, and larvae feed in late July through mid-August.

In this paper, we propose a new species of *Rhadinoceraea* from West Virginia and describe some aspects of its biology. Its closest relative, *Rhadinoceraea zigadenusae* Smith, occurs in southern Mississippi (Smith and McDearman, 1990). Larvae of most sawflies are folivores, but some species consume inflorescences including these two *Rhadinoceraea* species on *Zigadenus*. In the eastern United States, the genus *Zigadenus* occurs along the coastal plain with disjunct populations in the mountains of West Virginia, North Carolina, and Tennessee. Although *R. zigadenusae* was described from adults from Mississippi only, larvae of what were believed to be this species were noted from Alabama, North Carolina, South Carolina, and West Virginia (Smith and McDearman, 1990). We were fortunate to collect a good series of adults and make some observations on a West Virginia population of *Rhadinoceraea*, and, consequently, we compared them with the coastal plain *R. zigadenusae*.

The West Virginia population is reproductively isolated from the coastal plain populations. Further, differences in phenology, morphology, and habits distinguish these populations. Using these criteria, we regard the West Virginia population as a separate, new species closely related to *R. zigadenusae*.

MATERIALS AND METHODS

We located patches of the host plant, *Zigadenus*, and collected and observed *Rhadinoceraea* adults and larvae in and near the Dolly Sods Wilderness and Scenic Area, Tucker and Randolph counties, West Virginia, in 1991-1993. In an attempt to obtain adults, we ran three Cornell-style Malaise traps near South Prong Trail, south of Dolly Sods Picnic Area, from late April through late Sep-

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tember 1993. Trap 1 was about 40 m from a host patch with one inflorescence, 150 m from a patch with 50 inflorescences, and 200 m from a patch with thousands of inflorescences. Trap 2 was about 60 m from the host patch with one inflorescence, 200 m from the patch with 50 inflorescences, and 250 m from the patch with thousands of inflorescences. Trap 3 was in the largest patch.

## DESCRIPTION

### *Rhadinoceraea sodsensis* Smith and Barrows, NEW SPECIES

**Adults.**— Identical to *R. zigadenusae* (Smith and McDearman, 1990), except that vein 3r-m is absent in the forewing in 93% of the sample population (Fig. 2).

**Holotype.**— Female, labeled "West Virginia, Randolph Co., 9 km SE Red Creek, 38°55'N, 79°20'W, 18-VII-1993, on *Zigadenus*, Barrows & Smith." The elevation is about 1,160 m. This is a specimen lacking vein 3r-m in the forewing. Deposited in the National Museum of Natural History, Washington, D.C.

**Paratypes.**— WEST VIRGINIA: Same data as holotype (19 F. 6 M); same data, 8-18-VII-1993, Malaise trap #1 (3 F); Malaise trap #2 (3 F); Malaise trap #3 (6 F. 4 M); Tucker Co., Dolly Sods, 39°03'N, 79°20'W, 7-VII-1992, 1,220 m (ca. 4000' on label), D.R. Smith (1 M). Deposited with the holotype.

**Host.**— *Zigadenus leimanthoides* A. Gray (Liliaceae)

**Etymology.**— The name is derived from part of the name of the collection locality, the Dolly Sods Wilderness and Scenic Area in West Virginia.

## DISCUSSION

Larvae of *R. sodsensis* feed on *Z. leimanthoides* which occurs in the coastal plain along the Atlantic Ocean and in boggy areas above about 760 m in West Virginia. In West Virginia, the host flowers from June into August, and it flowers every year (Fernald, 1950; Strausbaugh and Core, 1977). Infestations of *R. sodsensis* may be relatively steady and low over the years. The host of *R. zigadenusae* is *Z. densus* (Descr.) Fernald, which occurs along the coastal plain in wet pine barrens and open swamps from southern Virginia to Florida west to eastern Louisiana. This species flowers in early spring, April to May, in response to fire after which flowering frequency gradually declines over one to three years, depending on habitat, until populations persist only in a vegetative state. *Rhadinoceraea zigadenusae* populations rise and fall with the flowering cycle following fire. Infestation rates reach levels where virtually all flowers in plant populations are consumed (McDearman, personal communication). Adults of both species of *Rhadinoceraea* appear when *Zigadenus* begins to flower. *Rhadinoceraea zigadenusae* flies in April to early May with larval feeding completed in May (Smith and McDearman, 1990), and *R. sodsensis* flies in mid-July with larval feeding completed by mid-August. Since the host in the West Virginia mountains is disjunct by some distance from coastal plain populations, and there is at least a two-month interval between appearance times of

the sawflies, the two sawfly populations are reproductively isolated by space and phenology. Thus, interbreeding in nature is impossible.

Of the 43 adults collected in West Virginia, 3 have vein 3r-m in the forewing (Fig. 1) and 40 lack this crossvein (Fig. 2). Of the 17 from Malaise traps, 1 has vein 3r-m; of the 26 from sweeping, 2 have vein 3r-m. All 14 Mississippi specimens of *R. zigadenusae* have vein 3r-m (Fig. 1). Otherwise, adults and larvae of both populations appear similar. Of the nine North American species of *Rhadinoceraea* this is the only one lacking vein 3r-m.

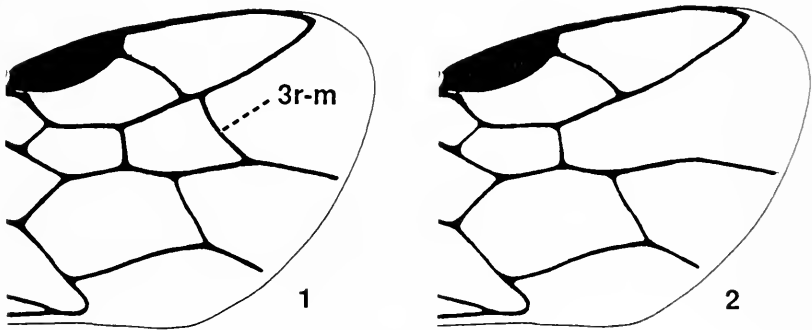


Fig. 1. Apex of forewing of *Rhadinoceraea zigadenusae*. Fig. 2. Apex of forewing of *R. sodsensis*.

One difference in habit was noted. *Rhadinoceraea zigadenusae* typically oviposits into the inflorescence branches among the flowers, whereas *R. sodsensis* oviposits into the main stem of the inflorescence below the flowering branches (McDearman, personal communication).

Field observations.— On July 18, 1991, we surveyed 559 inflorescences in a bog off Northland Loop Trail southwest of Red Creek Campground. Nineteen (4%) of these inflorescences harbored from 1 to 10 larvae. We found 3 inflorescences with 1 larva, 2 with 2 larvae, 4 with 3 larvae, 2 with 4 larvae, 1 with 5 larvae, 2 with 6 larvae, 1 with 7 larvae, 3 with 8 larvae, and 1 with 10 larvae. The infestation rate (plants with one or more larvae) was low compared to the Mississippi populations (nearly 100%), though in late July the infestation rate may have been higher. McDearman (personal communication) found 42% infestation in a *Zigadenus* patch, August 9, 1986, about 1 mile south of Red Creek Campground and estimated that the infested host plants had one or two larvae each.

The adult flight period is about two weeks in mid-July. On July 7, 1992, and July 18, 1993, we net-collected adults. We also collected 17 adults in the Malaise traps, all from July 8 to 18, 1993. We caught 3 females in trap #1, 3

females in trap #2, and 6 females and 4 males in trap #3. A higher catch would be expected in the trap in the large patch of the host. Those from traps 1 and 2 are probably dispersing females.

Every ten days from late July through mid-August 1993, we examined a haphazard sample of from 20 to 35 inflorescences from the largest patch near South Prong Trail and larvae were tabulated from each sample. On July 17, 41 small to medium-sized larvae were found on 15 flowering and 20 budding inflorescences; on July 27, 19 medium to large larvae were taken from 20 flowering inflorescences; on August 7, 9 large larvae were taken from 20 flowering inflorescences; and on August 17 no larvae were found from 20 flowering inflorescences. Thus, the larval feeding period is from mid-July through mid-August.

In conclusion, *R. sodesensis* is univoltine. Its flight period is very short, apparently about two weeks in mid-July, and larvae feed for about 25 days from mid July through mid-August, although flight activity and larval feeding periods are likely to vary from year to year due to weather differences. The West Virginia mountain *Zigadenus* populations are geographically and phenologically isolated; consequently, the sawfly populations are reproductively isolated from one another. The West Virginia *Rhadinoceraea* thus appears to be a distinct species based on isolation as well as phenological and morphological differences.

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## NEW PSEUDOSCORPION (CHEIRIDIIDAE) RECORD FROM MICHIGAN<sup>1</sup>

Paul Cooney<sup>2</sup>, Richard J. Snider<sup>3</sup>

**ABSTRACT:** Collections taken from straw debris at a grain elevator, located in Washtenaw County, Michigan, yielded 12 specimens of *Cheiridium museorum* (Leach). These collections represent a new record for Michigan.

A previous paper (Snider & Nelson, 1991) listed an up-to-date distribution of the pseudoscorpions known to occur in Michigan. Since that time a new record for a European species, that has been found previously in the United States, was established in Michigan. We present here collection information and comments about its known distribution.

### *Cheiridium museorum* (Leach), 1817

Muchmore (1972) first identified *C. museorum* (Leach) from the United States. His study specimens came from collections made by Peter Weygoldt at Pepperell, Middlesex County, Massachusetts during September 1966. He commented that such a common species in Europe might be expected to be found as an introduction to the United States. However, because of its small size and elusive habits, it might have been overlooked by collectors.

Weygoldt (1969), writing from the European perspective, stated that *C. museorum* is a cosmopolitan species. He said its distribution is probably influenced by human endeavors, and listed habitats that include barns, greenhouses, and sparrow nests. Legg & Jones (1988) reported the distribution to be most of Europe, and widespread in Great Britain. They reported grain storage areas and birds nests associated with human environs as favored habitats, as well as barns and houses. They further suggested that the species was overlooked because of small size (1.3 - 1.4 mm).

Currently there are four species of *Cheiridium* known from the continental United States. *Cheiridium insperatum* Hoff & Clawson (1952) was taken from rodent nests at Moab, Utah, and Muchmore (1992) reported a record from California; *Cheiridium firmum* Hoff (1952) came from treehole "material", Lawrence Co., Illinois, and Muchmore (1992) reported a conspecific specimen from Missouri; *Cheiridium reyesi* Muchmore (1992) from a cave in Kinney County, Texas; and finally *C. museorum* from Massachusetts and Michigan. A thorough synonymy and world distribution for *C. museorum* can be found in Harvey (1991).

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### *Cheiridium museorum* (Leach) from Michigan

A collection of *C. museorum* was taken from a grain and feed elevator building. The structure was old and constructed of wood, set up on pilings, leaving an open space beneath the structure. There was a loft used for straw storage, and debris over time had filtered to the floor below. Straw debris was collected from that which had accumulated, 12 to 15 inches deep. It was carefully sifted over a four day period, using a box-frame with 1/4 inch hardware cloth bottom. Below the sifter was placed a white enamel pan. From the siftings 11 specimens of *C. museorum* were removed, 5 females and 6 males. All specimens were placed in 95% ethanol with 1% glycerine for storage. Identification to genus was made using Muchmore (1990) and the species confirmed from Legg & Jones (1988).

The finding of *C. museorum* in a grain elevator building is not surprising when we consider the comments of Muchmore (1972) and Legg & Jones (1988). Here the habitat had long been associated with human activity. The building was located near a railroad track and both inter- and intrastate shipping could account for the species introduction.

Collection data: USA, Michigan, Washtenaw County, Dexter, grain elevator, straw debris on floor, February 14, and April 24, 1995, P. Cooney, collector. Six voucher specimens have been placed in the Entomology Collection at Michigan State University (MSUC), and 6 retained in the collection of Paul Cooney.

#### ACKNOWLEDGMENT

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# PRELIMINARY SURVEY OF ORIBATID MITES (ACARI: ORIBATIDA) FROM ZION NATIONAL PARK, UTAH<sup>1</sup>

R. Marcel Reeves<sup>2</sup>

**ABSTRACT:** Oribatid mites were collected from five habitat sites differing in elevation (1300-2405m) and moisture content in Zion National Park, Utah. A total of 36 families, 56 genera, and 76 species were identified with approximately 73% of the species undescribed. Five species were present at all five sites while 42 species were present only at single sites.

The terrestrial habitat with the greatest species richness and phylogenetic diversity is soil, most particularly wherever dead plant and animal remains accumulate and mix with inorganic soil particles (Behan-Pelletier and Bissett 1992). Arthropods are especially diverse in such soils and include sowbugs (Isopoda), millipedes, centipedes, symphylans, pauropods, spiders, pseudoscorpions, and many kinds of insects and mites. The arthropod group with the greatest abundance and diversity in most soils is the mite suborder Oribatida. However, it is estimated that only 10% of North American oribatid species have been described, the lowest percentage of all arthropod taxonomic groups (Behan-Pelletier and Bissett 1992). Identification by non-specialists is hampered by the few reliable keys available to genera and species and by the lack of generic and family-level revisions. Identification of immature stages is even more difficult. The objective of this study was to collect and identify the oribatid mites from habitats in different areas of Zion National Park, Utah. Only one oribatid species, *Gymnodamaeus umbraticus* Paschoal, has been recorded from Zion National Park, and the park is the type locality (Paschoal 1982).

## MATERIALS AND METHODS

Zion National Park, located in southwestern Utah, has elements of several vegetative types found in western United States. Vegetation is influenced by an annual rainfall of 10-20 inches (25.4-50.8cm) per year which usually occurs as winter/early spring and late summer wet cycles. Winters are short and mild, summers are long and hot. The Virgin River runs from north to south through the Zion Canyon. Along its banks are Fremont cottonwoods (*Populus fremontii* Wats.), willow (*Salix* sp.), boxelder (*Acer negundo* L.) and ash (*Fraxinus* sp.) while on higher ground nearby the dominant trees are gambel oak (*Quercus*

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*gambelii* Nutt.), rocky mountain maple (*Acer glabrum* Torr.) and juniper (*Juniperus* sp.). In certain places water either flows down surfaces of rock walls or drips down from above (i.e. Weeping Rock, see below) providing a special habitat for herbaceous plants and mosses. At approximately 1000-1400m elevation outside the canyon is a semidesert zone on which grows juniper (*Juniperus* sp.), pinyon pine (*Pinus edulis* Engelm.) and live oak (*Quercus* sp.) (i.e. Lava Point Road, see below). At higher elevations (1400m and higher) the dominant trees are Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), ponderosa pine (*Pinus ponderosa* Dougl.), white fir (*Abies concolor* Lindl. & Gord.) and quaking aspen (*Populus tremuloides* Michx.).

Collections were made in Zion National Park on July 12-14, 1993: 1) Gateway to the Narrows along the Virgin River (approximately 1300m), 2) Lava Point (2405m), 3) Lava Point Road (1365m), 4) Emerald Pool Trail (approximately 1435m) and 5) Kolob Canyons (approximately 1800m). The materials sampled in each of the 22 samples are as follows:

- 1) Gateway to the Narrows
  - Weeping Rock
    - grass litter (RM R93-55)
  - Gateway to Narrows
    - sifted hardwood leaf litter (RMR93-56)
    - sifted cattail/equisetum litter (RMR93-57)
    - sifted maple, oak leaf litter (RM R93-58)
    - sifted rotten wood, litter by log in flat (RMR93-59)
    - wet moss by rock wall (RMR93-60)
    - plants on rock wall (RMR93-61)
    - moss on wet wall (RMR93-62)
- 2) Lava Point area
  - Lava Point
    - sifted Douglas-fir leaf litter (RMR93-63)
    - sifted leaf litter under oak, shrubs (RMR93-64)
  - One half mile from Lava Point
    - sifted quaking aspen leaf litter (RM R93-65)
    - sifted ponderosa pine litter (RMR93-66)
    - sifted rotten wood (RMR93-67)
- 3) Lava Point Road, 9 mi North of Virgin
  - sifted pinyon pine/juniper/oak leaf litter (RMR93-68)
- 4) Emerald Pool Trail
  - sifted oak/maple/juniper leaf litter (RMR93-69)
  - sifted oak litter (RMR93-70)
  - moss and lichens on rocks (RMR93-71)
  - sifted Douglas-fir/juniper/oak/maple leaf litter (RMR93-72)
- 5) Kolob Canyons area
  - sifted juniper leaf litter (RMR93-73)
  - sifted pinyon pine leaf litter (RMR93-74)
  - sifted oak leaf litter (RMR93-75)
  - sifted juniper leaf litter (RMR93-76)

Sifted samples were taken using a standard size canvas sweep net, covering the opening with 1/2 inch mesh galvanized hardware cloth, placing the material

to be sampled on top of the hardware cloth and shaking the net. The smaller particles falling into the net were placed in plastic bags for storage and shipment.

Sample size varied depending on the substrate sampled with most sifted samples filling gallon-sized plastic freezer bags. Very wet substrates or substrates from rock surfaces which could not be sampled by sifting were generally much smaller.

These samples were stored in plastic foam coolers and kept from overheating. Moisture was added to dry location samples to encourage mites to become active. Extraction using Berlese funnels began July 16 after return to New Hampshire. Extracts were checked daily until no more mites appeared, with all extractions completed by August 8, 1993.

During the sorting process representatives of each form of oribatid mite were removed and put into dishes containing lactic acid to clear specimens. All oribatids were removed in those samples with few specimens. Specimens were identified in temporary mount slides (depression slides with a cover slip over one edge) in lactic acid. Representatives of each species were mounted in Hoyer's medium and ringed with red GLPT insulating varnish to prevent dehydration. Some species required dissection to see important diagnostic characters.

Identification of specimens was first made to genus using Balogh and Balogh's (1992) world key to genera. A list of the described species in each genus was obtained from the oribatid catalog (Marshall *et. al.* 1987) and comparisons made to the literature citations for each species. Some comparisons were made to material in the Canadian National Collection (CNC) and Valerie Behan-Pelletier at CNC confirmed some of the more difficult identifications. Voucher specimens will be deposited in the United States National Museum.

## RESULTS

A qualitative assessment of the families, genera, and species from each of the five areas is provided in Table 1. Thirty-six families, 56 genera, and 76 species of oribatid mites were represented. Included were two new genera and 51 new species, 73% of those species encountered.

A wide range in moisture and elevational characteristics was present among the samples and influenced distribution of many of the mite species. In the Narrows area near the Virgin River samples #55, #60, #61 and #62 were taken on or near wet rock surfaces. The wettest sample, #60, was partly in standing water and is the only sample containing *Hydrozetes* sp. This sample also contained water mites (Hydrachnellae) and damselfly naiads (Odonata). Two additional samples, #57 and #59, from the flat next to the river in the Narrows area, also contained moist conditions, with #57 at the edge of a small swampy location. Sowbugs (Isopoda) were abundant in these two samples. Among the eleven additional species found only in these wet samples are three species of

*Malaconothrus*, a genus that is known to prefer wet habitats (Rajski 1961, Travé 1963). In the Narrows area but collected away from the river on a dry hillside were samples #56 and #58. These contained five species found nowhere else. *Aeroppia* sp. was found only in the Narrows samples but from both wet and dry locations.

At Lava Point, the highest elevation sampled, ponderosa pine, Douglas-fir and white fir provided a denser vegetative cover and greater accumulation of organic matter on the forest floor. Samples #63-66 were dry, however sample #67 was collected at greater depth and moist conditions were present. Sample #67 produced nearly all the 13 species found only at Lava Point, including *Brachychthonius* sp. and *Eobrachychthonius* sp. The Brachychthoniidae, including the *Liochthonius* from the wet Narrows samples, are very small (200-250  $\mu\text{m}$  long) weakly sclerotized mites and were present only in samples with moderate to high moisture content.

The most xeric site was the single sample taken under pinyon pine, juniper and oak on the Lava Point Road. Only *Lucoppia* sp. #1 was unique to this location.

Of the four samples taken at the Emerald Pool area, #71 (moss and lichens on rocks) contained *Lucoppia* sp. #2, the only oribatid species in this sample, and #72 (a north facing slope with Douglas-fir and ponderosa pine present) contained *Licnodamaeus* sp. #1 and *Eupterotegaeus rhamphosis*, the only samples where these species were present.

Seven species were found only in the Kolob Canyon samples.

## DISCUSSION

Species found on all five collection sites at Zion National Park are *Camisia biverrucata*, *Gymnodamaeus umbraticus*, *Joshuella* sp. #1, *Tectocephus* sp., and *Propelops canadensis*. Two of these species, *Camisia biverrucata* and *Joshuella* sp. #1, were absent in all the wet samples at the Narrows. Five additional species were found on four of the five collection sites: *Trhylochthonius americanus* was absent from Lava Point and the wet samples in the Narrows, *Ametroproctus oresbios* from Emerald Pool area, and *Belbodamaeus* sp., *Liacarus* sp. #1, and *Trichoribates* sp. absent from the single Lava Point Road sample. All of these species have thick integuments or, like *C. biverrucata*, produce a body surface coating of cerotegument to which dirt particles often adhere. Their integumental structure may have influenced their survivability in very dry situations.

In summary 42 of the 76 species collected were found at one site only. The sites with the most species in common (32%) were Lava Point and Emerald Pool. These two sites have the highest elevations and a very similar vegetative cover. The site comparisons with the least number of species in common (20%) were the Narrows with Lava Point Road, and Lava Point with Lava Point Road.

Samples from the Narrows and Lava Point had the highest moisture content while the Lava Point Road samples came from the most xeric site.

Taxonomic revisions at the family level are important sources of information for faunal studies but few exist for the oribatids. The recent revision of the Eremaeidae of North America by Behan-Pelletier (1993) was most helpful. Of the eight species of eremaecids collected in this study two were described by Higgins and five were newly described by her. Only one was a new species.

Table 1. Oribatid families, genera and species present on the five habitat sites at Zion National Park, Utah. Species marked with asterisk (\*) are new records for Utah. Listing of families follows that of Balogh and Balogh (1992).

Family/Species	Narrows	Lava Point	Lava Point Road	Emerald Pools	Kolob Canyon
<b>Hypochthoniidae</b>					
* <i>Hypochthonius luteus</i> Oudemans	+				
<b>Cosmochthoniidae</b>					
* <i>Cosmochthonius lanatus</i> (Michael)	+		+		
<b>Brachychthoniidae</b>					
<i>Brachychthonius</i> sp.		+			
<i>Eobrachychthonius</i> sp.		+			
<i>Liochthonius</i> sp.	+				
<b>Phthiracaridae</b>					
<i>Atropacarus</i> sp.	+	+		+	
<i>Hoplophthiracarus</i> sp.	+				
<b>Oribotritiidae</b>					
* <i>Mesotritia brachytrix</i> Walker		+			
<b>Euphthiracaridae</b>					
<i>Rhysotritia ardua</i> (C. L. Koch)	+	+		+	
<b>Camisiidae</b>					
* <i>Camisia biverrucata</i> (C. L. Koch)	+	+	+	+	+
* <i>Camisia lapponica</i> (Tragardh)		+			
<b>Trhypochthoniidae</b>					
* <i>Trhypochthonius americanus</i> (Ewing)	+		+	+	+
<b>Malaconothridae</b>					
* <i>Malaconothrus gracilis</i> v. d. Hammen	+				
<i>Malaconothrus</i> sp. #1	+				
<i>Malaconothrus</i> sp. #2	+				

Family/Species	Narrows	Lava Point	Lava Point Road	Emerald Pools	Kolob Canyon
Hermaniellidae					
<i>Hermaniella</i> sp.	+	+		+	
Gymnodamaeidae					
<i>Gymnodamaeus umbraticus</i>					
Paschoal	+	+	+	+	+
<i>Joshuella</i> sp. #1	+	+	+	+	+
<i>Joshuella</i> sp. #2		+	+		
<i>Pleodamaeus plokosus</i> (Woolley & Higgins)		+		+	
Plateremaeidae					
<i>Allodamaeus</i> sp.	+				
Licnodamaeidae					
<i>Licnodamaeus</i> sp. #1				+	
<i>Licnodamaeus</i> sp. #2					+
Damaeidae					
<i>Belbodamaeus</i> sp.	+	+		+	+
<i>Caenobelba</i> sp.		+			
Cepheidae					
* <i>Eupterotegaeus rhamphosis</i>					
Higgins & Woolley				+	
<i>Eupterotegaeus</i> sp.	+				
Charassobatidae					
<i>Ametroproctus oresbios</i>					
Higgins & Woolley	+	+	+		+
Eremaeidae					
<i>Eremaeus monticolus</i>					
Behan-Pelletier		+		+	
* <i>Eremaeus oresbios</i>					
Behan-Pelletier		+			+
<i>Eremaeus</i> sp.		+			
* <i>Eueremaes alvordensis</i>					
Behan-Pelletier					+
<i>Eueremaes chiatous</i> (Higgins)		+			
<i>Eueremaes danos</i>					
Behan-Pelletier		+			
* <i>Eueremaes lindquisti</i>					
Behan-Pelletier	+		+	+	
<i>Eueremaes tetrosus</i> (Higgins)		+	+		
Liacaridae					
<i>Dorycranosus</i> sp.					+
<i>Liacarus</i> sp. #1	+	+		+	+
<i>Liacarus</i> sp. #2	+				



Family/Species	Narrows	Lava Point	Lava Point Road	Emerald Pools	Kolob Canyon
<b>Tectocepheidae</b>					
<i>Tectocepheus</i> sp.	+	+	+	+	+
<b>Oppiidae</b>					
<i>Aeroppia</i> sp.	+				
* <i>Microppia simplex</i> (Jacot)		+			
<i>Multioppia</i> sp.		+			
<i>Oppia</i> sp.	+				
* <i>Oppiella nova</i> (Oudemans)	+	+			
<b>Quadropiidae</b>					
<i>Quadropia</i> sp.	+	+			+
<b>Suctobelbidae</b>					
<i>Suctobelba</i> sp.		+			
<i>Suctobelbella</i> sp.	+				
<b>Hydrozetidae</b>					
<i>Hydrozetes</i> sp.	+				
<b>Cymbaeremacidae</b>					
<i>Scapheremaeus</i> sp.		+	+		
<b>Scutoverticidae</b>					
<i>Exochocepheus</i> sp. #1			+	+	+
<i>Exochocepheus</i> sp. #2				+	
<i>Exochocepheus</i> sp. #3	+				
<b>Xylobatidae</b>					
<i>Xylobates</i> sp.	+				
<b>Oribatulidae</b>					
<i>Gerloubia</i> sp.					+
<i>Lucoppia</i> sp. #1			+		
<i>Lucoppia</i> sp. #2				+	
<i>Lucoppia</i> sp. #3	+				
<i>Paraphauloppia</i> sp.	+				
<i>Oribatula</i> sp.	+	+			
<i>Zygoribatula</i> sp. #1					+
<i>Zygoribatula</i> sp. #2					+
?genus		+			
<b>Haplozetidae</b>					
<i>Peloribates</i> sp.		+		+	
<b>Scheloribatidae</b>					
<i>Hemileius</i> sp.	+				+
<i>Scheloribates</i> sp. #1	+	+			
<i>Scheloribates</i> sp. #2	+				
<b>Ceratozetidae</b>					
<i>Trichoribates</i> sp.	+	+		+	+
?genus		+			

Family/Species	Narrows	Lava Point	Lava Point Road	Emerald Pools	Kolob Canyon
Mycobatidae					
<i>Punctoribates</i> sp.	+				
Humerobatidae					
<i>Humerobates</i> sp.		+			
Phenopelopidae					
* <i>Propelops canadensis</i> Hammer	+	+	+	+	+
Oribatellidae					
<i>Oribatella</i> sp. #1	+				
<i>Oribatella</i> sp. #2		+			+
Tegoribatidae					
<i>Lepidozetes</i> sp.		+			
Galumnidae					
<i>Pilogalumna</i> sp.		+		+	
<b>Total Families - 36</b>	<b>29</b>	<b>25</b>	<b>11</b>	<b>18</b>	<b>16</b>
<b>Genera - 56</b>	<b>36</b>	<b>34</b>	<b>12</b>	<b>21</b>	<b>20</b>
<b>Species - 76</b>	<b>40</b>	<b>40</b>	<b>14</b>	<b>22</b>	<b>21</b>

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## RELATIONSHIPS OF THE ARTHROPLEIDAE, HEPTAGENIIDAE, AND PSEUDIRONIDAE (EPHEMEROPTERA: HEPTAGENIOIDEA)<sup>1</sup>

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**ABSTRACT:** Phylogenetic relationships indicate that *Pseudiron* represents a sister lineage to all other genera that have traditionally been placed in the family Heptageniidae. Among the latter lineage, *Arthroplea* represents a sister lineage to a lineage including all other genera. Recognition of the families Pseudironidae (*Pseudiron*), Arthropleidae (*Arthroplea*), and Heptageniidae *sensu stricto* is suggested within the framework of a strictly phylogenetic classification. The deduced cladogram of the three lineages and their apomorphic characterization is presented.

The superfamily Heptagenioidea is a monophyletic grouping of Ephemeroptera that was shown by McCafferty (1990) to include, as far as is now known, the extant families Coloburiscidae, Isonychiidae, Oligoneuriidae, and Heptageniidae. This fundamental relationship has been recognized by other workers (Edmunds 1973, Landa 1973, McCafferty and Edmunds 1979, Landa and Soldán 1985) and a first cladistic hypothesis was offered by McCafferty (1991a). Although a close relationship of the fossil family Epeoromimidae and Heptageniidae had been suggested by Tshernova (1970), McCafferty (1990) excluded Epeoromimidae from the Heptagenioidea because it apparently lacked larval synapomorphies that defined the superfamily. Although the Heptagenioidea clearly appear to have arisen from a minnowlike (pisciform) ancestor, the exact point of origin remains problematic; however, if it is derived at the base of the pisciform lineage, its provisional consideration as a separate suborder Setisura (McCafferty 1991b) would be appropriate. Also, although there is little question as to the monophyletic nature of the Heptagenioidea, we are not completely sure that it is holophyletic at this time since some problematic pisciform families may eventually prove to share its common ancestry. More cladistic research is expected to resolve these latter questions.

The family Heptageniidae is by far the largest and most apotypic of the major lineages of Heptagenioidea. It constitutes a familiar group of "flatheaded" mayflies that are distributed mainly in streams throughout the "world continent" [i.e., excluding only South America and the Australian regions; see Wilson (1992)]. These mayflies may have evolved from stream-dwelling, minnowlike, passive filter feeders (see McCafferty 1991a). A relatively consistent concept of the Heptageniidae as a distinct taxon of mayflies began with Eaton's (1883) informal grouping, but it was not until the reclassification of Edmunds and Traver (1954) that the group was universally recognized at the family level.

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There are two genera of highly specialized mayflies, *Arthroplea* Bengtsson and *Pseudiron* McDunnough, that have been placed either in separate subfamilies of Heptageniidae or in separate families. Recent treatments of these genera may be found in Studemann *et al.* (1987) and Pescador (1985), respectively. The Holarctic genus *Arthroplea* was considered to constitute the separate family Arthropleidae by Balthasar (1937), and this classification has sometimes been followed in Europe. In North America, for the most part, the taxon has been considered only a subfamily of Heptageniidae. The Nearctic genus *Pseudiron* was considered to constitute the subfamily Pseudironinae of Heptageniidae by Edmunds and Traver (1954). Landa and Soldán (1985) and McCafferty (1990) did not believe that *Pseudiron* was related to the Heptageniidae. Landa and Soldán (1985) considered Pseudironinae in the family Siphonuridae *sensu lato*, but this was done on the basis of unreliable internal anatomical characters. McCafferty (1991b) gave it familial status within a particular group of pisciform families outside the Heptagenioidea, mainly because of the similarity of certain larval characteristics associated with the sand-dwelling larvae. It now appears that this grouping of psammophilous mayflies in the provisional infra-order Arenata may represent an artificial construct because defining apomorphies are highly adaptive and may not have been commonly derived (see also McCafferty 1991c, McCafferty and Wang 1994).

The main purpose of this paper is to demonstrate the phylogenetic relationships of *Arthroplea* and *Pseudiron* to Heptageniidae *sensu stricto*.

## FAMILIES OF THE HEPTAGENIIDAE COMPLEX

Our detailed comparison of *Arthroplea*, *Pseudiron*, and the numerous genera that have unquestionably been considered in the Heptageniidae has revealed that together they form a monophyletic group within the Heptagenioidea. *Pseudiron* shares a number of apomorphies common to this entire grouping (see below). Thus the placement of *Pseudiron* in, or as a cognate of, the Heptageniidae, as initially suggested by Edmunds and Traver (1954), is validated. For purposes of discussion below, we will refer to this monophyletic grouping as the Heptageniidae complex.

Shared characteristics of the Heptageniidae complex that distinguish it from other Heptagenioidea are as follows: Larvae have bodies that are generally depressed with outspread legs, and associated with this condition is a head capsule that has lost a considerable amount of its convexity and thus become relatively flattened and flanged. The head is prognathous with dorsal eyes and antennae, but the associated prognathous mouthpart orientation along with a reduced clypeus was already apparent in the related heptagenioid family Oligoneuriidae, as was some primordial tendency towards the flanging of the head capsule. The apomorphic depression of the larvae has independently evolved from the plesiomorphic fusiform shaped body to various degrees in

some other mayfly lineages outside the Heptagenioidea, especially within certain lineages of the extremely diverse family Leptophlebiidae. Maxillary gills and filtering foreleg setae that are present in certain plesiotypic families of Heptagenioidea are absent in the Heptageniidae complex and presumably evolved in an early ancestor of the Heptagenioidea. The absence of these features in the Heptageniidae complex therefore may represent a reversion to the general outgroup condition widespread throughout the Ephemeroptera. A row of usually well-developed hairlike setae is present posteriorly along the forefemora. This characteristic, however, is highly subject to homoplasy among mayflies.

The alate stages of the Heptageniidae complex reflect the flattened condition of the larvae with a corresponding broadening of the thorax and various shortening and broadening of the adult head capsule. The broadening of the thorax in the alate stages is expressed by the relative width of the medio-elongate depression of the furcasternum of the mesothorax. In the Heptageniidae complex, this depression is variously broadened compared to a narrow-elongate depression found in the alate forms of mayflies with narrow elongate larval bodies. Alate stages of the Heptageniidae complex also have forewings in which both CuP and A<sub>1</sub> are more elongated than that found in other Heptagenioidea and the more primitive pisciform mayflies. This is best expressed by CuP ending variously beyond the midlength of the anal margin (with very few exceptions in certain species). Two pairs of cubital intercalaries are also present in the forewings of the Heptageniidae complex (rarely reduced to one pair, for example, in a species of *Rhithrogena* Eaton) and at least the first pair ends in the outer margin. McCafferty (1991a) hypothesized that this basic cubital venation evolved in a common ancestor of the Oligoneuriidae and Heptageniidae complex because it is present in the most plesiotypic Oligoneuriid subfamily Chromarcyinae (more apotypic lineages of Oligoneuriidae having become highly specialized for rapid flight with geminated elongate veins and loss of crossveins). The presence of two pairs of cubital intercalaries may be subject to homoplasy in mayflies. For example, two pairs of cubital intercalaries are also found in the Ametropodidae and some Metretopodidae; however, the exact relationships of these latter families must be further researched. The relative length of CuP may be variously represented outside the Heptagenioidea.

In order to resolve the higher classification within the Heptageniidae complex, we subjected the genera of the Heptageniidae complex to a cladistic analysis. It is critical that the cladistic position of *Arthroplea* and *Pseudiron* be determined if a phylogenetic classification is to be followed. For example, if either of these lineages originated from within Heptageniidae *sensu stricto*, then that particular lineage would necessarily be disqualified from consideration as a separate family because such a classification would also establish Heptageniidae as paraphyletic. The branching sequence would also obviously have an impact on the consideration of lineages as subfamilies.

Our analysis indicated that *Pseudiron*, *Arthroplea*, and all other genera of the Heptageniidae complex form three monophyletic lineages, respectively. The deduced branching sequence of the three lineages is shown in Figure 1. The evidentiary apomorphies are indicated by letters on Figure 1 and are detailed in Table 1. Our conclusions apparently are in some agreement with previous conclusions by Jensen and Edmunds (1973), wherein they stated that *Pseudiron* and *Arthroplea* arose independently from near the base of the "proto-Heptageniidae." Jensen and Edmunds (1973), however, gave no phylogenetic data to substantiate their conclusions, and a third conclusion that *Raptoheptagenia* Whiting and Lehmkuhl (treated as *Anepeorus* McDunnough) was also derived basally is not supportable. Our additional cladistic data (McCafferty and Wang,

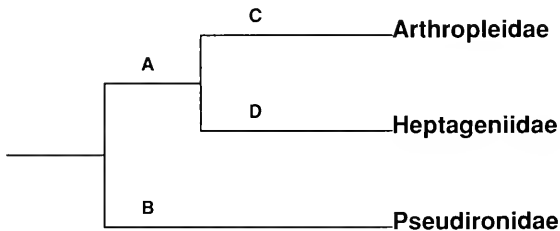


Fig. 1. Cladogram of the Heptageniidae complex (letters represent synapomorphies listed in Table 1).

Table 1. Apomorphies used in configuring the cladogram of the major lineages of the Heptageniidae complex (Fig. 1), with respective plesiomorphies indicated.

Apomorphy	Plesiomorphy
A. Adult hindtarsal segment 1 completely articulated with tibiae (clearly 5-segmented) (Fig. 235; Edmunds <i>et al.</i> 1976)	- Hindtarsus segment 1 fused or partially fused to tibiae (tarsus apparently 4-segmented) (Figs. 234, 236; Edmunds <i>et al.</i> 1976).
B. Larval tarsal claws subequal to tibiae (Fig. 406; Edmunds <i>et al.</i> 1976). Larval gills lamellae with elongate appendage (Fig. 406; Edmunds <i>et al.</i> 1976).	- Tarsal claws much shorter than tibiae. - Gills without elongate appendage.
C. Male genital forceps with 3 small terminal segments. Larval maxillary palps extremely elongated (Fig. 405; Edmunds <i>et al.</i> 1976).	- Forceps with 2 small terminal segments. - Maxillary palps not elongate.
D. Larval labial base broad and enlarged, with thickened labial palp segment 1 obliquely and subterminally fitted to base (Fig. 20; McCafferty 1991a).	- Labial base and palps not developed as such and palps articulated terminally (Figs. 12, 14, 16, 18; McCafferty 1991a).

in preparation) will show *Raptoheptagenia* to be derived from within the Heptageniinae.

By incorporating a sequencing convention (see, e.g., Wiley 1981), we propose that the three distinctive lineages depicted in Figure 1 be recognized as separate families. Not only is this in compliance with the precepts of a phylogenetic classification, but the three families are easily keyed out as such in both the larval and alate stages. In recent family keys to adult mayflies of North America (e.g., Edmunds *et al.* 1976, Edmunds 1984), Heptageniidae *sensu lato* had to be keyed out at two different places in those keys, *i.e.*, at one point as Heptageniidae in part (= Heptageniidae *sensu stricto*) and at another point as Heptageniidae in part (= Pseudironidae). This situation is now obviated by the revised classification.

As pointed out above, in addition to the families Heptageniidae, Arthropleidae, and Pseudironidae, the mayfly families Ametropodidae and Metretopodidae also possess adults with paired elongate cubital intercalary veins in the forewings. All of these families also have relatively elongate CuP and A<sub>1</sub> veins in the forewings. Presently, we are not sure of the relationships of the latter families with each other or with the former three families of the Heptagenioidea. Adults of all of these groups can be easily keyed using the taxonomic keys of Edmunds *et al.* (1976) and Edmunds (1984), for example, Ametropodidae adults possess a developed median caudal filament and those of the others do not. Adults of Chromarcyinae (Heptagenioidea, Oligoneuriidae), a group known only from southeast Asia, possess a cubital wing venation similar to the latter five families, however, they are told by the possession of more than four elongate MP<sub>1</sub> intercalary veins and CuP and A<sub>1</sub> veins that do not extend quite as far along the anal margin of the forewing. Adults of some species of the large and diverse families Baetidae and Leptophlebiidae can be found to have paired elongate cubital intercalaries, but they are otherwise highly distinctive and should not be confused with the families that consistently show this cubital characterization.

#### ACKNOWLEDGMENT

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## A CONTRIBUTION TO THE STUDY OF THE GENUS *ANACLILIEA* (DIPTERA: MYCETOPHILIDAE)<sup>1</sup>

Edward I. Coher<sup>2</sup>

**ABSTRACT:** Two species of *Anacliliea*, *A. winchesteri* and *A. vallis*, are described from Vancouver Is., Canada. These are the second and third species of the genus *Anacliliea* described from the Nearctic Region. A newly noticed characteristic of the tergal portion of the male terminalia, the apical shelf, is used to support separation of these species from each other and the Palaearctic *dispar*. This characteristic is not yet known for other described species of the genus.

The genus *Anacliliea* consists of one fossil species described by Meunier (1904), 3 species from the western Palaearctic Region and three species reported from the Nearctic Region (Vockeroth, 1981), one of which has been described by Bechev (1990). Bechev also described a species from temperate Nepal and reviewed the genus.

The type of the genus *Anacliliea* is *A. anacliniformis* Meunier, 1904, an amber fossil. Johannsen (1909) gave page preference to that species in designating the type of *Anacliliea*. Edwards (1940), after examination of three other Meunier fossil species of *Anacliliea* described at the same time as *anacliniformis*, determined that they probably represented *anacliniformis*.

Subsequently, *Paraneurotelia* Landrock, 1911 was erected for the western Palaearctic *P. dziedzickii*; its relationship to *Anacliliea* was noted. Edwards (1914) referred *Boletina dispar* Winnertz, 1863 to the Landrock genus. Later, Edwards (1925) suggested that *Paraneurotelia* was "probably synonymous with Meunier's *Anacliliea*, from Baltic amber" and in 1940 synonymized *Paraneurotelia* (sic) under *Anacliliea*.

Examination of an Edwards specimen of *dispar* from Great Britain and Barendrecht's (1938) specimen from the Netherlands confirm that they are conspecific with *dispar* of Landrock (1927). I have not seen Engel's specimen (1915) from the Faroes. Hutson *et al.* (1980) gave a short review of *dispar*, reporting it from Great Britain and Ireland.

In the Nearctic Region, Vockeroth (*loc. cit.*) indicated that there were three species of *Anacliliea*. Bechev (*loc. cit.*) described a single species obtained from Vockeroth. The present study presents descriptions of the males of two new species from Vancouver Is., British Columbia. It is not known if these represent any of the species known to Vockeroth; material available to him cannot be located. At this time, I cannot correlate females with males.

<sup>1</sup> Received February 9, 1995. Accepted June 7, 1995.

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## *Anacliliea* Meunier, 1904

Type species: *Anacliliea anacliniformis* Meunier, 1904:146

Designation Johannsen, 1909:70

*Paraneurotelia* Landrock, 1911:161; Edwards, 1940:121, *Paraneurotelia*  
(sic) synonymy

**Head.** Mouthparts flabellate; vertex, frons and parietal regions with short setae; posterior and anterior clypeus with fine setae; ocelli in a triangular conformation with smaller median ocellus anterior, lateral ocellus about 2x its diameter from eye; compound eye excavated dorsomedially along antenna socket; antenna 2+14 segmented, scape and pedicel with strong dorsoapical setae, flagellar segments slightly compressed, subrectangular; palpus 4-segmented with the apical segment long and thin; thorax with arched mesonotum; mesonotum and pronotum setiferous; pleura bare except pleurotergite with very fine postero-ventral setae; postnotum with fine setae posteriorly; katepisternite much larger than anepisternite; legs with fore and mesocoxae yellowish, forecoxa setose anteriorly, base brown, mesocoxa with some distal anterior setae, metacoxa with a row of posterior setae expanded distally; femora compressed; tibial spurs 1-2-2, tibiae brownish, mid tibia with a dorsal and hind tibia with a ventral paired irregular row of setae; hind tibia expanded distally with sparse lateral apical comb; wing with macrotrichia over entire surface, most heavily in cell R<sub>3</sub>; humeral crossvein, Sc, R, R<sub>1+2+3</sub> and R<sub>4+5</sub> setose, Rs bare; setation on M and Cu and their branches not as robust; C ending beyond tip of R<sub>4+5</sub>; 1A represented by a fold parallel to Cu<sub>2</sub>; 2A reaching level of fCu; abdomen setiferous, subcylindrical, with eight apparent segments; sternites divided longitudinally by two membranous areas into a broad median and narrow lateral sclerites; eighth segment not modified and shorter than seventh.

**Male.** Terminalia: tergal portion (tgt) a truncated triangle, setiferous with a bare, lightly pigmented apical shelf (as) at a right angle which is distinctive from species to species when observed from a posterior view.

**Biology:** The population of British Columbia *Anacliliea* collected in Malaise traps between 3 July and 9 September peaked on 15 July. Records from the literature indicate that in all other areas where *Anacliliea* has been found, it appears one or two months earlier.

## *Anacliliea vallis* Coher, NEW SPECIES

(Fig 1)

**Male.** A small yellowish-brown fly with the following characteristics in addition to those for the genus: Antenna with flagellar segments concolorous. Thorax with disk of mesonotum chestnut-brown. Legs with fore and mesocoxa yellowish, forecoxa with base brown, metacoxa brown; femora yellowish, with metafemur darkened distally, mesofemur less so. Wing (2.5mm) with C projecting beyond tip of R<sub>4+5</sub> half the distance to M<sub>1+2</sub>; base of M<sub>1+2</sub> much weakened, fM slightly basad of fCu; Sc ending in C before level of fM. Halter cream colored with an oval pilose knob. Abdomen chestnut. Terminalia with subtrapezoidal shelf (Fig. 1b) of tergal portion less than twice as wide as high, basal lateral margins rounded; Sinsclerite (Fig. 1a) with median ventral margin entire.

Material examined: Holotype, male, CANADA: British Columbia, Vancouver I., Carmanah Valley, March 7- July 11, 1991, N. Winchester. Deposited in the Canadian National Collection, Ottawa.

Paratopotype. June 4 - July 15, 1991. In my collection.

**Etymology.** The name *vallis* is derived from the Latin for valley.

**Discussion.** Taken during the maximum flight time of *winchesteri* n.sp. (Comparison of the wings of *vallis* and *winchesteri* show macrotrichia of the former slightly more dense, wing broader. These characteristics are not placed in the descriptions since minor variations would cancel them as separational charac-

teristics. Like *winchesteri*, this species is separable from all other known species by the coloration pattern of the coxae. The male terminalia readily separate this species from all others presently known.

*Anacliliea winchesteri* Coher, NEW SPECIES

(Fig. 2)

**Male.** A small chestnut brown fly with the following characteristics in addition to those for the genus. Antenna with first two flagellar segments lighter than remainder. Legs with fore and meso-coxa yellowish, forecoxa with base brown, metacoxa brown; femora yellowish, with hind femur darkened distally, midfemur less so; tibiae brownish. Wing: (2.0-3.0mm), C projects beyond tip of  $R_{4+5}$  less than half way to  $M_{1+2}$ ; the base of  $M_{1+2}$  much weakened, fM virtually level with fCu; Sc ending in C slightly beyond level of fCu. Halter whitish with an oval pilose knob. Abdomen chestnut with segment eight appearing darkened. Male terminalia with apical shelf of tergal portion subtrapezoidal (Fig. 2b), about 3 times as wide as high, basal lateral margins broadly connected to tergite. Synsclerite (Fig. 2a) with median ventral margin with a roughly U-shaped median depression.

**Material examined:** *Holotype*, male, CANADA: British Columbia, Vancouver I., Carmanah Valley, June 4 - July 15, 1991, N. Winchester. Deposited in the Canadian National Collection, Ottawa. **Paratypes.** June 21-July 3, 1991 (3m); July 4 -15, 1991 (36m); July 31-August 11, 1991 (1 m). Canadian National Collection and my personal collection.

**Discussion.** If colorational characteristics are valid, this species, like *vallis*, may be distinguished from all previously described species on the basis of coxal color. The male terminalia readily separate this species from all others presently known.

I am pleased to dedicate this species to Neville Winchester who has done so much to contribute material to the study of the Mycetophilidae in boreal North America.

*Anacliliea dispar* (Winnertz) 1863

(Fig. 3)

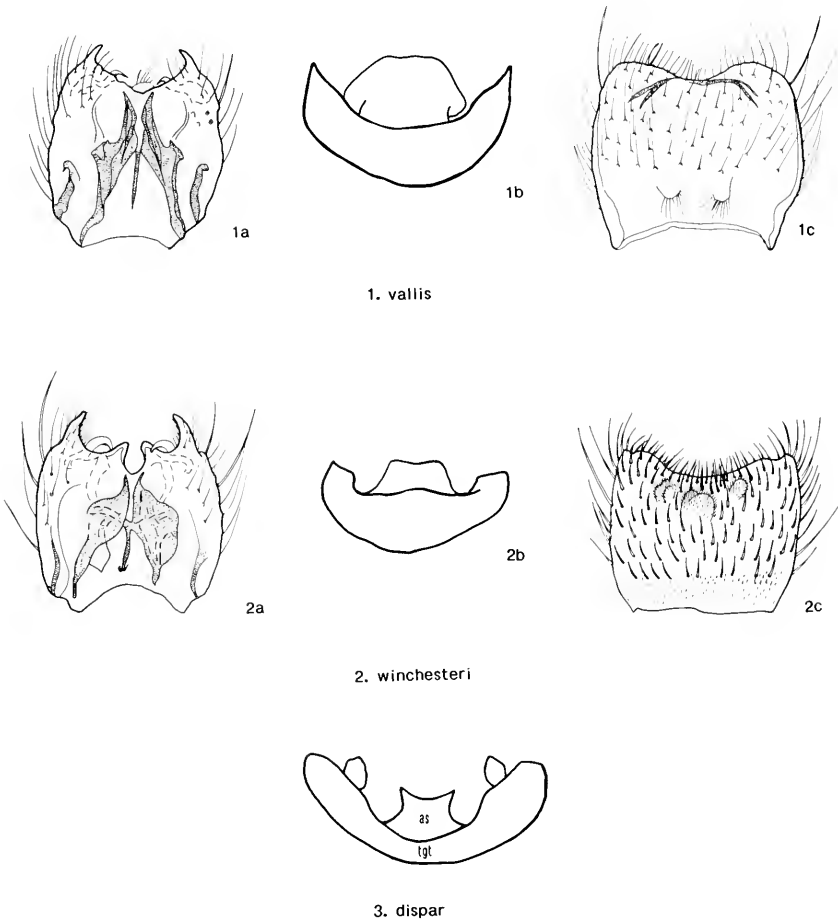
This European species exhibits an apical shelf which has a uniquely forked appearance. Bechev (*loc. cit.*), reports a widespread western Palaearctic distribution for this species.

*Anacliliea vockerothi* Bechev, 1990

The localities given by author of this species are not in Canada as noted but are found in the southeastern U.S.A. Specimens are not available at this time so that characteristics of the apical shelf of this species cannot be given.

*Anacliliea beshovskii* Bechev, 1960

The remarks for *vockerothi* apply to this species.

**Anaclileia**

Figs. 1-3 Male terminalia *Anaclileia* spp. Fig. 1. *A. vallis* n.sp. 1a. synsclerite, ventral. 1b. apical shelf. 1c. tergal somites, dorsal. Fig. 2. *A. winchesteri* n.sp. 2a. synsclerite, ventral. 2b. apical shelf. 2c. tergal somites, dorsal. 3. *A. dispar* Winnertz. as - apical shelf; tgt - tergal somite.

## CATALOGUE OF SPECIES

- anacliniformis* Meunier, 1904:146 fossil; Johannsen, 1909:86, designated genotype. Edwards, 1940:120; Matile, 1988:233, *anacliniformis* (sic).
- behovskii* Bechev, 1990:68
- dispar* (Winnertz) 1863:777 *Boletina*; Schiner, 1864:455; Grzegorzek, 1873:26; Dziedzicki, 1885:192; Kowartz, 1894:4; Thalhammer, 1900:105; Kertesz, 1902:74; Johannsen, 1909:73, 1909:86, *Palaeoanaclina*; Edwards, 1914:361, *Paraneurotelia*, 1925:558, *Paraneurotelia*, 1940:121; Engel, 1915:98, *Palaeoanaclina*; Enderlein 1928:13, *Paraneurotelia*; Barendrecht, 1938:39 *Paraneurotelia*; Landrock 1927:59 *Paraneurotelia* 1940:42 *Paraneurotelia*; Seguy, 1940:89, *Paraneurotelia*; Hutson, *et. al.*, 1980:48; Matile, 1988:233; Bechev, 1990:68.
- dissimilis* Meunier, 1904:148 fossil; Edwards, 1940:121 = *anacliniformis*.
- dziejdzickii* (Landrock) 1911:161 *Paraneurotelia*; Landrock, 1927:59, *Paraneurotelia*, 1940:42, *Paraneurotelia*; Edwards, 1940:120; Matile, 1980:95, 1988:233; Bechev, 1990:68.
- gazagnairei* Meunier, 1904:147 fossil; Edwards, 1940:121 = *anacliniformis*.
- nepalensis* Bechev, 1990:69.
- sylvatica* Meunier, 1904:147 fossil; Edwards, 1940:121 = *anacliniformis*.
- vallis* Coher, n.sp.
- vockerothi* Bechev, 1990:71
- winchesteri* Coher, n.sp.

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## BOOK REVIEW

**IDENTIFICATION GUIDE TO THE ANT GENERA OF THE WORLD.**  
Barry Bolton. 1994. Harvard University Press, Cambridge, Massachusetts. 222 pp. \$65.00 hardcover.

Ants are commonly encountered in most terrestrial habitats. In addition to vast numbers of individuals, they are a diverse group. All belong to the family Formicidae (all ants and only ants). Living species are currently classified into 16 subfamilies and 296 genera. Estimates of species range between 15,000 and 20,000 with roughly 9,000 formally described. Such diversity can be intimidating for those beginning their study of ants; it may account for the relative scarcity of ecological studies of ants (in comparison to other organisms). Barry Bolton attempts "to provide a series of identification keys to the living ant subfamilies and genera of the world." (page 1). I believe he achieved this goal in a superb manner.

Since this book concerns identification of ants, I selected a number of specimens representing different subfamilies and genera from North America, South America, Australia, Europe, Africa, and Asia. Keys are separated by zoogeographical region to speed accurate identifications. I was able to identify all material using the keys. The numerous (over 500) scanning electron microscope photographs helped confirm these identifications. I believe anyone seriously wishing to identify ants can use this work to properly determine the identity at the genus level.

Several sections of this book deserve special recognition. First, there are a number of paragraphs dealing with proper preparation of specimens. When I recall my early experiences pinning ants, no such reference was readily available. Although one eventually discovers the proper way, such guidance should be quite helpful for budding myrmecologists. This section reflects the attention to detail which makes this book an excellent resource. There is also a section discussing how to use the keys. This also should prove exceptionally valuable to those unfamiliar with the use of dichotomous keys. The glossary of morphological terms is thorough and well illustrated. Terms are defined so as to be understandable to the reader. The bibliography of faunistic studies in the rear of the book should help locate pertinent local references in most cases.

Each subfamily is introduced with a diagnosis of the group and a synoptic classification of all genera within that subfamily. A thorough list of references should help those needing species rank identifications. Inclusion of all proposed names from family through sub-genus (with their current status) is also helpful. Discussion of extinct subfamilies with a listing of extinct genera is a definite plus.

It is rare one encounters a truly useful book. This is one. Those wishing to identify ant genera should make ready reference of this work. Those wishing to learn more about this world's ant fauna will find this a valuable addition as well.

Mark B. DuBois  
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## BOOK REVIEW

JOURNEY TO THE ANTS: A STORY OF SCIENTIFIC EXPLORATION. Bert Hölldobler and Edward O. Wilson. 1994. Belknap Press of Harvard University, Cambridge, MA. 224 pp. \$24.95.

*Journey to the Ants* is an appropriate sequel to Hölldobler and Wilson's magnum *opus*, *The Ants*. It is not just a story about insects, but also about people — Wilson and Hölldobler in particular — as glimpses are provided into their personal journeys from boyhood naturalists to eminent scientists. Readers who might be intimidated by the technical detail and size of *The Ants* will find in the 224 pages of *Journey to the Ants* the same high quality, lively narrative, and contagious excitement which previously brought the authors a Pulitzer Prize. Indeed I was disappointed when the last page was turned and the end of the story reached.

The story begins by placing ants in perspective — the dominant group of animals in many if not most temperate and tropical terrestrial ecosystems. Wherever one looks, whether it is the high canopy of a Peruvian rainforest or a temperate grassland, ants shape the structure and function of ecosystems. Indeed social insects, which are dominated by ants, comprise only 2 percent of the known insect species but likely contribute at least half of the insect biomass. Why have ants achieved such a level of competitive superiority? Hölldobler and Wilson suggest that the answer lies in the very essence of sociality — the colony with its overwhelming numbers and organization.

Readers of *Journey to the Ants* will be treated to a captivating introduction to ant biology and a glimpse into the lives of some of Earth's most intriguing and bizarre creatures. Major topics which are examined include colony structure, communication, war (inter and intraspecific), evolutionary history of ants and the fossil record, origin and advantage of the cooperative social structure, the colony as a superorganism, ant slave trade, symbiotic relationships with other species, and microclimatic control within the colony. Separate chapters are given to the treatment of army ants and an overview which examines "The Strangest Ants".

The book is accompanied by a wealth of exceptional color photographs and artistic illustrations which provide snap shots into the life of the colony and the individual. No glossary is provided (nor needed) since scientific jargon is held to a minimum and where necessary the terms are clearly defined in the text. The lack of a guide to the literature either in the form of a bibliography or literature cited section is unfortunate for those who might wish to pursue topics in more detail. Those wishing to engage ants at the personal level will find the last section "How to Study Ants" exceptionally valuable.

*Journey to the Ants* is recommended reading for anyone who enjoys nature and its amazing diversity. It will provide an open door to an exciting new world of discovery. A must for all libraries — public, undergraduate and university.

Joseph K. Sheldon,  
Dep't. Natural Sciences,  
Messiah College



## BOOK REVIEW

NINETY-NINE MORE MAGGOTS, MITES AND MUNCHERS. M.R. Berenbaum. 1993. University of Illinois Press, Urbana and Chicago. Illustrations by J.P. Sherrod.

If sequels are generally poor substitutes for the original, then this book is certainly an exception. May Berenbaum has assembled ninety-nine more essays on insects and related creatures which will keep your hemolymph flowing. Unlike her first book, *Ninety-nine Gnats, Nits, and Nibblers* which laid bare the secret lives of many common species, Berenbaum here moves her audience from the common (cabbageworms, corn earworms, cutworms, and Japanese beetles) to some of the more obscure and even bizarre insects and arachnids. Non entomologists who are fortunate enough to encounter this work will have an opportunity to peer into a strange and wonderful world. Even trained entomologists will likely have their imaginations stretched to picture a male *Cyrtodiopsis whitei*, a stalk-eyed fly, whose length of 8 mm is only 73% of its eleven millimeter eyespan.

The book is divided into nine species groups including Homebodies, Farm Workers, Field Hands, Bushwhackers, Sodbusters, Aerialists, Water Sports, Animal Appetites, and Inhumanities. Ten to twelve species are described within each group. The narrative should be easily understood by adults and mature youth, but the book is certainly not kids stuff. The essays contain a wealth of interesting natural history for each species as well as the scientific name and usually the family.

Thanks to careful writing and a good job of copy editing, the book is relatively free of errors. Perhaps those with questioning minds may wonder whether the femur of water boatman are really located adjacent to the tarsus — the case of the missing tibia, and whether beaver beetles feed on beavers or on beetles "Once on board a beetle, beaver beetles begin to feed." In a few places some additional explanation would have also been helpful. Only the sophisticated among Berenbaum's audience will be aware that juvenile deer ticks pass through both larval and nymphal stages. Indeed many entomologists with limited knowledge of acarology may even question the correctness of this statement.

With nearly 200 species covered in her first two volumes, I anxiously await the next installment in this series. As books go, let's hope that Berenbaum takes an r-strategy in her production. After all, she has 999,802 species to go and at her current rate, she is not keeping up with new species descriptions.

Joseph K. Sheldon,  
Messiah College, Grantham PA

## SOCIETY MEETING OF MARCH 22, 1995

### DEVELOPMENT TIMES FOR FORTY SPECIES OF COSTA RICAN STREAM INSECTS: IMPLICATIONS FOR SECONDARY PRODUCTION AND TEMPORAL VARIATION IN ABUNDANCE.

Dr. John Jackson

Stroud Water Research Center, Avondale, PA

While our general perception of a rainforest implies abundant rain and warmth, actually there is considerable variation in climate, vegetation and topography. Streams and rivers comprise vital components of the tropical ecosystem but have been little studied, particularly in the New World. Scientists at the Stroud Water Research Center, Academy of Natural Sciences of Philadelphia, have been interested in the role of disturbance and seasonality in the structure and function of temperate streams, and since 1990, have extended this interest into streams of the tropics. Dr. John Jackson, involved in this research since 1992, explained and summarized the findings to date at the Society's fourth meeting of the 1994-1995 season.

The Stroud Center studies have concentrated in an area of northwest Costa Rica, in tributaries of the Rio Tempisque, a Pacific drainage river. Unlike temperate streams, certain environmental factors such as water temperature and photoperiod are stable and allow researchers to pursue avenues of research difficult to investigate in temperate areas. Other characteristics like rainfall are not stable. Precipitation in the Rio Tempisque area amounts to 2.5-3 meters/year but this comes in pulses so that the aquatic life must deal conversely with flooding conditions and low flow during the year. Tied to this, the terrestrial vegetation is partly deciduous during the dry seasons, therefore varying the amount of leaf input, and the aquatic "vegetation", the periphyton, increases during stable flow periods. Because of the stable temperature and photoperiod, much of the initial research has focused on development times and life histories of the aquatic insects, using this as a base to examine other questions in population dynamics and secondary production. To achieve this, the Stroud Center researchers have relied on laboratory rearings (in controlled circumstances) of cohorts from individual egg masses and now have data for over 90 species in all major aquatic insect groups. Although this is a remarkable effort, the number of species reared doesn't come close to the over 300 species already found in the Rio Tempisque, many of these undescribed! Consequently, along with the rearing, the ecologists at the Stroud Center have had to form partnerships with systematists in the various groups to get their material identified and characterized.

Developmental times varied greatly among the stream insects, from 1-2 months for many chironomids, 3 months for some mayflies and caddisflies and over six months for certain stoneflies. A major explanation of the variability in development times is related to ultimate size of the insect. This basic knowledge of development times impacts directly on questions regarding disturbance. For example, the research has found that recoveries in numbers of insects following severe spates occurs in 3-4 weeks, yet the rearings indicate that life cycles are much longer; population recovery must occur in part from movement from refugia within the stream.

There were several entomological observations made at this early spring meeting. Howard Boyd discussed his finding in mid-March of two additional nesting aggregations of the bee *Colletes thoracicus* in Wharton State Forest, New Jersey. The newly discovered aggregations contained 200 and 350 burrows respectively in soft sand, with the aggregation discovered in 1992 also still active. Dale Schweitzer reported that increased butterfly activity has heralded the arrival of spring in southern New Jersey, including abundant orange sulfurs on March 12, and sighting six or more species of butterflies in each of the nine days leading up to this meeting. Indoor entomological pursuits were also discussed. Susan Whitney urged all to take advantage of the wonderful resources available through the computer via the World Wide Web, with entomological web sites popping up everywhere. Tommy Allen discussed collecting apterygotes locally, and noted that the apterygote collection at the University of Delaware has grown to over 10,000 slides in less than 4 years. There were 21 members and visitors at the meeting at the University of Delaware.

Jon Gelhaus,  
Vice President

**SOCIETY MEETING OF APRIL 26, 1995****BUTTERFLIES AT VALLEY FORGE NATIONAL PARK**

**Jane Ruffin  
Rosemont, PA**

Protected "natural" environments are not static, but subject to many changes, including from weather, human impact, disease and pests, and natural succession. Along with the present forces, we often forget that these same areas may have faced great impacts in the past, particularly when the evidence of these past forces is gone or concealed by the present landscape. This combination of present and past uses of the land, in light of a survey of butterfly biodiversity, was presented in a wonderful, beautifully illustrated talk by Jane Ruffin to the Society membership at the last meeting of the 1994-1995 schedule. Ms. Ruffin is an amateur lepidopterist and widely published nature photographer, who has authored the recent "Where are the Butterfly Gardens?" (available from The Lepidopterist Society).

Valley Forge National Historical Park comprises about 3500 acres set along the Schuylkill River at the edge of Philadelphia, with a topography of valleys to low hills between 100-500 ft. in elevation. Although many historical buildings are in evidence, much of the land is vegetated, with a mixture of woodland, park, rough lawn and managed meadow, and diverse wetlands such as the Schuylkill, Valley Creek, marshes and springs. Jane started her survey of the butterfly fauna last year, following the completion by botanists of a comprehensive vegetation survey. Jane spoke about the past uses of the land, and as anyone could guess from realizing George Washington's troops were encamped here, the uses predate the Revolutionary War period. Industries included the forges which gave the area its name, extensive wood cutting, a rock quarry, small gauge railroad, a root beer company, and farming. Land use is changing within the park even today, as the foresight of park stewards have converted many of the 1100 acres in rough lawn to wildflower meadows. Recent suburban development encircling the park has brought challenges including high deer populations, and great numbers of walkers, joggers, bicyclists and horse riders. The deer are a real concern, as they are eating nearly all of the understory vegetation in the woodlands, with subsequent decline in diversity of the plants and the animals they support.

But the butterflies took center stage in this talk and in the photographic slides. In the beginning of the second year of the survey, Jane has already enumerated 50 species, from the earliest species, the spring azure, many common species such as viceroys and buckeyes to the rarely seen striped and hickory hairstreaks. The meadow conversion has been a boon to the butterflies and other insects, increasing numbers and diversity by providing nectar and breeding resources. Another favorite place is a vernal pond created about 12 years ago by removing old coal dust from along the river, and which last year supported an abundant population of the damselfly *Lestes rectangularis*, along with diverse flowers and butterflies. Skippers proved a large part of the park fauna, with 20 species found already including several duskywing species. A wonderful slide which amazed the crowd showed an enormous tiger swallowtail captured by a very small crab spider on goldenrod.

Along with the presentation of the Calvert Award, there were some items of entomological interest, several even relating to the insect topic of the evening. The Academy of Natural Sciences' exhibit, *Butterflies Live & In Color!*, was open for viewing by the membership before the meeting. Esteban Gutierrez, a visiting cockroach specialist from Havana, Cuba was introduced to the audience. Jon Gelhaus noted that Dan Otte and Tommy Allen were off collecting in southern Africa, Otte after Orthoptera, Allen after apterygotes. Harold White noted that falcate orange tip butterflies were common this year, and Dale Schweitzer noted the same for henry's elfin; Schweitzer also noted that the orange tip can remain as pupae through an unfavorable year. Howard Boyd showed slides of scarab larvae and pupal chambers which he collected in shredded wood and decaying leaves of a squirrel nesting box hung on a tree. He asked for help on tips for rearing the larvae successfully, particularly the pre-pupal larvae in the brown, egg-like pupal chambers. Nearly 50 members and visitors were present.

Jon Gelhaus,  
Vice President

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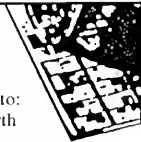
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