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# ENTOMOLOGICAL NEWS

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# AN ANNOTATED, ANALYTICAL BIBLIOGRAPHY OF "MONSTROUS" CICINDELINAE BEETLES, AND SOME PROBLEMS THEY AWAKEN<sup>1</sup>

Kenneth W. Cooper<sup>2</sup>

**ABSTRACT:** Brief introduction is given to monstrous beetles, with comment on the value of their exact analysis. All published accounts of such tiger beetles found (1849 - present) are cited, annotated, and their anomalies indexed. The 42 individuals recorded include 13 with branched appendages; of the 10 analyzable, only one (leg triplication) was sufficiently well presented to permit determination of secondary symmetries. It conforms to "Bateson's rules". Those specimens are listed for which re-analysis is desirable, along with problems some awaken.

At first thought, it seems astonishing that about 73% of some 690 natural occurrences of "monstrous" beetles having malformed, branched appendages known to Balazuc (1947) should be representatives of but four of the 140 or more families of beetles. The four are: Carabidae, including Cicindelinae, (ca. 42%), Scarabaeidae *s.l.* plus Lucanidae (ca. 16%), and Cerambycidae (ca. 15%). However, it is likely that the responsible causal developmental mishaps, or (the less likely) regenerative responses to injury, befall all kinds of beetles with fairly similar frequencies. The pronounced bias reflected by members of the four families probably owes chiefly to their being favorites among collectors, hence they are especially sought, collected, kept in large series, and closely examined by many for notable variations.

Cicindelinae, too, are much admired, fervently collected, and even enjoy the distinction of a journal devoted solely to their kind. It therefore seems surprising that tiger beetles have provided comparatively few published records of individuals with abnormal branching appendages (compared with the Carabinae, for example). Perhaps the hyperactive adults of so many tiger beetle species lead to speedy culling of monstrous adult forms from their populations. If so, those collected present but a fraction of the frequency of those in the population that entered adult life with branched appendages.

I have had cause to search for published, analytical accounts of cicindelids with branched appendages in connection with a study (in MS) of a specimen of *Cicindela scutellaris lecontei* (Hald.). This female has a trifurcated left antenna as well as a branched left mandible; all else seems normal. No cicindelid appears to have been recorded with a similarly

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anomalous mandible. Indeed duplications of mandibles are among the rarest of anomalies reported among beetles; only 8 cases of possible or actual mandibular furcation have been described or mentioned. That apparent rarity may owe to the facts that mandibles are essential to predation and feeding, and are structural units, whereas other appendages ordinarily have 2 or more parts (palps) and as many as 11 (antennae), or rarely more. Hence other appendages have from a few to many more elements that potentially may give rise to branches. None, when branched, is so likely to be as great a threat to life as is a non-functional mandible.

I have searched for published cases of monstrous cicindelids by scanning titles in Derksen and Scheidung-Göllner (1963 - 1968, references from 1864 through 1900) and Zoological Record (from 1900 to June 1990), as well as references in Bateson (1894) and Balazuc (1947, 1969). Regrettably the titles of a large majority of reports on monstrous beetles give no clue to the taxa treated. As the total potentially relevant publications on monstrous beetles exceeds 1000, I was unable to review a majority of them. Accordingly I obtained and scanned or read articles by well-known workers on cicindelids whether or not their titles seemed promising (e.g., those of Walther Horn), those explicitly indicating a cicindelid anomaly, and those longer works dealing with a variety of teratological cases. Occasionally the latter provided a relevant case (e.g., Mocquerys 1860; Cockayne 1938).

There is very likely a fair number of described anomalies of tiger beetles, the obscure references to which are unknown to me. I give below an annotated listing of the accounts of all cicindelid anomalies I have found and read (other than the numerous accounts of peculiar maculations, and trivial reports of mismatched and incompletely expanded or matured elytra). It is hoped that items known to others, but missing from the annotated list and index, will be brought to my attention or published in *Cicindela* so that ultimately there will be available a complete bibliography, or nearly so, of teratological tiger beetles.

The importance of detailed accounts, supplemented by reliable illustrations, especially of duplicated and reduplicated appendages and their parts is that they provide information, and some boundary conditions, of the naturally occurring outcomes of developmental errors and processes. Currently workers in molecular biology are making very considerable advances in the possible explanation of developmental duplications by experiments (mostly in chick, mouse and salamanders), by biochemical analyses, and by *ad hoc* theory (e.g. see: Meinert in Kay and Smith 1989; Brockes 1990; Noji *et al.* 1991; Wanek *et al.* 1991). The theoretical interpretations of course must prove adequate to explain what is found in nature if they are to be widely applicable. It must be emphasized that many

naturally occurring cases on record far exceed in complexity the duplications so far produced by experimentation.

Bateson (1894) made a very thorough morphological study of duplicate and reduplicate anomalies of appendages in both vertebrates and invertebrates. He defined as "*primary symmetries*" those shown by corresponding appendages from the two sides of a bilateral organism; e.g., the arms of a man, or the 2 prothoracic legs of an insect, which are related to one-another as symmetrical mirror-images. To coleopterists, among his notable contributions was the demonstration that, as with many other kinds of organisms, only a minority of *carefully* analysed cases among beetles with branched appendages fail to show "*secondary symmetries*". For example: if a leg of a beetle bears an extra femur and tarsus, and the orientations of the morphologically dorsal, ventral, anterior and posterior surfaces of each element of the leg has been determined, then the duplicated parts are almost always found to exhibit secondary symmetries; that is, they are mirror-images (but not necessarily dimensionally so) of the corresponding parts of the leg from which they arise, and therefore are similar to those parts of the corresponding leg on the opposite side of the body. He also showed that reduplicated (trifurcated) appendages are fairly common anomalies, and that in them all three of the branches tend to lie in the same plane when each element is fully extended along its main axis. In trifurcations, the parts of the middle member are mirror-images of the corresponding parts of both the limb from which it and its system member arose, as well as of those of its sister branch. If the asymmetrical letter F is used to denote the symmetry of antennal parts, and the parts of the branches of an antenna be indicated as 0 (the original length) from which the sister branches 1 and 2 arise together, then the case just described may be represented as:  $F_{0,1}\overline{F}, F_2$ , or  $F_{2,1}\overline{F}, F_0$  (depending on the orientation of the primary length of branch 0).

Genuine exceptions to these rules have been found, but they are too few to have given rise to alternative or additional "rules". They may possibly form a sizable, but lesser class, for there are now very large numbers (1000 or more) of published, relevant cases among insects, which are unresolvable pro or con because the original descriptions and their illustrations are inadequate for a decisive analysis of their morphology. Regrettably this is also so for all but one of the relatively small number of described duplicate and reduplicate appendages of tiger beetles. It is desirable that henceforth adequate analyses and illustrations be required for all descriptions of teratologies. If the original specimens on which accounts were based are still available for study, careful analysis of most of them is to be desired. Some cases may defy resolution because of inadequate morphological landmarks, but they too should be



thoroughly analyzed so that this may be known to be so (as Bateson and Cockayne have so carefully done for certain cases). Means for drawing up suitable descriptions are given by Bateson (1894) and Balazuc (1947); Cockayne's notes and analyses (1925-1938, 1943) on specimens of monstrous beetles may serve as easily available, useful models.

### Annotated bibliography of "monstrous" cicindelids.

Specific names and their authors are those given in the texts. Other than Horn's (1938) recording of an artefactual chimaera, references are limited to those describing naturally occurring developmental, regulatory, or possibly regenerative errors that occurred in stages prior to completion of pupation. Structures apart from those discussed are said or assumed to be normal. Simple deformations caused by mechanical damage to the pupa or still teneral adult, as described by Antoine (1913), are omitted. Horn (1927) has stated under what circumstances departures from the normal range of maculation are worthy of record, and he supplied nearly 40 examples he judged to be such; no other references to peculiarities of markings are cited, nor do the common occurrences of unduly shortened or mismatched elytral lengths since Shelford (1915) and Horn (1927) provide sufficient records. The bibliography is arranged in chronological order; most of the individual cases of anomalies are numbered.

Guérin-Méneville, F.E. 1849. Cicindéletes de la Guinée Portugaise, découvertes par M. Bocandé, avec des notes de ce voyageur et la description des espèces nouvelles. *Rev. mag. Zool.* (2 serie) 1: 76-84, 138-150.

1. *C. anthracina* (p. 82), ♂: L(ef)t mesoleg developmentally atrophied; consists of coxa, trochanter, and a small rounded stump of femur.

Mocquerys, S. 1860. *Recueil de coléoptères anormaux*. No. 4, 16 printed pp (not numbered), ill. Published by author; Rouen. [Republished by la Société des Amis des Science naturelles de Rouen, with an introduction by J. Bourgeois: 1880. *Coléoptères anormaux* par Feu M. S. Mocquerys, Rouen; xvi + 142 pp, 125 figs.]

2. *Cicindela campestris* (Fab.) (1860, 9th unnumbered page with fig.; 1880 reference, p. 88, fig.; here species attributed to "Lin." by editor), ♂ (sexed from figure): R(ight) antenna 7 articles, with a spherical tubercle at the anterior apices of articles 4-6, and apically on 7.

Gadeau de Kerville, H. 1886. [Cinque coléoptères du genre mélomélie]. *Ann. Soc. ent. France* (ser. 6) 6, Bull. Séances: CLXXIX.

3. *C. decemguttata* Fabr. v. *durvillei* Dej., ♂: R antenna slightly longer than L; article-8 doubled, with the anterior branch having normal articles 9-11, posterior branch with 2 articles together equal in length to normal articles 9-11. Horn's (1908, p 19) citation is erroneous.
- Gadeau de Kerville, H. 1888. Coléoptères et hémiptères anormaux. *ibid.* 8, Bull. Séances: LXXXII-LXXXIV.
4. *Cicindela sylvatica* L., ♀: R antenna slightly shorter than L; article-3 bifurcate, bearing the remainder of the primary antenna and supplementary article. Bateson (1894, p 550) saw the specimen and classed it as either "partially amorphous or mutilated". Horn's (1908, p 19) citation is erroneous.
- Smith, J.D. 1888. An abnormal *Cicindela*. Proc. Entomol. Soc. Wash. 1:107.
5. *Cicindela belfragei*, ? sex: a sharp tubercle on left side of "thorax".
- Lopez, C. 1891. A proposito di alcune Coleotteri anormale. Riv. ital. Sci. nat. e Boll. Naturalista, Siena. 11: 22-26.
6. *Cicindela sylvicola* Dejean, ? sex: L antenna bifurcate at 8th article; anterior branch but a single article; posterior branch with 3 normal articles.
7. *Cicindela sylvatica* L., ? sex: ? R or L antenna (analogous to Mocquerys' specimen, see #2 above): with 7 articles, and with 4 spherical tubercles as described by Mocquerys; antenna shortened beyond 3rd article; article-4 very short, bent on self, concave above, and much swollen. Both of Lopez' specimens are listed by Cockayne (1938, p 392) as among those beetles with furcate antennae of which the symmetry "...is not clear". It is doubtful that Mocquerys' specimen of *C. campestris* and Lopez' of *C. sylvatica* have furcate antenna. I concur that the symmetry relations (if any) of both cases 2 and 7 are unclear; the specimens need restudy.
- Balbi, E. 1897. Difformitates et monstrositates coleopterorum. Naturalista Siciliano 2: 150-159, 2 pls.
8. *Cicindela campestris* L., p 152, figs 1 and 1(@2x), ? sex: L mandible with a long, slender, gently inwardly curved, pointed prolongation, arising laterally near midlength, which is white, with pearly reflections (a failure to tan and color normally like the remainder of the mandible?).
9. *Cicindela campestris* L., p 152, figs 2 and 2(@2x), ? sex: R and L antenna 11-jointed, of normal lengths but with deformed articles. R antenna has articles 1-4 distinct, article-5 as long as the first 4 to-

gether, remaining articles shortened. L antenna has the 1st article as long as normal segments 1-5 joined; remaining articles shortened. fig. 1(@2x) and text in part difficult to reconcile.

Horn, W. 1905. Systematischer Index der Cicindeliden. Deutsche Entomol. Ztschr 1905; Beilage, 56 pp.

10. *Therates rugifer* Horn, holotype, p 11, ♀: a valid species, but rugulose sculpturing of head and prothorax "...in typo monstrosa!" [Horn 1902. Neue Cicindeliden gesammelt von Fruhstorfer in Tonkin 1900. Deutsche Entomol. Ztschr. 1902: 65-75 --- also mentions a marked deepening of the juxta-sutural engraving of the elytra, a blister on left elytron.] See also comments on pp 475-476, and fig. 36, in Horn 1927 (below).

Moore, R. 1906. Notes on the habits of *Cicindela*. Entomol. News 17: 338-343.

11. *Cicindela purpurea*, ? sex: ankylosis of the elytra.

Codina, A. 1908. Noticia sobre una monstruositat que 's trova en el palpe esquerra d'una female *Cicindela paludosa* var. *sabulicola* Waltl. Institut. Catalana d'Hist. Nat. 5: 74-76, 1 fig.

12. *Cicindela paludosa* var. *sabulicola* Waltl., ♀: L antenna trifurcate, article-6 shortened, apically widened, 7th still wider apically, with 2 articular facets, from the inner of which extends 4 normal articles completing the apex of the normal (original) antenna; a bifurcate, "U"-shaped article-8, attaches to the outer facet of 7; from each limb of 8 there extends a length of 3 articles; each accessory limb shorter than normal, the outermost shortest.

Köster, W. 1910. Monströse Fühlerbildung. Entomol. Blätt. Biol. System. Käfer. 6: 245.

13. *Cicindela germanica* L. abb. *coerulea* Hrbst, ♀: L antenna with only 5 regular articles present; a 4-article limb given off below from the apically 2-facetted article-3, terminal article of 2nd limb is bowed dorsally.

Shelford, V. 1915. Abnormalities and regeneration in *Cicindela*. Ann. Entomol. Soc. Amer. 8: 291-295, pl. 24.

14. *Cicindela tranquebarica*, fig. 1, ? sex: deformed labrum.

14a. *Cicindela tranquebarica*, Fig. 5, ? sex: R elytron shorter.

15. *Cicindela sexguttata*, fig. 4, ? sex: L elytron shorter.

- Campos, F. 1918. Algunos casos teratologicos observados en los Artropodos. *Ann. Ent. Soc. Amer.* 11: 97-98.
16. *Tetracha suturalis* Horn, ? sex: L middle leg with apparently 6-jointed tarsus; perhaps derived by a fracture and healing of article-3.
- Luigioni, P. 1926. Coleotteri anomali. Sopre due casi di polimelia riscontrati in due individui di "*Cicindela germanica*" Lin. *Pontifica Acad. Sci., Rome, Atti* 79: 81-86, 2 figs.
17. *Cicindela germanica* Lin., 1 fig., ? sex: R fore tibia with 3 tarsi of 5 articles each; apex of tibia angulate, spatulate posteriorly beyond normal apex. The normal tarsus arises from the not-angulate apex, the 2 accessory tarsi from the broadened angulation.
- \*18. *Cicindela germanica* Lin., 1 fig., ? sex: L mid-leg trifurcate, all from same coxa; the anterior 2 sister legs, each with its own trochanter, arise as though from a bifurcated base; both smaller than normal, anterior the larger; posterior leg normal. All appear to have arisen in same plane. The middle leg is the mirror image of both the anterior and posterior (normal) legs --- case conforms to Bateson's rules.
- Horn, W. 1927. Ueber "Monstrositäten" and verwandte Vorgänge bei Cicindelinen, Teil I. II. Wanderversammlung Deutscher Entomologen in Stettin. *Entomolog. Mitt.* 16: 471-477, 48 figs. [No additional parts appear to have been published.]
19. *C. aurlenta* subsp. *setosomalaris* Horn, fig. and case 34, ? sex: antenna (? side) of 4 articles, article-4 strongly flattened, distally broadened, bisinuate apically. [Horn also gives 3 cases of abnormal antennae (doubtfully natural) in two *Pogonostoma coeruleum* G. Lap. and one *P. chalybeum* Klug but he comments that these may be due to deformations caused in packing somewhat teneral individuals; see cases and figures 52-54.]
20. *Tricondyla cyanea* subsp. *brunnea* Dokht., fig. and case 33, ? sex: anterior rim of pronotum deeply, slightly asymmetrically, marginate — appearing as 2 separate, prominent lobes.
21. *Collyris levigata* Horn, fig. and case 49, ? sex: shortened and strongly, transversely crimped pronotum.
22. *C. campestris* L., fig. and case 51, ♀: foretarsus (? side) strongly shortened, 4 articles, 3rd bifurcate, with a reduced claw-bearing segment arising from lateral fork of article-3.
23. *C. japana* Mtsch., fig. and case 1, ? sex: L elytron shortened. There are other cases in other species of R or L elytra shortened, ? sexes: see figs. 11, R; 14, L; 16, R; 17, R; 18, R; 22, L; 39, L.
24. *C. striolata* Ill., fig. and case 2, ? sex: both elytra symmetrically shortened.

- Cockayne, E.A. 1938. Supernumerary antennae in insects. Trans. Roy. Entomol. Soc. London. 87: 385-396, 1 pl.
25. *Cicindela 10-guttata* Fabr., p 391, figs. 4, 4A, ? sex: R antenna normal for first six segments; seventh has two joints at distal end; from the outer arises a branch with four segments a little shorter than normal, otherwise well-formed; from the inner arises another branch of four segments. The first of these very broad, short, thick; the second also shorter, thicker than a normal ninth segment, so this may be a fused double structure. [The words are Cockayne's, but the description has been abbreviated. He classified the specimen as having "Antennae with two extra parts, the symmetry of which is not clear" (p 390).]
- Horn, W. 1938. 2000 Zeichnungen von Cicindelinae. Entomol. Beihefte, Berlin-Dahlem 5: 71 pp, 90 pls.  
*C. dohrni* Dokht., p 11. The holotype has been lost. Very probably an artefact; pronotum and elytra are from *C. macrocnema obliquans* Chaud.; head from a common type with dense, short setation of the genae and above. (Not included in numerical sequence because specimen probably a hoax.)
- Wood, G.R. 1965. A trifurcate tiger beetle antenna (Coleoptera: Cicindelidae). Jour. Kansas Entomol. Soc. 38: 392-394, 2 figs.
26. *Cicindela scutellaris lecontei* (Hald.); ? sex: R antenna trifurcate at apically V-shaped article-9; from each limb of 9 extends a branch of 2 articles; a single, incompletely divided article extends between the arms of the V. All 3 branches appear to lie in the horizontal plane; the anterior of these terminated the "normal" portion of the antenna.
- Willis, H.L. 1967. Bionomics and zoogeography of tiger beetles of saline habitats in the central United States (Coleoptera: Cicindelidae). Univ. Kansas Sci. Bull. 47: 145-313, 168 figs.
27. *Cicindela nevadica knausi*, p 205, figs 85, 86, ♂: L antenna incompletely trifurcated; partially bifurcate at apical fourth of article-3, hence with 2 apical articular facets bearing (? above) a limb of 8 individual articles, and (? below) a longer limb in which articles-7 and -8 of that limb are incompletely marked off, and doubled, but not separated lengthwise. In this respect, the antenna differs from most trifurcate antennae in which the 2 accessory branches arise from a common element — see cases 12, 26, and those in Bateson (1894), Balazuc (1947, 1969), and Cockayne (1938).  
[Willis 1969. Unusual antennal deformity in *Cicindela nevadica*. *Cicindela* 1: 1, and cover photo, again touches on this specimen.]
28. *C. nevadica knausi*, p 205, fig. 82, ♂: labrum deformed, L side.

29. *C. nevadica nevadica*, p 205, fig. 81, ♂: labrum deformed, L side.  
 30. *Cicindela nevadica knausi*, p 205, Fig. 84, ♀: 4 holes, from small to very large, in R elytron; 30a. — another minor case in subspecies *olmosa* (p 205, fig. 83, female: R elytron).

Larochelle, A. 1974. Unusual antennal deformity in *Cicindela punctulata* Olivier. *Cicindela* 6: 69-70, 1 fig.

31. *Cicindela punctulata* Olivier, ♂: L antenna presumably with representation of only 10 articles; article-6 bifurcate posteriorly in basal half, but without any attached, segmented ramus.

### Summary and Index of Anomalies

The annotated citations give access to reported natural occurrences of structurally anomalous cicindelids. Represented are 23 species, and 6 genera of which 18 are species of *Cicindela*. In all, there are some 42 individual cases among the 31 numbered listings.

Representing each case by its number in the list, its sex (where stated), the side involved (when given), and by placing that set of 3 ordered items in parentheses if falling in more than one category of anomaly [as examples: 1 ♂ L; 5 ♀ L; 22 ♀ ?; and (13 ♀ L)]; all of the individuals may be categorized as follows.

#### A. Branched or multiple appendages (*Schizomelics*)

1. antenna bifurcate: 3 ♂ R; 6 ♀ L; (13 ♀ L); 31 ♂ L.
2. antennae trifurcate: 4 ♀ L; 12 ♀ L; 25 ♀ R; 26 ♀ R; 27 ♂ L.
3. mandible: 8 ♀ L (a neomorph?).
4. legs triplicate: 18 ♀ L.
5. tarsi duplicate: (22 ♀ ?).
6. tarsi triplicate: 17 ♀ R.

#### B. Malformations

7. antenna: 2 ♂ R; 7 ♀ ?; 9 ♀ R + 9 ♀ L; (13 ♀ L); 19 ♀ ?.
8. labrum: 14 ♀ RL; 28 ♂ L; 29 ♂ L.
9. pronotum: 5 ♀ L; 20 ♀ -; 21 ♀ -.
10. elytron short: 14a ♀ R; 15 ♀ L; 23 ♀ L [+ 7 cases listed under 23, of which 4R, 3L and ? sex for all].
11. elytra, both short: 24 ♀ -.
12. elytra ankylosed: 11 ♀ -.
13. elytra with holes: 30 ♀ R; 30a ♀ R.
14. leg: 1 ♂ L.
15. tarsus, extra joint: 16 ♀ L.
16. tarsus missing joint: (22 ♀ ?).
17. sculpture: 10 ♀ -.



## COMMENTARY

None of the above categories is unique to cicindelids; see Balazuc (1947, 1969) for many examples among other beetles.

Of the 13 cases of abnormally branched and multiple appendages, the description and illustration of only one (# 18) permits a decision regarding the symmetry relations among its parts. They are, in anterior to posterior order,  $F_2, 1\bar{F}, F_0$ , hence in accord with Bateson's rules (see p 3).

If available for restudy, cases 3, 6, 12, 26 and 27 (antennae) deserve careful analysis of the symmetries of their branches. Case 27 is of special importance, for it possesses two points of incipient branching, namely at articles -3 and -9 of the probably original antenna; two such widely separated branch points are remarkable. It is important that the secondary symmetries (if any) be determined and placed on record. Cases 4 and 25 have been declared unresolvable as mentioned in the annotations, and this is probably so for case 13 as well.

The supernumerary tarsi of case 17 should offer no difficulty for a determination of their symmetries; that of case 22 is very likely to prove unanalyzable.

Cases 2 and 7 deserve restudy on their own merits, and also because Cockayne (1938) placed case 2 on his list of beetles with *furcated* antennae. The "spherical tubercles" present at the apical ends of the terminal four articles may in fact prove to represent aborted remnants of the 4 missing articles of the 2 aberrant antennae; or perhaps they can be proven to be true branches (unlikely, however, for the small terminal tubercle). No anomalous branching of an order higher than trifurcation, involving at most 2 branch points from the original axis is known to me for appendages of insects. In any case, these anomalies complicate the problem of antennal development in the pupal beetle.

Finally, Balbi's extraordinary specimens (cases 8 and 9) could profitably be restudied; the mandible is apparently but uncertainly anomalous in ways that none of the small number of known furcate mandibles are. Furthermore, the apparent maintenance of normal antennal lengths by differential shortening when a single (but different) joint in each antenna is exceptionally long awakens a puzzling problem in regulation during differentiation.

The summaries for cases of schizomely and malformation, and the two taken collectively, show no statistical tendency for the right or left side to be affected more frequently.

It is hoped that in future the sex of a specimen having a structural anomaly will always be given. Of the forty specimens mentioned in the annotations, only 14 are of stated sex (7  $\sigma\sigma$ , 7  $\text{♀♀}$ ). It is not likely that most anomalies fall unequally upon the two sexes but, if any do, how can it become known unless the sexes of all specimens, or nearly all, are stated?

## ACKNOWLEDGMENTS

I warmly thank E. Gorton Linsley and Howard P. Boyd for their helpful comments on the manuscript, and my colleague, John Pinto for help with the translation of Lopez (1891) and for his attempt to locate the Balbi specimens on my behalf.\*

This survey and analysis would not have been possible without the skillful, resourceful and energetic help so cheerfully given by Sandra Eberhard in charge of inter-library loans for the U.C.R. Bio-Ag Library; it is a pleasure to acknowledge all that she has done on my behalf in this and earlier undertakings.

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\*Prof. Pinto received the following information from Dr. Marco Bologna, of the Università degli Studi dell'Aquila, who, for his own needs had already searched for the Balbi collection. It is not at the museum in Genoa, where Balbi lived, nor has it been traced to any other Italian museum. It is presumed destroyed.

## A NEW GENUS AND SPECIES OF IASSINAE (HOMOPTERA: CICADELLIDAE) FROM BRAZIL<sup>1, 2</sup>

H. Derrick Blocker<sup>3</sup> and M.D. Webb<sup>4</sup>

**ABSTRACT:** A unique specimen of leafhopper from the Mato Grosso in Brazil represents a distinct new genus and species of Iassinæ, *Daveyoungana collosa*, probably related to the genus *Scaropsia*. Other possibly closely related New World genera are *Scaroidana* and *Bythonia*.

A unique specimen of leafhopper, recently found in the Natural History Museum in London by the second author, from the Mato Grosso in Brazil, represents a distinct new genus and species of Iassinæ, *Daveyoungana collosa*, probably related to the genus *Scaropsia* Blocker (1979a). Other possibly closely related New World genera are *Scaroidana* Osborn (Blocker, 1979b) and *Bythonia* Oman (Blocker and Webb 1990). The unique shape of the male genital segment is similar to that of the Old World genus *Batracomorphus* Lewis (Knight 1983).

### *Daveyoungana*, new genus

**Type species:** *Daveyoungana collosa*, new species

Color reddish; vertex with pair of fuscous spots located midway between midline and eye; with fuscous pattern on pronotum and scutellum; forewings with brownish tint, veins dark; venter stramineous with reddish tint.

Vertex narrow (Fig. 1), parallel-margined; vertex, pronotum, scutellum, and face transversely striate; face (fig 2) with anteclypeus wide basally, gradually narrowed by 1/2 apically; ocelli on margin of head, not visible dorsally, distant from eye; hind femoral chaetotaxy 2-2-1, basal seta reduced in size; forewings (Fig. 3) of uniform texture, sparsely set with inconspicuous microsetae, vein separating appendix and first apical cell complete, with three basally closed anteapical cells, appendix broad, hind wing with R and M veins fused apically; fore tibia rounded dorsally.

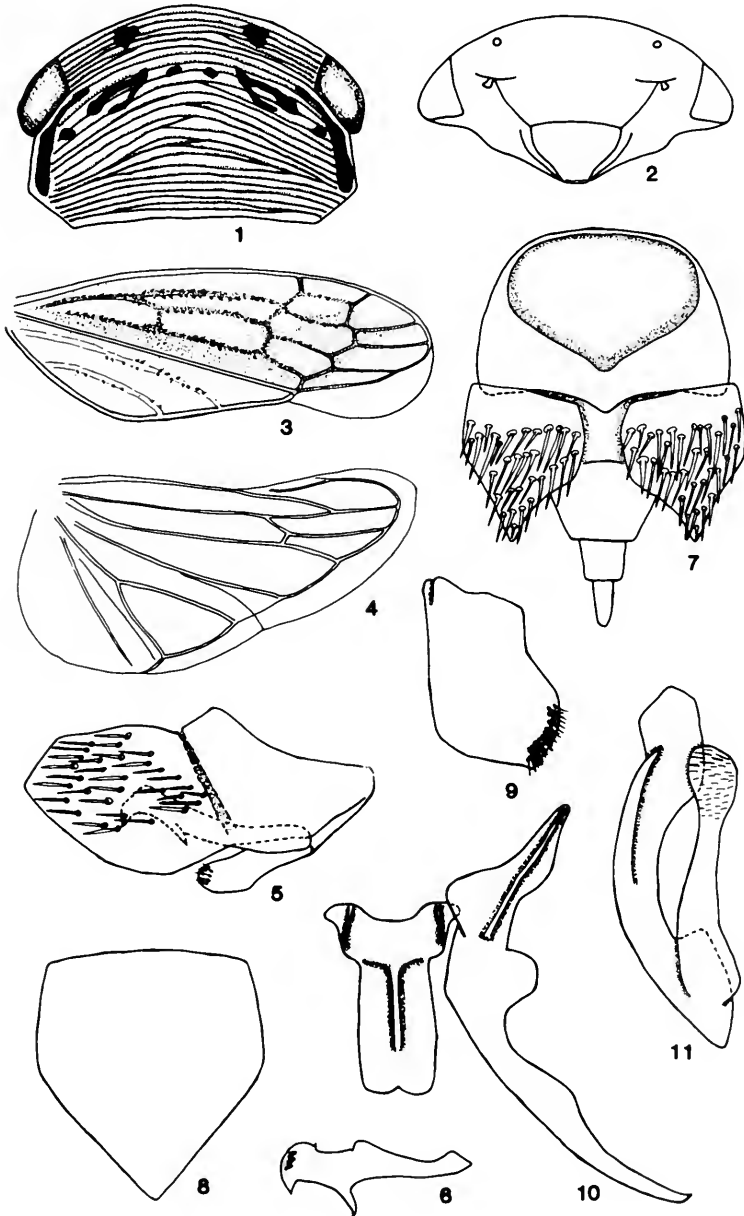
Pygofer, laterally, with a fracture at anterior 1/3 (Fig. 5) and an internal process (Fig. 6) that is caliper-shaped apically, caudal lobe of pygofer heavily setose, separated from its counterpart dorsally (Fig. 7), anterior 1/4 jointed by a sclerotized band; abdominal sternum VII (Fig. 8) with triangular posterior margin concealing the anterior portion of the pygofer.

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Figs. 1-11. *Daveyoungana collosa*: 1, vertex and pronotum, dorsal view; 2, face, anteroventral view; 3, forewing, dorsal view; 4, hind wing, dorsal view; 5, pygofer and plate, lateral view; 6, pygofer process, lateral view; 7, genital segment, dorsal view; 8, abdominal sternum VII, ventral view; 9, plate, ventral view; 10, connective and style, broad (dorsal) aspect; 11, aedeagus, lateral view.

*Daveyoungana* is probably most closely related to the New World genus *Scaropsia* (known only from a female specimen), on the basis of a pair of fuscous spots on the vertex, but can be easily distinguished by the head being wider than the pronotum. In addition to the spots on the vertex, it can be separated from *Scaroidana* and *Bythonia* by the rounded rather than scored dorsal surface of the fore tibia, broad appendix of the forewing, triangular posterior margin of the male pregenital sternum, apically fused R and M veins of the hindwing, and shorter and broader pygofer plates and from *Bythonia* by the shape and origin of the pygofer process. The separation of the caudal lobe of the pygofers of the genital chamber in *Daveyoungana* is similar to that in *Batracomorphus* Lewis but is unique to New World Iassinae. We take great pleasure in naming this genus in honor of the late David A. Young, a superlative Homoptera systematist, teacher, and friend.

***Daveyoungana colloso*, new species**  
(Fig. 1-11)

Length of male 6.8 mm; head width 2.4 mm; pronotal width 2.3 mm; interocular width 1.8 mm; vertex length 0.2 mm; pronotal length 1.2 mm. Female unknown.

As generic description with the following additions: Pygofer plates (Fig. 9) narrow, short, curved slightly laterad, with tuft of microsetae on caudolateral margin; style (Fig. 10) elongate, with rounded preapical lobe associated with the pygofer process; connective (Fig. 11) broadly Y-shaped; aedeagus (Fig. 11) elongate, shaft expanded apically, with pair of processes arising before midlength and extending past apical 1/4, acute apically, with pair of lightly sclerotized arms arising from dorsal apodeme extending past midpoint of shaft, expanded apically.

Holotype male, BRAZIL, Mato Grosso, 12° 49' S-51° 45' W, 5 xi 1968 (R. Beaver) gallery forest, U.V. light trap (deposited in The Natural History Museum, London).

*D. colloso* is probably related to *Scaropsia trombida* Blocker. See discussion of the genus.

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## NOTES ON *BRIARAXIS DEPRESSA* (COLEOPTERA: PSELAPHIDAE)<sup>1</sup>

Donald S. Chandler<sup>2</sup>

**ABSTRACT:** Discovery of the male of *Briaraxis depressa* prompted this redescription of the genus and species. It is known only from the Dry Tortugas, west of the Florida keys.

When returning from Cuba in 1894, H.F. Wickham was forced to spend a week at the yellow fever quarantine station on the Dry Tortugas, a group of small sandy islands 90 km west of Key West. He was able to go ashore for only a few hours a day to collect on Garden Key, which is almost entirely occupied by Fort Jefferson, and collected insects from the small marginal beaches, lamenting the depauperate fauna of the island (Wickham 1895). A pselaphid specimen collected during this enforced visit was sent by Wickham to his friend, Emil Brendel, for identification. Brendel (1894:158) compared this pselaphid to the European *Trichonyx* Chaudoir and the Australian *Briara* Reitter before describing it as a new genus and species, *Briaraxis depressa*. The holotype female of *depressa* has been the only representative of this species known to pselaphid workers for nearly 100 years.

While sorting the miscellaneous Pselaphidae at the National Museum of Natural History, Washington, I was quite surprised to discover a second specimen of this species (a male!) bearing the same label information as the holotype. Apparently Wickham had obtained two specimens, a male and female, and sent only the female to Brendel for his comments. The second specimen was later given to the National Museum as part of the Wickham collection. Discovery of the male has prompted me to redescribe the genus and species, since there have been some misinterpretations in discussion of the characters attributed to this taxon.

Brendel (1894) stated that the first visible abdominal tergite lacked basal longitudinal carinae, and that there were four vertexal foveae. This characterization has been used in subsequent treatments by Raffray (1908) and Bowman (1934), and in keys to Nearctic genera by Park (1953) and Chandler (1990). Foveae in Pselaphidae are the visible openings of internal cuticular projections, or may be applied to sharply defined cuticular pits. There is only one pair of foveae on the vertex indicating internal cuticular apodemes, and these are present in almost all Pselaphidae. There are also two small shallow impressions slightly postero-

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medial to the antennal bases (Fig. 1) that may indicate the insertions of the dorsal arms of the tentorium. However, they are not distinct enough to be regarded as foveae in the sense used by all pselaphid workers. Also, the basal longitudinal carinae of the first abdominal tergite are present, but are short and just barely visible extending from beneath the covering elytra.

### *Briaraxis* Brendel

*Briaraxis* Brendel 1894:158. Type species: *Briaraxis depressa* Brendel, by monotypy.

Bowman 1934:82, Park 1953:308 (key), Chandler 1990:1184 (key).

*Briaraxis* Raffray 1908:219, misspelling.

Head broad and flat, with nude vertexal foveae, base medially impressed, eyes distinct, gula with prominent median longitudinal carinate ridge, two gular foveae, 11 antennomeres, apical three forming club; pronotum broadest near apex, lateral margins slightly sinuate near pubescent antebasal foveae, median antebasal fovea nude, with longitudinal sulcus extending anteriorly from median fovea and indistinct nearing pronotal apex, two procoxal foveae; elytra with two basal foveae, discal fovea with faint stria distinct only on mesal margin to about one-third elytral length; mesosternum with lateral mesosternal foveae, median mesosternal fovea slightly offset to right and with internal apodeme directed antero-laterally to right, lateral mesocoxal foveae present, metasternal foveae present; abdomen with first tergite slightly longer than second, with latero-basal foveae, abdominal apex strongly curved so that fourth tergite not visible in dorsal view, tergite I with short divergent basal longitudinal carinae barely visible; sternite II with both medio-basal and latero-basal foveae. The presence of a discal stria on the elytra places this taxon in the subtribe *Brachyglutina* of the tribe *Brachyglutini* (Newton and Chandler 1989).

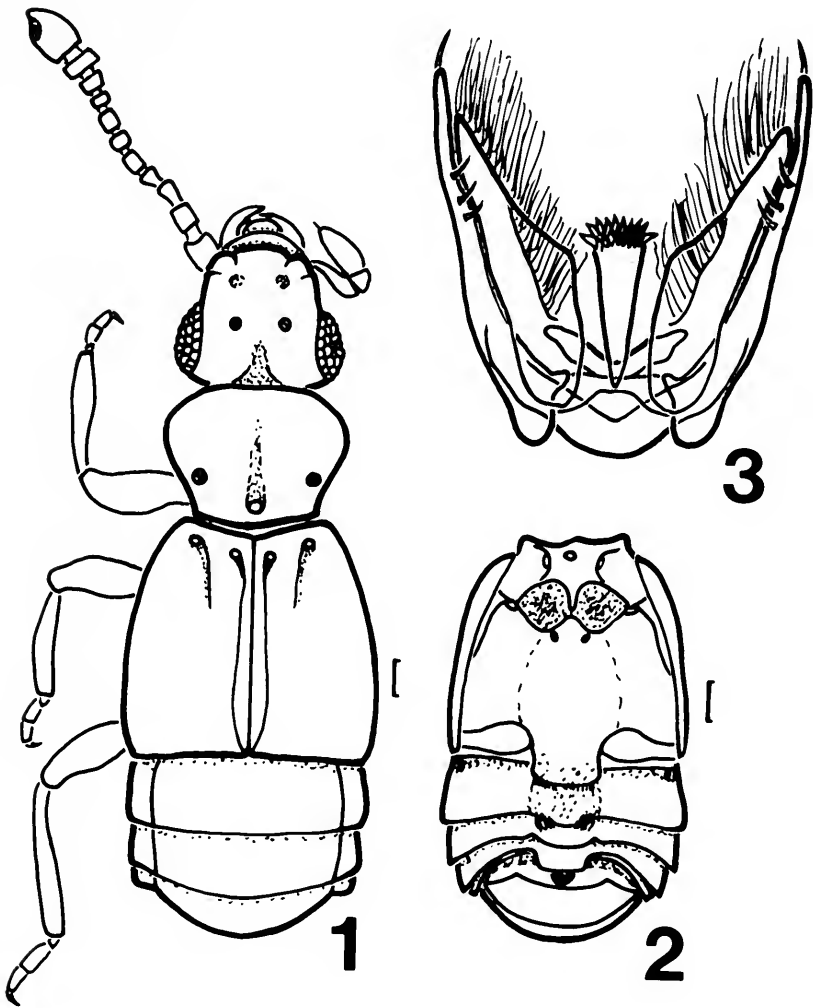
### *Briaraxis depressa* Brendel (Figs. 1-3)

*Briaraxis depressa* Brendel 1894:159, pl. V, fig. 6. Type locality: Garden Key, Dry Tortugas, Florida. Holotype female (ANSP). Bowman 1934:82.

**Male from Garden Key, Dry Tortugas:** length 1.69 mm, head and pronotum lightly and densely punctate, elytra lightly roughened; head with two small impressions postero-medial to antennal bases; metasternum longitudinally impressed, with prominent square metasternal flange projecting posteriorly between metacoxae, apex setate except at middle; sternite II with short rounded lobe at middle, setate at lobe apex except at middle, longitudinally impressed in area posterior to metasternal flange, sternite III with medial lobe set off by lateral incisions, sternite IV with medial rectangular flange projecting posteriorly, tergite V barely visible, tergite V with deep medial circular incision, apex of V depressed anteriorly into abdomen.

**Female holotype** lacking metasternal flange and abdominal modifications.

**Specimens examined, 2:** Holotype female, Garden Key, Dry Tortugas, Florida, VI-7/13, Wickham (ANSP); male, same data with Garden Key written on the underside of the label (USNM).



Figs. 1-3. *Briaraxis depressa*. Scale lines equal 0.1 mm.

1. Dorsal view of male, 2. Ventral view of male mesothorax to abdomen, 3. Dorsal view of aedeagus.

**Comments:** This species is known only from the type locality of the Dry Tortugas, several small low sandy islands west of Key West. Wickham (1895) found this species "under rubbish on the beach." He found the fauna of the Dry Tortugas to be typical of that of southern Florida and the Bahama Islands. However, this species was not recorded in treatments of the Caribbean pselaphid fauna (Park *et al* 1976), or the pselaphids of South Bimini, Bahamas (Park 1954).

#### ACKNOWLEDGMENTS

I would like to thank Gloria N. House, National Museum of Natural History, Washington, D.C. (USNM), for the loan of the specimen, and Don Azuma, Academy of Natural Sciences, Philadelphia (ANSP), for his courtesies when examining the holotype. John F. Burger and R. Marcel Reeves are thanked for reading the manuscript.

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## A PRELIMINARY SURVEY OF THE TRICHOPTERA OF THE OZARK MOUNTAINS, MISSOURI, U.S.A.<sup>1</sup>

Michael L. Mathis<sup>2</sup>, David E. Bowles<sup>3</sup>

**ABSTRACT:** One hundred thirty-three species of caddisflies representing 15 families and 49 genera are reported from the Ozark Mountains of Missouri. Families exhibiting the greatest species richness included the Hydroptilidae (36 spp.), Leptoceridae (26 spp.), and Hydropsychidae (26 spp.). Sixty-four species are reported for the first time from the state.

With regard to its trichopteran fauna, the central region west of the Mississippi River is one of the more poorly-studied areas in the United States. Iowa, Missouri, Nebraska, Oklahoma, and South Dakota lack comprehensive species lists. In an attempt to increase our knowledge about caddisflies inhabiting this region, we initiated studies in mountainous areas of Oklahoma and Missouri. We report here on our results from the Ozark Mountains of Missouri.

The Ozark Mountains are the northernmost range of the Interior Highlands extending southward from the Missouri River into northern Arkansas, westward into Oklahoma, and eastward into Illinois. Within Missouri, the Ozarks can be divided into two physiographic provinces, the Border and the Plateau (Fig. 1) (Thom and Wilson 1980). The Ozark Border extends as a narrow band along the lower Missouri River eastward to the Mississippi River south of St. Louis. The larger Ozark Plateau lies south of the Border region encompassing most of the southern half of the state. Our collections were drawn primarily from the latter province, an area characterized by thin limestone soils and abundant clean streams and large volume springs (Johnson 1987). Agricultural impacts are minimal, primarily consisting of small-scale livestock-rearing operations. Much of the area is incorporated into the Mark Twain National Forest and supports a mixed oak-hickory assemblage not subjected to wholesale clearcutting. The combination of infertile, rugged landscapes not conducive to agriculture, minimal value of forest products, and relatively little urbanization or heavy industry has not encouraged large scale anthropogenic disturbances in this area.

Five states bordering Missouri have comprehensive inventories of their Trichoptera; 153 species are reported from Arkansas (Unzicker *et al.* 1970; Bowles and Mathis 1989), 183 From Illinois (Ross 1944), 104

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from Kansas (Hamilton and Schuster 1978, 1979, 1980; Hamilton *et al.* 1983), 181 from Kentucky (Resh 1975; Phillippi and Schuster 1987), and 298 from Tennessee (Edwards 1966; Etnier and Schuster 1979). During this investigation, 133 species were collected from the Ozark Mountains of Missouri raising the total number of trichopterans reported from the state to 143 species. These results suggest the presence of a rich trichopteran fauna within the state, especially considering that only the Ozark Mountain region has been sampled intensely.

One hundred eight UV-light samples were collected between June 1985 and October 1988. Other locations were sampled by sweep-netting and handpicking of immature stages. Additional records were obtained from the collection of Trichoptera at the Illinois Natural History Survey (INHS) and from published accounts, especially those of Ross (1944) and Gordon (1974). The majority of species determinations were based on male specimens, but females and larvae were used in some instances.

In the species list, the scientific name and citation of taxonomic authorship are followed by numbers corresponding to specific collection sites and by month of collection. In cases where determinations were based on material other than males, the nature of the material is given in parentheses. Specimens representing possible new taxa are designated by the abbreviation "nr." between the genus and specific epithet of their closest relative. The initial report is cited for those species previously reported from the Ozarks of Missouri. Sixty-four new state records are indicated by an asterisk (\*). Voucher specimens are deposited in the University of Arkansas Arthropod Museum, INHS, or collections of the authors. Higher taxonomy is according to Weaver and Morse (1986).

#### COLLECTION SITES

1. Barry Co.; Roaring River State Park; 6 mi S Cassville, Hwy 112; June.
2. Carter Co.; Current River, Ozark National Scenic Riverway (ONSR); Big Spring National Park; 7 mi S Van Buren, Hwy 103; August.
3. Carter Co.; Big Spring, ONSR; Big Spring National Park; 7 mi S Van Buren, Hwy 103; May-August.
4. Christian Co.; Swan Creek; Hwy 125 bridge at Garrison; August.
5. Crawford Co.; Meramec River; Hwy 19 bridge; 1 mi N Steelville; INHS.
6. Crawford Co.; Onondaga Cave spring run; October; INHS.
7. Dent Co.; Crooked Creek (Wilson, 1984).
8. Dent Co.; Current River; Montauk State Park; 23 mi SE Salem, Hwy 119; October.
9. Franklin Co.; Meramec River; 5 mi SW St.Clair, PP Hwy; June.
10. Gasconade Co.; Stony Hill; September; INHS.
11. Iron Co.; Champion Springs; near Annapolis; April; INHS.
12. Iron Co.; Speers Spring; 5 mi N Annapolis, Hwy 49; July; INHS.
13. Iron Co.; Stout's Creek; Royal Gorge near Arcadia; July; INHS.

14. Laclede/Dallas Co.; Bennett Spring; Bennett Spring State Park; 11 mi W Lebanon, Hwy 64; October, November.
15. Laclede/Dallas Co.; Niangua River; Hwy 64 bridge; 12 mi W Lebanon; October.
16. Lawrence Co.; Spring River; Hwy 60 bridge; 2 mi S. Aurora; August, October.
17. McDonald Co.; unnamed spring along Hwy 71; 1 mi NW of Arkansas state line; July.
18. McDonald Co.; Elk River; Mt. Shira Public Fishing Area; 1 mi N Noel, Hwy 59; July.
19. McDonald Co.; Little Sugar Creek; 3 mi S Pineville, Hwy 71; July.
20. Miller Co.; Lake of the Ozarks; Bagnell Dam; May; INHS.
21. Oregon Co.; Eleven Point River; Hwy 19 bridge; 1.5 mi NE Greer; July, September.
22. Oregon Co.; Greer Spring; June; INHS.
23. Ozark Co.; Althea Spring, 8 mi NW Caulfield, H Hwy; August.
24. Ozark Co.; North Fork White River; Patrick Bridge Access; H Hwy, 8 mi NW Caulfield; August.

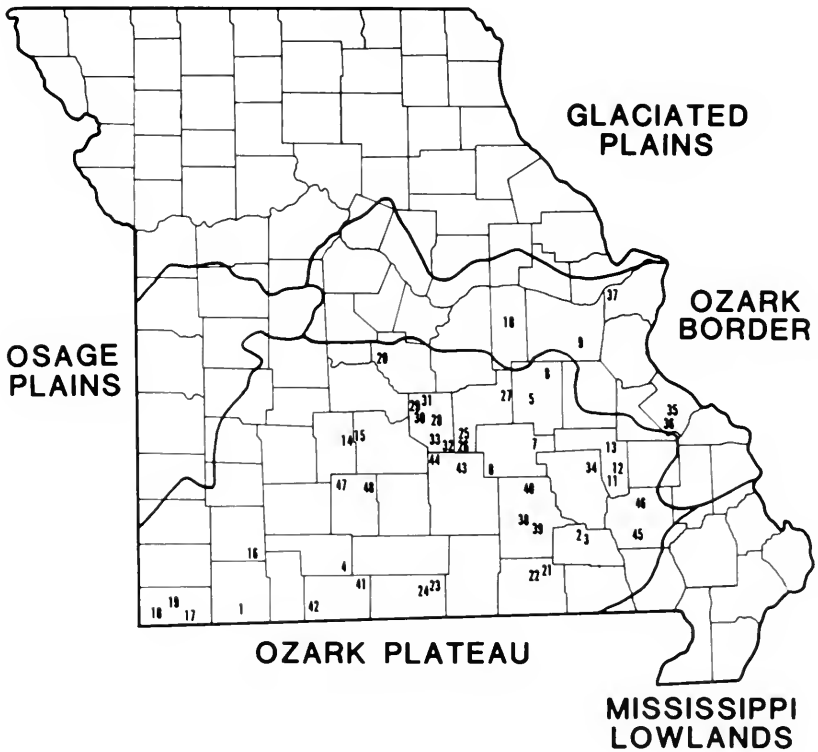


Figure 1. Collection sites and physiographic provinces of Missouri (after Johnson, 1987). Numbers correspond to those provided in text for "Collection Sites."



25. Phelps Co.; Spring Creek; bridge at junction Hwy M and J; 6 mi W Flat; July.
26. Phelps Co.; unnamed spring, tributary of Spring Creek; NW 1/4, NE 1/4, Section 27, T 35 N, R 10 W; October.
27. Phelps Co.; Maramec Spring; 5 mi SE St. James, Hwy 8; October-January.
28. Pulaski Co.; Waynesville Spring; along Roubidoux River in Waynesville, Loop 44; June.
29. Pulaski Co.; Gasconade River; downstream T Hwy bridge; 5 mi SE Swedeborg; March-November.
30. Pulaski Co.; Cave Spring; Wayne Roam farm near Swedeborg; S Road T-740; March-November.
31. Pulaski Co.; unnamed spring; Edith Roan farm near Swedeborg; Road T-740; March-November.
32. Pulaski Co.; Fort Leonard Wood; no specific site; May; INHS.
33. Pulaski Co.; Stone Mill Spring; Fort Leonard Wood; NE 1/4, SW 1/4, Section 21, T 35 N, R 10 W; October.
34. Reynolds Co.; East Fork Black River; Johnson's Shut-Ins State Park; 3 mi NE Lesterville, U Hwy; August.
35. St. Genevieve Co.; River Aux Vases Creek; June; INHS.
36. St. Genevieve Co.; Pickle Spring; July; INHS.
37. St. Louis Co.; Babler State Park; 8 mi N Eureka, Hwy 109; April.
38. Shannon Co.; Alley Spring, ONSR; 5 mi W. Eminence, Hwy 106; July, August.
39. Shannon Co.; Jack's Fork River; Hwy 106 bridge, 5 mi W. Eminence; August.
40. Shannon Co.; confluence of Sinkin Creek and Current River; July; INHS.
41. Taney Co.; Beaver Creek; 1 mi N Bradleyville, low-water bridge off Hwy 125; August.
42. Taney Co.; Hollister, no specific site; May; INHS.
43. Texas Co.; Big Piney River; Hwy 32 bridge; 9 mi W. Licking; October.
44. Texas Co.; Roubidoux River; Hwy 17 bridge; 11 mi NW Roby; October.
45. Wayne Co.; Williamsville, no specific site; July-September; INHS.
46. Wayne Co.; near Silva, no specific site or date; INHS.
47. Webster Co.; Niangua River; Y Hwy bridge, 8.5 mi NE Marshfield; July.
48. Webster Co.; Osage Fork River; M Hwy bridge, 3 mi E. Niangua; August.

## SPECIES LIST

### Suborder Annulipalpia Infraorder Curvipalpia Superfamily Hydropsychoidae

#### Family Hydropsychidae

- \* *Ceratopsyche bronta* (Ross). Stations 17, 18, 19, 21, 31, 41, 47; April, May, July, August.
- C. morosa* (Hagen). Stations 2, 23, 24, 25, 29, 34; July, August (Scheftner and Unzicker 1984).
- C. piatrix* (Ross). Stations 8, 21, 22, 38, 45; March, April, June-August, October (Ross 1938).
- \* *C. slossonae* (Banks). Station 1; June.
- Cheumatopsyche aphanta* Ross. Stations 1, 4, 12, 34; June-August (Gordon 1974).
- C. campyla* Ross. Stations 1, 29, 30, 31, 34, 47, 48; May-September (Ross 1944).
- \* *C. gracilis* (Banks). Station 2; June.
- \* *C. harwoodi enigma* Ross, Morse and Gordon. Station 41; August.
- C. lasia* Ross. Station 45; September (Ross 1944).
- C. minuscula* (Banks). Stations 4, 29, 30, 31, 38, 39, 41, 45, 48; May-September (Gordon 1974).

- C. oxa* Ross. Stations 1, 16, 24, 25, 30, 31, 41, 48; May-August (Gordon 1974).  
*C. pettiti* (Banks). Stations 8, 9, 21, 22, 27, 29, 30, 31, 41, 47; May-October (Gordon 1974).
- \* *C. rossi* Gordon. Stations 21, 38, 39; April, July, August.
  - C. sordida* (Hagen). Stations 2, 3, 18, 19, 24, 29, 30, 31, 34, 38, 39; May-September (Ross 1944).
  - C. speciosa* (Banks). Stations 1, 20, 42, 45; May-August (Ross 1944).
  - \* *Diplectrona modesta* Ross. Station 31; May-July, September.
  - \* *D. metaqui* Ross. Station 31 (larva); January.
  - Hydropsyche arinale* Ross. Station 13; July (Ross 1944).
  - \* *H. betteni* Ross. Stations 1, 29 (female); May, June.
  - H. bidens* Ross. Station 45; August (Ross 1944).
  - H. orris* Ross. Station 39; August (Nimmo 1987).
  - H. scalaris* Hagen. Stations 10, 18, 28, 29, 30, 31, 38, 39, 41; May-September (Ross 1944).
  - H. simulans* Ross. Stations 29, 30, 31, 35, 45; May-September (Ross 1944).
  - Macrostemum carolina* (Banks). Stations 24, 39; August (Wallace 1975).
  - \* *M. zebratum* (Hagen). Station 3; July.
  - Potamyia flava* (Hagen). Stations 2, 3, 24, 29, 34, 38, 39; June-August (Hagen 1861).
- Family Polycentropodidae**
- Cerootina calcea* Ross. Stations 4, 29, 42; June-August (Ross 1944).  
*Cymellus fraternus* (Banks). Stations 29, 39, 42; June-August (Ross 1944).  
*Neureclipsis crepuscularis* (Walker). Stations 42, 46; May (Ross 1944).  
*Nyctiophylax affinis* (Banks). Stations 2, 3, 16, 24, 29, 30, 34, 39, 41; May-September (Morse 1972).  
*Polycentropus centralis* Banks. Stations 4, 10, 29, 30, 31, 41, 45; May-September (Banks 1914).
- \* *P. chelatus* Ross and Yamamoto. Stations 29, 30; April, May.
  - P. cinereus* Hagen. Stations 24, 30, 31, 32, 42; May, August (Ross 1944).
  - P. confusus* Hagen. Stations 16, 21; July, August (Ross 1944).
- Family Psychomyiidae**
- \* *Lype diversa* (Banks). Station 32; May.
  - \* *Paduniella nearctica* Flint. Stations 39, 48; August.
  - Psychomyia flavida* Hagen. Stations 1, 2, 3, 4, 8, 16, 18, 19, 21, 23, 24, 25, 29, 30, 38, 39, 41; April-October (Ross 1944).

### Superfamily Philopotamoidae

#### Family Philopotamidae

- \* *Chimarra aterrima* Hagen. Stations 12, 16, 21, 23, 31; April, July, August, October.
- C. feria* Ross. No date or specific site given (Ross 1941).
- C. obscura* (Walker). Stations 2, 4, 16, 18, 19, 21, 24, 29, 30, 31, 35, 39, 48; May-September (Ross 1944).
- C. socia* Hagen. Stations 29, 48; May-August (Lago *et al.* 1990).
- \* *Wormaldia moesta* (Banks.) Stations 11, 30, 31; April-June.
- \* *W. shawnee* (Ross). Station 30; June.

### Infraorder Spicipalpia Superfamily Hydroptiloidea

#### Family Glossosomatidae

- Agapetus artesus* Ross. Stations 21, 22, 27; July, October-January (Ross 1938).  
*A. illini* Ross. Stations 11, 20, 21, 29, 37, 38; April-August (Ross 1944).  
*Glossosoma intermedium* (Klapalek). Stations 3, 23, 26, 38; August, October (Nimmo 1974).

- Protoptila lega* Ross. Stations 21, 24, 29, 39; May-August (Ross 1941).
- \* *P. maculata* Hagen). Stations 2, 3, 21, 29, 30; May-August.
- P. sp. nr. maculata*. Stations 3, 39; August.
- \* *P. tenebrosa* (Walker). Stations 21, 24, 29; July, August.
- Family Hydroptilidae**
- \* *Hydroptila ajax* Ross. Stations 29, 47; July.
- H. albicornis* Hagen. Stations 2, 3, 8, 18, 19, 21, 24, 28, 29, 30, 31, 38, 39; April-October (Ross 1944).
- H. angusta* Ross. Stations 4, 29; July, August (Hamilton and Schuster 1978).
- \* *H. armata* Ross. Stations 15, 18, 21, 24, 29, 30, 31, 48; April-October.
- H. arresa* Mathis and Bowles. Stations 3, 8, 21, 23, 24, 38, 39; July-October (Mathis and Bowles 1990).
- \* *H. broweri* Blickle. Stations 4, 23, 24, 34, 39; August.
- \* *H. consimilis* Morton. Stations 1, 8, 15, 21, 25, 28, 29, 30, 31, 38, 47; May-August, October.
- H. grandiosa* Ross. Stations 3, 15, 24, 29, 30, 31, 34, 38, 39; April-October (Ross 1944).
- H. hamata* Morton. Stations 2, 3, 4, 18, 19, 24, 29, 30, 31, 34, 38, 39; April-September (Ross 1944).
- \* *H. perdita* Morton. Stations 2, 3, 4, 15, 18, 24, 25, 29, 30, 31, 34, 38, 39, 47, 48; April-October.
- \* *H. spatulata* Morton. Stations 3, 23, 24, 29, 30, 39; April-August.
- H. nr. strepha*. Stations 24, 38, 39; August.
- \* *H. tusculum* Ross. Station 38; August.
- \* *H. virgata* Ross. Station 3; August.
- \* *H. waubesiana* Betten. Stations 29, 30, 31; June-September.
- \* *Ithytrichia clavata* Morton. Stations 2, 3, 29, 39; June, August.
- Leucotrichia pictipes* (Banks). Station 7; no date given (Wilson 1984).
- Neotrichia kitae* Ross. Station 42; May (Ross 1941).
- N. minutisimella* (Chambers). Stations 2, 24, 39, 45; June, August (Ross 1944).
- N. vibrans* Ross. Stations 24, 29, 39, 42, 45; June-September (Ross 1944).
- \* *Ochrotrichia anisca* (Ross). Stations 29, 30, 31; May-July.
- \* *O. arva* (Ross). Stations 23, 24; August.
- \* *O. contorta* (Ross). Station 22; June (Ross 1941).
- \* *O. eliaga* (Ross). Station 30; May, June.
- \* *O. riesi* Ross. Station 31; September.
- \* *O. spinosa* (Ross). Stations 3, 8, 23; August, October.
- O. tarsalis* (Hagen). Stations 2, 3, 4, 28, 29, 30, 31, 38, 39, 42; May-September (Ross 1944).
- \* *O. unio* (Ross). Station 30; June.
- \* *Orthotrichia aegerfasciella* (Chambers). Stations 16, 29, 30, 31, 47; May-September.
- \* *O. cristata* Morton. Stations 29, 30, 47; June, July.
- \* *Oxyethira coercens* Morton. Stations 8, 24, 38, 39; August, October.
- O. dualis* Morton. Stations 3, 16, 27, 29, 38; July, August, October (Ross 1944).
- \* *O. forcipata* Mosely. Stations 30, 34, 47; June-August.
- \* *O. pallida* (Banks). Stations 3, 19, 24, 28, 29, 30, 34, 39, 48; June-September.
- \* *O. zeronia* Ross. Station 34; August.
- \* *Stactobiella delira* (Ross). Station 29; April.

### Superfamily Rhyacophiloidea

#### Family Rhyacophilidae

- \* *Rhyacophila fenestra* Ross. Stations 30, 31; May, June.
- \* *R. glaberrima* Ulmer. Station 36; July.

**Suborder Integripalpia  
Infraorder Plenitentoria  
Superfamily Limnephiloidea**

**Family Brachycentridae**

*Brachycentrus numerosus* (Say). Station 45 (larvae); (Flint 1984).

*Micrasema ozarkana* Ross and Unzicker. Stations 14, 21, 22, 27; April, June, July, November (Ross and Unzicker 1965).

\* *M. rusticum* (Hagen). Stations 22, 32; May, June.

**Family Lepidostomatidae**

\* *Lepidostoma libum* Ross. Stations 30, 31; April, May.

*L. togatum* (Hagen). Stations 2, 3, 21, 24, 26, 33, 38, 42; April-August, October (Ross 1946).

**Family Limnephilidae**

\* *Frenesia missa* (Milne). Stations 30, 31; September-January.

*Glyphopsyche missouri* Ross. Station 27; October, November, January (Ross 1944).

\* *Ironoquia punctatissima* (Walker). Stations 30, 31; September, October.

\* *Neophylax concinnus* McLachlan. Stations 6, 30, 31; September-November.

*N. fuscus* Banks. Stations 5, 43, 44; October (Ross 1944).

\* *Pseudostenophylax uniformis* (Betten). Stations 30, 31; April-June.

\* *Pycnopsyche guttifer* (Walker). Stations 8, 14; October.

\* *P. subfasciata* (Say). Stations 15, 29; October.

**Superfamily Phryganeioidea**

**Family Phryganeidae**

*Agrypnia vestita* (Walker). No date or specific site given; (Wilson 1984).

*Phryganea sayi* Milne. Station 30; June (Hagen 1873).

\* *Ptilotomis ocellifera* (Walker). Station 13; July.

**Infraorder Brevitentoria  
Superfamily Leptoceroidea**

**Family Leptoceridae**

*Ceraclea ancylus* (Vorhies). Station 29; May (Sullivan 1929).

*C. cancellata* (Betten). Stations 2, 4, 23, 24, 29, 30, 41; May-August (Ross 1944).

\* *C. flava* (Banks). Stations 29, 30; June.

*C. maculata* (Banks). Stations 2, 21, 25, 29, 30; June-August (Ross 1944).

\* *C. punctata* (Banks). Station 18; July.

*C. tarsipunctata* (Vorhies). Stations 29, 45; May, July (Ross 1944).

*C. transversa* (Hagen). Stations 2, 28, 29, 30, 31, 39, 41, 48; May, June, August (Resh 1976).

*Mystacides sepulchralis* (Walker). Station 39; August (Yamamoto and Wiggins 1964).

*Nectopsyche candida* (Hagen). Stations 21, 39; July-September (Haddock 1977).

\* *N. diarina* (Ross). Station 40 (larva); July.

*N. exquisita* (Walker). Stations 2, 3, 12, 18, 29, 39, 41, 42, 45; May-August (Ross 1944).

*N. pavidata* (Hagen). Stations 3, 29, 39, 41; June-August (Ross 1944).

*Oecetis avara* (Banks). Stations 2, 3, 4, 12, 18, 21, 24, 29, 30, 31, 33, 34, 39, 41, 48; May-September (Ross 1944).

*O. cinerascens* (Hagen). Station 45; July, August (Ross 1944).

\* *O. ditissa* Ross. Stations 29, 30, 31, 41, 47; May-August.

*O. sp. nr. eddlestoni*. Station 34; August.

- O. inconspicua* (Walker). Stations 2, 16, 18, 21, 24, 27, 28, 29, 30, 31, 34, 38, 39, 41, 47; June-September (Ross 1944).  
*O. nocturna* Ross. Stations 18, 29, 30, 31, 48; May-September (Ross 1966).  
 \* *O. persimilis* (Banks). Stations 2, 29, 39, 41; May, August.  
*Setodes oxapius* (Ross). Stations 2, 3, 21, 24, 29, 30, 31, 34, 38, 39, 45; May-September (Holzenthal 1982).  
 \* *Trienodes flavescens* Banks. Station 30; August.  
 \* *T. ignitus* (Walker). Station 29; May.  
 \* *T. injustus* (Hagen). Stations 29, 30, 31, 34, 38, 39; May, June, August, September.  
 \* *T. marginatus* Sibley. Station 24; August.  
 \* *T. nox* Ross. Station 4; August.  
 \* *T. tardus* Milne. Station 29; July.

#### Family Molannidae

- \* *Molanna blenda* Sibley. Stations 21, 30; May, July.

#### Family Odontoceridae

- \* *Marilia flexuosa* Ulmer. Stations 4, 18, 19, 39; July, August.

### Superfamily Sericostomatoidea

#### Family Helicopsychidae

- Helicopsyche borealis* (Hagen). Stations 1, 2, 3, 4, 12, 16, 18, 19, 21, 23, 27, 29, 30, 34, 38, 39, 41, 48; May-September (Ross 1944).

## SUMMARY

In addition to the 133 species reported herein, 10 other species of Trichoptera are reported from Missouri, but are either extralimital to the Ozarks or from unknown localities. These include three hydroptilids (*Mayatrichia ayama* Mosely (Ross 1944), *Neotrichia edalis* Ross (Blickle 1979), and *N. okopa* Ross (Hamilton and Schuster 1978)), two hydropsychids (*Hydropsyche rossi* Flint, Voshell, and Parker (Flint *et al.* 1979) and *H. venularis* Banks (Banks 1914)), two philopotamids (*Chimarra moselyi* (Denning) and *C. parasocia* Lago and Harris (Lago and Harris 1987)), two leptocerids (*Nectopsyche albida* (Walker) (Haddock 1977) and *N. spiloma* (Ross) (Ross 1944)), and one polycentropodid (*Plylocentropus placidus* (Banks) (Schuster and Hamilton 1984)). The validity of Bank's record of *H. venularis* from a site near St. Louis (Banks 1914) is uncertain. Flint *et al.* (1979) suggest that this species is common throughout the southeastern United States where it favors medium to large rivers, but did not include Bank's record among their valid ones for the species. If this record is valid, then a total of 143 species of Trichoptera have been reported from Missouri.

Endemism of Trichoptera within the Interior Highlands recently has been discussed in two reviews on the arthropod fauna of the southeastern U.S.A. Allen (1990) listed 22 species of caddisflies he considered

to be Interior Highland endemics; however, a careful review of Hamilton and Morse (1990) yielded only 13 species that are truly endemic to the region. Including those species described after the publication of Allen (1990) and Hamilton and Morse (1990), we know of 16 species of endemic Trichoptera that have been described from the Interior Highlands. These include nine species reported only from the Ozarks (*Agapetus artesus*, *Hydroptila artesus*, *Neotrichia kitae*, *N. arkansasensis* Mathis and Bowles, *Ochrotrichia contorta*, *Paduniella nearctica*, *Glyphopsyche missouri*, *Micrasema ozarkana*, and *Setodes oxapius*<sup>4</sup>), one species apparently confined to the Ouachitas (*Ochrotrichia weedlei* Ross), and six species that occur in both ranges (*Rhyacophila kiamichi* Ross, *Agapetus medicus* Ross, *Paucicalcaria ozarkensis* Mathis and Bowles, *Wormaldia strota* Ross, *Helicopsyche limnella* Ross, and *Lepidostoma ozarkense* Flint and Harp). Two other species once thought to be Interior Highland endemics have been collected recently outside the region. *Hydroptila sandersoni* Mathis and Bowles (Mathis and Bowles 1990) has been collected in northern Alabama (Steve Harris, personal communication); a single specimen of *Neotrichia edalis* was recovered from a sample sent to us from south-central Texas (San Marcos River, Hays County).

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<sup>4</sup>The type locality of *Setodes oxapius* given by Ross (1938) is Ellerville, OK, a town no longer shown on maps. It is located in Cherokee Co., 9 mi NE of Tahlequah, OK.

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# 1990 ADDITIONS TO THE ANNOTATED LIST OF THE INSECTS OF MACAU<sup>1</sup>

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**ABSTRACT:** One Orthoptera, 18 species of Coleoptera, 6 Diptera, 12 Heteroptera, 17 Lepidoptera and 1 species of Neuroptera are listed from Macau. The majority of species were collected on the outside walls, ceilings or on the floors of buildings comprising the University of East Asia campus on the island of Taipa during early morning hours.

The insect fauna of Macau is believed similar but not identical with that of the better known fauna of Hong Kong or those of its many associated islands. The species reported here were found during 1990 but had not been observed on buildings during the previous year (Easton 1991), either because populations were very low during 1989 or some species may develop on a 2-year cycle. Not all of the species found in Macau have been reported in Hong Kong, e.g. the cerambycid beetle, *Imantocera penicillata* (Hope) (personal communication, C. Lau).

The campus buildings are connected by walkways that are illuminated at night and insects found were those that remained either on the ceilings, walls or the floors on the outsides of the structures until early morning. Sites listed in this study include buildings such as Block I, Block III, Tai Fung, K.C. Wong and the library as well as areas connecting buildings such as the skyway lobby, classroom CLG 401 and the temporary classroom corridor. Identifications were carried out with the aid of Hill *et al.* (1982), Hill and Cheung (1978) and Hill (1982) and collected material has been compared with identified specimens in the Agriculture and Fisheries entomology collection, Hong Kong, as well as Bishop Museum in Honolulu, Hawaii. Common names have been taken from Hill and Cheung (1978), Hill (1982) and Hill *et al.* (1978) for Hong Kong.

## LIST OF SPECIES

### ORTHOPTERA

#### Tettigoniidae

*Mecopoda elongata* (L.) large leaf grasshopper, 23 November, outside of library; 24 November inside Block I building.

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## HEMIPTERA

## Coreidae

*Leptocorisa acuta* (Thunberg), rice bug, 26 October, skyway lobby. This bug is found commonly attracted to lights in Hong Kong during July (Hill *et al.* 1982).

## Largidae

*Physopelta gutta* Burmeister, 20 February outside CLG 401 classroom. Even though adults are attracted to lights, all nymphal stages have been observed feeding on the seeds of *Mallotus paniculatus* trees during February. The fruits of this tree fall to the ground in late fall and some remain caught in the lower foliage of the trees. First instar nymphs were observed feeding on the seeds on the ground while older stage nymphs and adults climb trees and feed on seeds caught in lower branches. Mating of adults was also observed at this time.

## Lygaeidae

*Metochus unguittatus* Thunberg, 10 November on ceiling of Tai Fung Bldg.

## Pentatomidae

*Calliphara nobilis* (Linnaeus), blue shield bug, 19 August on wall of Tai Fung Bldg. Immature and adults of this species have since been observed feeding on the fruits of wild figs on the island of Coloane.

## Pyrrhocoridae

*Dindymus rubiginous* (Fabricius) 31 October, 3 November, 10 and 19 December on trunks of trees and ground on the Guia (lighthouse) hill in Macau. Insects were observed feeding on others of their kind and one specimen was noted feeding upon an ant.

## Reduviidae

*Triatoma rubrofasciata* (DeGeer), 14 July on bottom floor of Block III building under a rock used by maintenance workers to brace a door. This bug is reported to feed on murine blood in Hong Kong (Hill, 1982) and in Macau the insect was found in an area frequented by *Rattus rattus*. Hill (1982) also believed it to feed on man in rural areas.

## HOMOPTERA

## Cicadidae

*Cryptotympana mandarina* Distant during June on floor outside of Tai Fung building. Hill and Cheung (1978) referred to this species in their book as *C. mimica* Walk. (Males have a triangular opercula) but in a recent revision of the genus by Hayashi (1987) *C. mimica* is now considered to be a junior synonym of *C. mandarina* (personal communication, J.P. Duffels). Easton (1991) listed another closely related species from Macau in this genus as *C. pustulata* (Fabr.) but according to Hayashi (op. cit.) the correct name should now be *C. atrata* (Fabr.) (males have a rounded opercula but are otherwise similar to *C. mandarina*). The exuviae of both species as well as malformed adults have been found near the base of *Casuarina equisetifolia* and *Acacia confusa* trees in a cemetery on Taipa island suggesting that the roots of these plants serve as food for nymphal development.

*Gaeana maculata* Walker, spotted black cicada, 25 March in woods of Siac Pai Van near park operated by the Agriculture and Forestry department on Coloane Island. This species is one of the earliest to emerge from the ground in the spring (earlier than *Cryptotympana* above) but individuals have not been observed on the island of Taipa suggesting a different food preference for the nymphs.

*Platyleura hilpa* Walker, the spotted brown cicada, 9 June, 3 August on floor outside of Tai Fung building. This species has been observed to emerge from the ground a little later in the season than *G. maculata* and during the time when both species of *Cryptotympana* were active. Nymphs have been observed emerging at night (9:00-10:00 p.m.) near the trunks of *C. equisetifolia* trees on the edge of the campus. The winged remains of this species were often found lying on the ground in the vicinity suggesting that it serves as a food source for *Suncus murinus*, a common insectivorous small mammal on the island.

#### Flattidae

*Lawana imitata* (Melichar), 21 August ex longan fruit trees, *Euphoria longan* near Siac Pai Van on Coloane Island, Pun Wing Wah, leg.

#### Fulgoridae

*Fulgora candelaria* (Linnaeus), lantern-fly, 21 August on trunks of longan fruit trees on Coloane Island, 19 December from same host on Guia hill on the Macau peninsula. This insect is also common on the trunks of lychee fruit trees (*Litchi chinensis*) that are less common in Macau but are widely grown in the neighboring Guangdong Province of China. Hill and Cheung (1978) and Lee and Winney (1981) list this insect under the genus *Pyrops* but recently Chinese authorities have classified it as a species of *Fulgora* (Economic Insect Fauna of China, Fascicle 36, 1985, Homoptera, Fulgoroidea, Beijing).

*Fulgora rathburii* Kirby, 31 August, nymph on trunk of *C. equisetifolia*, the horsetail tree on the island of Taipa.

#### NEUROPTERA Ascalaphidae

*Hybris subjacens* (Walker), 21 May under street lamp on campus, 24 May on wall of Tai Fung building. Hill *et al* (1982) reported it as regularly occurring in Hong Kong.

#### LEPIDOPTERA Amathusiidae

*Faunes eumeus* (Drury), the common faun, 7 April on hiking trail on summit of Coloane Island.

#### Arctiidae

*Nyctemera plagifera* Walker, 17 December on outside of classroom. CLG 401.

#### Danaidae

*Danaus similis* (Linnaeus), the blue glassy tiger, 25 March in Agricultural Park on Coloane Island. This species has been found congregating on tree foliage during colder periods in December along a hiking trail on Coloane Island.

### Geometridae

*Obeidia tigrata*<sup>3</sup>, the brown tiger moth. Adults are active during spring months in forested glens on hilltops. An emergence estimated at nearly 1,000 individuals was observed on Taipa Island in early May in which adults were observed feeding upon the white blossoms of *Homalium* trees and blooms of *Abarema lucida*. Mating has been observed near dusk. Larvae have been reared on *Celastrus hindsii* (Pers. comm., M. Bascombe)

### Lymantridae

*Lymantria dissoluta* Swinhoe, 11 June on outside of library.

### Noctuidae

*Eligma narcissus* Cramer, 28 September near skyway lobby on the outside wall of the building.

*Ophideres fullonica* Linnaeus, 1 August on outside wall of Tai Fung building.

*Speiredonia retorta* Linnaeus, 1 August on wall of Block I building.

### Nymphalidae

*Hestina assimilis* (Linnaeus), red ring skirt, 3 November in temporary classroom corridor.

*Neptis columella* (Cramer), the short banded sailor, 25 May in table tennis room. This species was reported as common in Hong Kong (Hill *et al.*, 1978).

### Pieridae

*Delias aglaja* (Linnaeus), the black jezebel, 13 April near the Hovione pharmaceutical factory, Taipa Island.

### Papilionidae

*Graphium agamemnon* (Linnaeus), the tailed green jay, 25 March in park operated by the Agriculture and Forestry department, Coloane Island.

*Papilio demoleus* Linnaeus, the lime butterfly, 31 July in temporary classroom corridor.

### Sphingidae

*Gurelca hyas* Walker, November in temporary classroom corridor.

*Macroglossum sitiene* Walker, July, November in classroom corridor.

*Theretra silhetensis* Walker, 23 June, 3 January on outside wall of Block I building near skyway lobby.

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<sup>3</sup>Name of describer of species not possible to be obtained by author of paper due to limited research resources.

**Uranidae**

*Lyssa menoetius* Hopffer, 2 August on side of building in city of Macau. This moth was listed as a species of *Nyctalemon* earlier by Hill *et al.* (1982) in Hong Kong and Anon (1982/83) in southern China.

**DIPTERA**  
**Calliphoridae**

*Chrysomya megacephala* Fabricius, common during winter months on campus buildings. This fly is often seen near accumulations of organic matter and attracted to decaying animal carcasses.

**Culicidae**

*Armigeres magnus* (Theobald), is found almost throughout the year as larvae inhabiting the leaves of *Nepenthes mirabilis* along a hiking trail on the island of Taipa. Ramos (1990) lists it from the same plant leaves on the island of Coloane.

*Armigeres subalbatus* (Coquillett), May, June on outside windows near the library and cultural center on campus in the early morning.

*Culex sumatranus* Brug, was found in a similar environment as *A. magnus* above in leaves of *N. mirabilis* on Taipa Island where adequate drainage occurs on vegetated slopes. Ramos (*op cit.*) lists it from Coloane Island where it occupies similar habitats.

**Streblidae**

*Raymondia pagodarum* Speiser, 19 November in the fur of *Miniopterus schreibersi*, common bent-winged bat inhabiting Choc-Van Cave on Coloane Island.

**Syrphidae**

*Eristalis* sp. 8 January, adult in temporary classroom corridor while larva was found in polluted drainage before emptying into the Pearl River delta.

**COLEOPTERA**  
**Buprestidae**

*Chalcophora japonica chinensis* Schauff, the golden buprestid, 31 October on the Guia Hill jogging track, Macau Peninsula. This species is believed to feed as larvae on *Pinus mansonia* (Lee and Winney, 1981).

**Cerambycidae**

*Aeolesthes induta* (Newman), 5 April on outside wall of Block I building.

*Aristobia approximator* (Thomson), 27 September on floor of skyway lobby.

*Pyrestes haematica* Pascoe, 28 March, 24 April on wall of Block I building.

*Chelidonium sinense* (Hope), blue bamboo longhorn beetle, 28 May on wall of Tai Fung building; 30 May outside classroom CLG 401.

*Chlorophorus annularis* (F.), the bamboo longhorn, 28 May on outside wall of Tai Fung building; 18 June near library. This species was particularly common during 1990 and may have emerged from the numerous bamboo poles used in the scaffolding of new buildings that were being constructed next to the campus.

*Xystrocera globosa* (Olivier), 9 April, 5 May on outside wall of Block I building.

#### Chrysomelidae

*Nisotra orbiculata* (Motschulsky) August ex *Hybiscus rosa-sinensis* blooms on Coloane Island, Pun Wing Wah, leg.

#### Curculionidae

*Odioporus longicollis* (Olivier), banana stem weevil, 17 June in temporary classroom corridor.

#### Dytiscidae

*Eretes sticticus* (Linnaeus), September on floor outside of K.C. Wong building.

#### Meloidae

*Epicauta tibialis* Waterhouse, the black blister beetle, 5 May on unpaved secondary road through cemetery on Taipa Island.

*Mylabris phalerata* Pallas, large yellow-banded blister beetle, 9-29 August ex *Hybiscus rosa-sinensis* blooms growing along a fence line near the cemetery on Taipa Island. The adults have been observed feeding on the flowers of this bush and in Hong Kong, Hill and Cheung (1978) have reported it as defoliating *Hybiscus* plants.

#### Scarabaeidae

*Anomala antiqua* (Gyllenhal), 15 June on the floor outside of Tai Fung building.

*Apogonia cribricollis* Burmeister, 4 June on the floor outside of the Tai Fung building.

*Holotrichia geilenkensei* Brenske, the brown cockchafer, 25 March on floor inside block I building; 29 March on floor outside of K.C. Wong building and 11 May on wall of Tai Fung building. This is one of the most abundant insects observed on campus floors during the spring of the year. Larvae are subterranean feeding on plant roots (Hill, 1982).

#### Staphylinidae

*Anatylus tetrocarinatus* Block, 16 March beneath human excrement on Taipa Island.

*Philonthus longicornis* Stephens, 20 March beneath decaying carcass of domestic housecat, Taipa Island.

## Tenebrionidae

*Strongylium erythrocephalum* Fabricius, red-legged darkling beetle. 22 May on floor of skyway lobby; 23, 30 June on wall outside of classroom CLG 401. In Hong Kong Hill (1982) claimed that this species occurs occasionally on vegetation in large numbers.

## ACKNOWLEDGMENTS

The author wishes to thank Clive Lau (Agricultural officer of the Agriculture and Fisheries Department, Hong Kong Government) for access to their insect collection on the Tai Lung Farm, Sheung Shi, New Territories. Appreciation is also due to Horace Last (Woodville, West Sussex, England) for determination of the staphylinid beetles, to J.T. Medler and G.A. Samuelson (J.L. Gressitt Center for Research in Entomology, Bishop Museum, Hawaii) for help with the flattid and chrysomelids and cerambycids respectively and to Hans Duffels (Instituut Voor Taxonomische Zoölogie, Amsterdam) for determination of the cicadas in the genus *Cryptotympana*.

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## BOOK REVIEW

**WOMEN IN THE FIELD: AMERICA'S PIONEERING WOMEN NATURALISTS.** Marcia Myers Bonta. 1991 Texas A&M University Press, College Station. 299 pp. Cloth \$29.50; paper \$13.95.

The lives and scientific endeavors of 25 American women (early naturalists, botanists, entomologists, ornithologists and ecologists) are profiled in this appealing and informative book that features 30 illustrations. Beginning with little-known pioneers of the late 1700's (such as Maria Martin, whose botanical backgrounds graced some of Audubon's illustrations), and ending with the renowned Rachel Carson, the reader cannot help but be awed by these women, who often suffered personal hardships and labored under the prejudices of a male-dominated society. Consider, for example, the double standard that plagued ornithologist Margaret Morse Nice, whom Konrad Lorenz regarded as the real founder of ethology. Nice's father, a history professor, raised her to be an enlightened individual but declared that, "housewife and mother were to be her ultimate goals," so her graduate studies were pursued over parental protestations. She was made a fellow of the American Ornithologists' Union in 1937 (the second woman to be so honored), but was excluded from the local Wheaton Ornithological Club of Columbus, Ohio because of her sex.

Most women portrayed in Bonta's book did not have the advantage of an advanced degree, but their devotion to science was often single-minded and their exploits in its pursuit were sometimes death-defying. Youths seeking an Indiana Jones type of heroine need not look beyond Ynes Mexia, who, between the ages of 55 and 67, backpacked with dogs for 22 miles around Mount McKinley and traveled by balsa raft, dug-out canoe, two-passenger open airplane, hydroplane, horseback and on foot to collect botanical specimens from the far-reaches of Mexico, Central America, the Andes and the Amazon. Alice Eastwood risked life and limb to save numerous herbarium type specimens of the California Academy of Sciences during the 1906 San Francisco earthquake; all of her personal specimens and books housed at the Academy were lost. Eastwood, who as a young woman guided Alfred Russel Wallace up Gray's Peak, Colorado, continued her work until she officially retired at the age of 90. Several others in the book remained active into their 80's. Some, like Rachel Carson, Margaret Morse Nice, Anne Haven Morgan (a student of J.G. Needham) and Carrie Dormon, spearheaded conservation efforts to protect and preserve natural areas, and heightened public awareness about the hazards of pesticides.

Also included are the biographies of three entomologists (Anna Botsford Comstock, Annie Trumbull Slosson and Edith Patch); since two of these women were recently featured in the *American Entomologist* (Vol. 36 No. 2), readers may be familiar with their stories. Mary Treat, a naturalist of the Pine Barrens, published a book in 1877 on ants, and corresponded with C.V. Riley, Samuel Scudder, Sir Joseph Hooker and Charles Darwin. Lesser-known contributors to the field (Margaretta Morris, Adele Marion Fielde, Maria E. Fernald, Elizabeth Gifford Peckham, Nellie Rau and Mary E. Murtfeldt) are highlighted in the introduction to the chapter on entomologists.

Historians of science may be irked by the author's use of quotes and direct assertions that go uncited in the text, although references for each chapter and its introduction are given at the end of the book. The bibliography includes many primary sources and archival holdings, making it possible for interested readers to conduct further research on these remarkable women. On the whole, this is an inspiring account of women who, by dint of determination and love of nature, surmounted formidable odds and made important



contributions to science. The quality of the illustrations (many of them photographs of these women in the field) is good and the book is printed on acid-free paper, making the paperback (\$13.95) a very reasonable purchase.

Carol Anelli Sheppard  
Research Entomologist  
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## BOOK REVIEW

**DRAGONFLIES OF THE FLORIDA PENINSULA, BERMUDA AND THE BAHAMAS** by Sidney W. Dunkle. 1989. Scientific Publishers, Gainesville, FL - Washington, DC. \$14.95 (paper)

**DAMSELFLIES OF FLORIDA, BERMUDA AND THE BAHAMAS** by Sidney W. Dunkle. 1990. Scientific Publishers, Gainesville, FL - Washington, DC. \$12.95 (paper) \$19.95 (cloth)

Dragonflies and damselflies are among the largest and most colorful insects. In many ways they rival butterflies in attracting people's attention. Yet, to the frustration of many naturalists and amateur entomologists, there is no good modern field guide to the Odonata of North America to rival those for Lepidoptera or those for the Odonata of Europe and Japan. This deficiency has been recognized by sepcialists and for several decades there has been talk of a colorful popular field guide, but none has appeared.

For the people of Florida, Bermuda, and the Bahamas this wait is over. Sidney W. Dunkle, Manager of the International Odonata Research Institute in Gainesville, has produced two beautiful guide books containing closeup color photographs of every species known to occur in the area. Considering the elusiveness and wariness of many species, this is both a photographic and an entomological accomplishment. Most species can be identified from the photographs. For those that cannot, supplemental figures are provided. In addition to the photographs which highlight these books, there are brief, accurate descriptions of each species and notes on their distribution, ecology, and behavior.

While some of the 140 species in these books do not occur elsewhere in the United States, about a third of all species in the United States occur in Florida and are presented in these books. Consequently, these books are very useful guides for areas beyond Florida, particularly the Gulf and Atlantic Coasts. For example, 75 of the about 110 species known from Delaware are illustrated and described.

These books on the dragonflies and damselflies of Florida, Bermuda, and the Bahamas are reasonably priced. They are recommended for anyone interested in the Odonata, the natural history of Florida, or photographs of colorful insects. Given the success of these books, perhaps Dr. Dunkle can be persuaded to produce similar guides to the dragonflies and damselflies of the United States.

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## BOOK REVIEW

**DRAGONFLIES AND DAMSELFLIES OF CAPE COD.** Virginia Carpenter. Illustrations by Terry Ellis. 1991. Natural History Series No. 4. The Cape Cod Museum of Natural History, Brewster, MA 02631. 80 pp. 32 fig., 8 color pl. \$9.95.

Cape Cod, the hook-shaped peninsula of sand left by glaciers and altered by erosion, represents the northern end of the Atlantic Coastal Plain. Its many kettle-hole ponds of various sizes and stages of succession, a few small streams, and cranberry bogs provide habitats for about 95 species of dragonflies and damselflies. Most of these species are illustrated and described in Virginia Carpenter's attractive and reasonably priced field guide. While the style and format are different from Dunkle's recent books on the dragonflies and damselflies of Florida, Bermuda, and the Bahamas this book nicely complements Dunkle's books. Together their books would permit the identification of all but a few infrequently encountered species east and south of the Appalachian Mountains.

Carpenter, like Dunkle, is appealing to a general audience of amateur naturalists by using color and recently created English names. While the names were not made by Carpenter and are not "common" in the sense that specialists in the Odonata know them, I suspect the effect of this book and others will be to make them common. In that light, I rejoice at some like Halloween Pennant which is appropriate for *Celithemis eponina*. For others I wish another name were used or created. For example in her foreword, Carpenter muses, "...I cannot help thinking I am not alone in the joy I feel when the Long-legged Green Darner graces a pond with his presence." She is not alone. To see the strong-flying magnificent *Anax longipes* cruise over a pond with its brilliant red abdomen visible for 100 meters or more is a thrill to remember. But wouldn't "Red Darner" or "Flaming Darner" do justice to a species unmistakable at a distance but whose long legs and green thorax most observers will never note? (It is ironic that the otherwise excellent color illustration of the Long-legged Green Darner is in dorsal view and does not show its long hind legs.)

In the absence of a much needed general field guide to North American Odonata, Carpenter's book will certainly help fill the void for entomologists and naturalists not only on Cape Cod but in the northeastern United States as well.

Harold B. White  
Department of Chemistry & Biochemistry  
University of Delaware

## BOOK RECEIVED AND BRIEFLY NOTED

**BEEES OF THE WORLD.** 1991. C. O'Toole & A. Raw. Facts on File, N.Y. 192 pp. \$24.95 hardcover.

A popular book on bees for the general reader. Subjects include bee diversity, behavior, and lifecycles of solitary bees as well as the highly social ones, flower-bee relationships, the role of male bees, and the significance of associated insect species. Nicely illustrated with both line drawings and color photographs.

## BOOK REVIEW

**THE ECOLOGY OF A GARDEN. THE FIRST FIFTEEN YEARS.** 1991. J. Owen. Cambridge Univ. Press. 403 pp. \$100 hardcover.

In somewhat the same vein as Frank Lutz's *A Lot of Insects*, (1941), this volume relates and documents the wildlife in the author's Leicestershire garden between 1972 and 1986. In total, 1782 species of animals and 422 species of plants were recorded and the diversity, abundance, and annual fluctuations of many animal groups were monitored.

This is a definitive work which should be of considerable interest to entomologists. After an introduction to gardens and their natural history, and to the flora of gardens, the author fills the next 244 pages (60% of the book) to a review of the butterflies, moths, ichneumonids and other parasitic wasps, hoverflies/syrphids, bees and wasps, beetles, other insects, and other invertebrates found in her garden. In each group the author discusses its natural history, species diversity and garden species, annual and seasonal fluctuations in numbers, larval habits and food plants, and ecology.

One of the more important conclusions reached by Dr. Owen may be that, with increasing destruction of natural habitats, country gardens may have considerable significance for conservation.

H.P.B.

## BOOKS RECEIVED AND BRIEFLY NOTED

**DUNG BEETLE ECOLOGY.** 1991. I. Hanski & Y. Cambefort, eds. Princeton Univ. Press. 481 pp. \$60 hardcover.

This series of 20 essays offers an account of the population and community ecology of dung beetles worldwide, with an emphasis on comparisons between temperate and tropical species assemblages. These essays cover the topics of evolution and taxonomy, and ecology and population biology. The authors also discuss changes in dung beetle faunas due to human-caused habitat alteration and examine the possible effects of introducing dung beetles to cattle breeding areas that lack efficient native species.

**THE ACARI. REPRODUCTION, DEVELOPMENT, AND LIFE-HISTORY STRATEGIES.** 1991. R. Schuster & P.W. Murphy, eds. Chapman & Hall. 554 pp. \$210 hardcover.

A series of 58 essays contributed by 89 leading acarologists in the fields of life-history strategies; reproduction; diapause, development and trophic relations; systematics, physiology, morphology and behavior; and field studies and applied aspects.

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# ENTOMOLOGICAL NEWS

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## TWO NEW SPECIES OF *ATHYSANELLA* (HOMOPTERA: CICADELLIDAE) FROM CALIFORNIA<sup>1, 2</sup>

H. Derrick Blocker<sup>3</sup>, A.L. Hicks<sup>4</sup>

**ABSTRACT:** Two new species of *Athysanella* (*Gladionura*), *expulsa* and *vanesca*, are described from the California Bay area near San Francisco. Each species is represented by a unique male specimen.

Two new species of *Athysanella* are described from Santa Cruz Co. and Alameda, California from specimens lent by the California Academy of Sciences. Because it is possible that the original habitats for these species have been greatly altered or destroyed during the past 75 years, we consider it important to describe these two species represented by unique specimens at this time. We hope that California entomologists will attempt to find relict patches of short grasses, or possibly *Distichlis* (saltgrass), in the Bay area of San Francisco. These patches might reveal other specimens of these new species as well as specimens of the several additional species of *Athysanella* that have not been collected there for the past 50 or so years. These two species undoubtedly belong to the subgenus *Gladionura* and are probably closely related.

### *Athysanella* (*Gladionura*) *expulsa*, new species

(Figs. 1-4)

Length of male 2.8 mm; head width 1.1 mm; pronotal width 1.05 mm; interocular width 0.45 mm; vertex length 0.4 mm; pronotal length 0.35 mm; female unknown.

Character code 0-1-1-1-0-0-1-0-1-0-0-1-1-1-0-0-1-1 (see Blocker and Johnson 1990).

Color dark brown dorsally with irregular stramineous spots; vertex with darker band between ocelli; dorsum stramineous with darker brown spots on pronotum and vertex; forewings with costal margin and veins paler in color; venter mostly stramineous; face with fuscous bands one either side of midline; body with irregular fuscous markings.

Forewings brachypterous, exposing 5.0 pregenital abdominal terga; ocelli 1.5 x its diameter from eye; hind tibial spur approximately 3/4 length of basal tarsomere.

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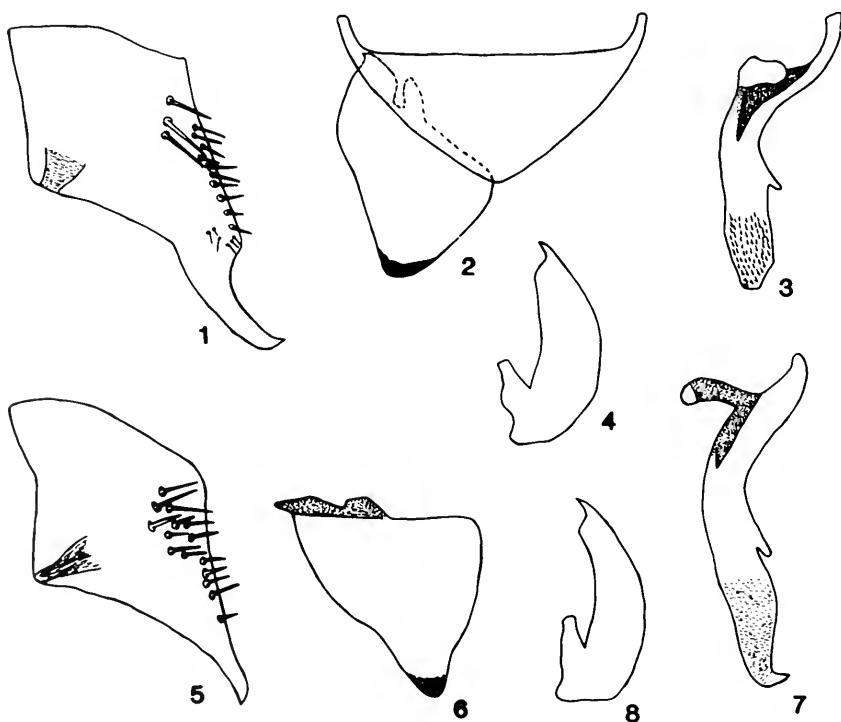
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Pygofer (Fig. 1) short, process elongate, curved laterad, sickle-shaped, acute apically; plates (Fig. 2) triangular, rounded and embrowned apically; style (Fig. 3) bluntly rounded apically, preapical lobe digitate; aedeagus (Fig. 4) simple, slightly widest basally, with slender, hooked apex.

Holotype male, California, Alameda, Nov., Koebele Collection (no other information included); described from this single specimen deposited in the California Academy of Sciences.

*A. (Gladionura) expulsa* keys to couplet 11 in Blocker and Johnson (1990); *curvata* appears to be the best choice at that point but can be distinguished by the shape of the style; *expulsa* probably belongs to the *argenteola* group.



Figs. 1-8. *Athysanella expulsa*: 1, pygofer, lateral view; 2, valve and plate, ventral view; 3, style, broad (dorsal) aspect; 4, aedeagus, lateral view. *Athysanella vanesca*: 5, pygofer, lateral view; 6, plate, ventral view; 7, style, broad (dorsal) aspect; 8, aedeagus, lateral view.

*Athysanella (Gladionura) vanesca*, new species

(Figs. 5-8)

Length of male 3.0 mm (est.); head width 1.15 mm; pronotal width 1.1 mm, interocular width 0.45 mm; vertex length 0.4 mm; pronotal length 0.35 mm; female unknown.

Character code: 0-1-1-1-2-0-1-0-1-0-0-1-1-0-0-1-1

Color basically stramineous dorsally with a dark brown pattern on vertex, pronotum, and scutellum; forewing brown with costal margin and veins paler in color; venter primarily stramineous; face with brown lines on either side of midline; thoracic area with brown patches.

Forewings brachypterous, exposing 4.5 pregenital abdominal terga; ocelli 2 x its diameter from eye; hind tibial spur approximately 1/2 length of basal tarsomere.

Pygofer (Fig. 5) short, numerous macrosetae on dorsocaudal margin, process elongate and acute apically, curved lateroventrally; plates (Fig. 6) triangular, embrowned apically; style (Fig. 7) elongate, preapical lobe digitate; apex digitate, acute; aedeagus (Fig. 8) simple, with apical hook.

Holotype male. California, Santa Cruz, Co., #4A, 500 ft., 9 June 1917 (W.M. Giffard); described from this single specimen deposited in the California Academy of Sciences.

*A. (Gladionura) vanesca* keys to couplet 9 in Blocker and Johnson (1990) and does not fit either choice. It is probably closely related to *expulsa* but can be distinguished by the shape of the style; it is probably a member of the *argenteola* group.

## ACKNOWLEDGMENTS

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## MAYFLIES (EPHEMEROPTERA), STONEFLIES (PLECOPTERA), AND OTHER INTERESTING BIOTA OF WILDCAT CREEK, SOUTH CAROLINA, A BIODIVERSITY REFERENCE STREAM<sup>1</sup>

Susan M. Daniels<sup>2</sup>, John C. Morse<sup>3</sup>

**ABSTRACT:** The Wildcat Creek catchment, in the upper Piedmont region of South Carolina, is being considered for special protection to preserve its biological diversity. To help assess this diversity, specimens of mayfly (Ephemeroptera) and stonefly (Plecoptera) nymphs were collected and identified to the lowest taxonomic level possible with currently published information. Additional records were obtained from the Clemson University Arthropod Collection, Clemson University graduate student theses, and publications. A total of 35 mayfly species and 24 stonefly species are reported from the stream.

Wildcat Creek is located nine km northwest of the campus of Clemson University, Clemson, South Carolina. Its watershed encompasses approximately 204 ha (504 ac), the lower 96 ha (236 ac) of it owned by Clemson University. The University property is under commercial timber management by the Clemson University Experimental Forest. Private lands on the upper half of the watershed, held by 28 landowners, are mostly devoted to residential and agricultural uses. The stream's watershed is being considered for special protection as a natural area with exemplary biological diversity.

The land on which the Experimental Forest and Wildcat Creek now lies was acquired by the United States government in 1933, during the depression, as a result of federal programs designed to stop land degradation. When first obtained, the land, managed by the Clemson University Forestry Department, consisted of "eroded hills patched with stunted and decadent hardwoods, the farms gullied, desperate with poverty" (Sorrells 1984). Clemson University became the steward of the forest in 1954 and, since 1933, has developed it as a model of managed forest property (Sorrells, 1984).

Wildcat Creek is a clear, cold, first-order stream of the upper Piedmont region (about 245-275 m [800-900 ft] elevation above mean sea level [EAMSL]), with a sand and gravel substrate and generally closed forest

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canopy. The riparian vegetation is mixed hardwoods, with pine stands on higher slopes; occasional wildlife plots occur in the watershed and a picnic shelter and shaded recreation area are located near the mouth. The stream enters Six Mile Creek about 500 m above its confluence with Lake Issaqueena.

The area is used for teaching and research by Clemson University groups. Field laboratories for courses in biological sciences, entomology, and forestry are regularly taught here. Research for several M.S. theses and Ph.D. dissertations in the University's Department of Entomology has been completed in the watershed since the mid 1960's and a dissertation research project is in progress here for the Department of Biological Sciences. The site is open to the public each year from March through October and is a popular recreation area for picnicking, hiking and horseback riding.

Seven species of macroinvertebrates in the watershed have been designated by The Invertebrate Taxa Review Committee of the South Carolina Heritage Trust Program as endangered or threatened in South Carolina or the United States (Morse *et al.* 1979, and unpublished data):

1. *Sphodros coylei* Gertsch and Platnick, 1980 (Arachnida: Araneae: Atypidae). Endangered in the United States, this spider is known only from Clemson and the Wildcat Creek area, South Carolina. The habitat of this spider is thought to be woodlands (Gertsch and Platnick 1980, Gaddy and Morse 1985). An intensive search for specimens of this species in the Wildcat Creek watershed, funded by the South Carolina Heritage Trust Program, resulted in discovery of one specimen (K.M. Hoffman pers. comm.).
2. *Macromia margarita* Westfall, 1947 (Insecta: Odonata: Macromiidae). This species is threatened in South Carolina, where Wildcat Creek is the only known locality. Specimens have also been found in North Carolina and Georgia. Nymphs are found in cold running water with rocky bottom and low organic content (Westfall 1947, T.R. White pers. comm.).
- 3-7. The following species of caddisflies (Trichoptera) were considered threatened in South Carolina and will be discussed in more detail in a subsequent publication:  
*Polycentropus carlsoni* Morse (Polycentropodidae),  
*Wormaldia thyria* Denning (Philopotamidae),  
*Pseudogoera singularis* Carpenter (Odontoceridae),  
*Psilotreta frontalis* Banks (Odontoceridae), and  
*Agarodes griseus* Banks (Sericostrimatidae).

The Wildcat Creek drainage also is the type locality for one species of black fly (Diptera: Simuliidae), *Simulium loerchae* Adler (1987), and is the site of two undescribed species in the *S. tuberosum* complex (Adler pers. comm.). Furthermore, the plant *Nestronia umbellula* Rafinesque (Santalaceae), North American sandalwood, has been labeled as a species for national concern by the Advisory Commission for South Carolina Rare and Endangered Plants (Rodgers *et al.* 1979).

Due to the occurrence of these unusual plants and animals, the South Carolina Wildlife and Marine Resources Department (SCWMRD) approached Clemson University to designate its lands in the Wildcat Creek watershed as a Registered Heritage Site. The purpose was to protect the area from pollution, sedimentation, clearcutting, or sales to private developers. The University's Forest Advisory Committee also is considering other alternative protective agreements.

Another important reason for protecting the habitat and fauna of the stream is the likelihood that Wildcat Creek may serve as a reference stream for pollution assessment in the upper Piedmont. The United States Environmental Protection Agency (US EPA) (Plafkin *et al.* 1989) and the cooperating South Carolina Department of Health and Environmental Control (SC DHEC) regularly monitor populations of aquatic insects, especially pollution-intolerant mayflies, stoneflies, and caddisflies ("EPT") to detect changes in water quality. One or more reference streams in a given "ecoregion" are important standards against which to compare others in the same ecoregion.

No comprehensive taxonomic study of the macroinvertebrates of Wildcat Creek has been made. McCaskill (1967, 1973) and McCaskill and Prins (1968) included Wildcat Creek stoneflies in their research on Plecoptera of northwestern South Carolina. Three species of *Tallaperla* were cited from Wildcat Creek by Stark (1983). Carlson (1971) studied emergence patterns of Wildcat Creek mayflies, creating a partial list of its species. He also collected stoneflies and caddisflies, depositing them in the Clemson University Arthropod Collection. White *et al.* (1979) published a report on the emergence patterns of stoneflies of northwestern South Carolina, including data from Wildcat Creek. Students from the Clemson University Aquatic Insects course (ENT 469/669) and Taxonomy of Immature Insects course (ENT 808) have collected and identified specimens from the stream since 1959, many of which specimens and records are now in the Clemson University Arthropod Collection. A separate study of the caddisflies of Wildcat Creek is in progress (M.A. Floyd pers. comm.).

## MATERIALS AND METHODS

Research was initiated in the summer of 1991 to collect and identify mayflies and stoneflies from Wildcat Creek and to combine the resulting data with those from the above-mentioned other resources to develop comprehensive lists for these insect orders. Collections were accomplished with the semi-quantitative sampling equipment and techniques recommended by the US EPA (Plafkin *et al.* 1989) in anticipation of comparative use of the resulting data in water quality assessments of other upper Piedmont streams. Identifications were accomplished for genera of Ephemeroptera and Plecoptera with the keys of Merritt and Cummins (1984) and Stewart and Stark (1988), except in cases where generic names have changed since these publications. Identifications for species were accomplished by specialists mentioned in the Acknowledgments or, for nymphs, were determined or confirmed by us with the keys of Unzicker and Carlson (1982) and Unzicker and McCaskill (1982) for mayflies and stoneflies, respectively.

Specimens and records in the Clemson University Arthropod Collection were combined with the results of the above sampling and literature search.

## RESULTS AND DISCUSSION

Thirty-five species of mayflies (Table 1) and 24 species of stoneflies (Table 2) are reported from Wildcat Creek.

The diversity of mayfly and stonefly species from Wildcat Creek is comparable with that of faunas of other streams surveyed in similar or nearby ecoregions of North and South Carolina (Table 3), exceeding the numbers of total species and unique species (among these streams only) for most of these other streams. Among these streams, only Upper Three Runs Creek, Aiken County, South Carolina, has larger total and unique numbers of stoneflies. (Upper Three Runs Creek ranks among streams with the highest recorded insect species diversity in the world and its environmental characteristics are quite different from those of Wildcat Creek [Morse *et al.* 1980, 1983].) Furthermore, the number of mayfly and stonefly species alone (59, not including caddisflies) is greater than the EPT taxa richness criterion for "excellent" classification by North Carolina Division of Environmental Management (NC DEM) standards for either Piedmont (>31 taxa) or Mountain (>41 taxa) ecoregion streams (Lenat, 1988). Although more extensive investigation techniques were used to estimate the total mayfly and stonefly fauna in Wildcat Creek than are usually employed in NC DEM biomonitoring procedures, the

Wildcat Creek taxa richness numbers nevertheless are valuable for demonstrating the high biodiversity of the stream.

For these reasons, we are convinced that the Wildcat Creek watershed is an exemplary biodiversity resource for South Carolina, not only for mayflies and stoneflies but also for other plants and animals. As such, it deserves special protection from habitat alteration, and the stream's macroinvertebrate fauna should be used by biological monitoring agencies as a standard for detecting freshwater perturbations. The watershed and its biota have been an excellent biological research and teaching environment for many years and efforts to maintain the habitat and continue that use as their primary function are appropriate.

Table 1. Mayflies (Ephemeroptera) of Wildcat Creek, Pickens County, South Carolina. Dates refer to range of capture times for imago or subimago specimens (only nymphs were collected where no dates are provided). Classification is according to McCafferty (1991). Determinations are by P.H. Carlson (PHC), S.M. Daniels (SMD), J.C. Morse (JCM), and W.L. Peters (WLP).

Suborder RETRACHEATA

Infraorder LANCEOLATA

Superfamily Leptophlebioidea

Family Leptophlebiidae

*Habrophlebia vibrans* Needham. 20 Apr - 28 Aug. PHC, WLP.

*Habrophlebiodes americana* (Banks). 20 Apr - 8 Oct. PHC, WLP.

*Leptophlebia austrina* (Traver). 15 Mar - 7 Apr. PHC, WLP.

*Paraleptophlebia guttata* (McDunnough). 5 Apr - 14 Oct. PHC, WLP.

Superfamily Ephemeroidea

Family Epemeridae

*Ephemera blanda* Traver. 13 May - 22 Aug. PHC, WLP.

*Hexagenia limbata* (Serville). PHC, WLP.

Infraorder PANNOTA

Superfamily Caenoidea

Family Ephemerellidae

*Ephemerella catawba* Traver. 14 May - 14 Jun. PHC, WLP.

*Ephemerella dorothea* Needham. 8 Apr - 4 Sep. PHC, SMD, JCM, WLP.

*Ephemerella inconstans* Traver. PHC, WLP.

*Ephemerella septentrionalis* McDunnough. PHC, WLP.

*Euryophella bicolor* (Clemens). PHC, WLP.

*Euryophella funeralis* (McDunnough). PHC, WLP.

*Euryophella prudentialis* (McDunnough). 6 May - 29 Jul. PHC, WLP.

*Euryophella temporalis* (McDunnough). PHC, WLP.

*Serratella deficiens* (Morgan). SMD, JCM.

Family Caenidae

*Caenis amica* Hagen. 15 Sep. PHC.

Superfamily Baetiscoidea

Family Baetiscidae

*Baetisca carolina* Traver. PHC.

**Suborder SETISURA****Family Isonychiidae***Isonychia (I.) bicolor* (Walker). 26 May - 29 Jun. PHC, WLP.*Isonychia (Prionodes) georgiae* McDunnough. 27 Jul - 5 Sep. PHC, WLP.**Family Heptageniidae***Epeorus dispar* (Traver). SMD, JCM.*Epeorus rubidus* (Traver). 10 Apr - 30 Jul. PHC, WLP.*Leucrocota aphrodite* (McDunnough). 14 Apr - 12 Sep. PHC, WLP.*Stenacron interpunctatum* (Say). 22 Apr - 25 Sep. PHC, WLP.*Stenonema carlsoni* Lewis. SMD, JCM (and Lewis, 1974, type locality).*Stenonema mexicanum integrum* (McDunnough). 22 May - 29 Sep. PHC, WLP.*Stenonema pudicum* (Hagen). 25 Apr - 11 Oct. PHC, WLP.*Stenonema terminatum* (Walsh). JCM.**Suborder PISCIFORMA****Infraorder IMPRIMATA****Family Baetidae***Acentrella ampla* Traver. 20 Mar - 29 Mar. PHC, WLP.*Baetis tricaudatus* Dodds. JCM.*Procloeon bellum* (McDunnough). 4 May - 26 May. PHC.*Procloeon quaesitum* McDunnough. PHC.*Procloeon rivulare* Traver. 26 May. PHC.*Procloeon rubropictum* (McDunnough). 12 Jun - 30 Jun. PHC.**Family Siphonuridae***Ameletus* sp. 15 Mar - 3 May. PHC, WLP.*Siphonurus mirus* Eaton. Apr. PHC, WLP.

Table 2. Stoneflies (Plecoptera) of Wildcat Creek, Pickens County, South Carolina. Dates refer to range of capture times for adult specimens (only nymphs were collected where no dates are provided). Classification is according to Stark *et al.* (1986). Determinations are by S.M. Daniels (SMD), V.H. McCaskill (VHM), J.C. Morse (JCM), an anonymous reviewer (ANR), W.E. Ricker (WER), H.H. Ross (HHR), B.P. Stark (PBS), and T.R. White (TRW).

**Group EUHOLOGNATHA****Family Capniidae***Allocapnia aurora* Ricker. 23 Nov - 12 Apr. BPS, WER, HHR.*Allocapnia recta* (Claassen). 23 Nov - 12 Apr. BPS, WER.**Family Leuctridae***Leuctra ferruginea* (Walker). 23 Nov - 12 Apr. BPS.**Family Nemouridae***Amphinemura wui* (Claassen). 31 May. WER.**Family Taeniopterygidae***Taeniopteryx maura* (Pictet). 23 Nov - 12 Apr. PBS.**Group SYSTELLOGNATHA****Family Peltoperlidae***Tallaperla cornelia* (Needham & Smith). 1 Jun. (Stark 1983).*Tallaperla laurie* (Ricker). 10 May - 22 Jun. WER (also, Stark 1983).*Tallaperla maria* (Needham & Smith). 25 Apr. (Stark 1983).



## Family Perlidae

- Acroneuria abnormis* (Newman). SMD, JCM, WER, TRW.  
*Acroneuria arenosa* (Pictet). SMD, JCM.  
*Beloneuria stewarti* Stark & Szczytko. SMD (and Stark and Szczytko 1976.)  
*Eccoptura xanthenes* (Newman). SMD, JCM, TRW.  
*Paragnetina prob. ichusa* Stark & Szczytko. SMD, JCM.  
*Paragnetina immarginata* (Say). SMD.  
*Perlesta frisoni* Banks. WER.

## Family Perlodidae

- Chioperla clio* (Newman). WER.  
*Diploperla duplicata* (Banks). SMD, JCM.  
*Isoperla dicala* Frison. 31 May. WER.  
*Isoperla holochlora* (Klapálek). SMD.  
*Isoperla similis* (Hagen). SMD.  
*Isoperla* sp. A. SMD.  
*Remenus bilobatus* (Needham and Claassen). WER.  
*Yugus bulbosus* (Frison). WER.

## Family Pteronarcyidae

- Pteronarcys biloba* Newman. VHM, WER.

Table 3. Total (tot) and unique (uniq) numbers of mayfly (Eph) and stonefly (Ple) species in selected streams of similar or nearby ecoregions of North (NC) and South Carolina (SC). WC = Wildcat Creek, Pickens County, SC, 1st order stream, upper Piedmont; BC = Broadway Creek, Anderson County, SC, 3rd order stream, upper Piedmont (unpublished data); CC = Coley Creek, Oconee County, SC, and Transylvania County, NC, 1st order stream, Mountains (Morse *et al.* 1989); UC = Upper Three Runs Creek, Aiken County, SC, 3rd order stream, Sandhills (Morse *et al.* 1980); FS = Fourholes Swamp, Berkeley and Dorchester Counties, SC, 3rd order stream, Coastal Plain (unpublished data); CP = entire Coastal Plain in South Carolina (Carlson, 1981).

	WC		BC		CC		UC		FS		CP	
	tot	uniq	tot	uniq	tot	uniq	tot	uniq	tot	uniq	tot	uniq
Eph	35	15	21	6	18	8	25	14	—	—	18	14
Ple	24	11	12	2	21	9	28	14	2	0	5	0

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University). Our sincere appreciation goes to Michael A. Floyd and Kevin M. Hoffman for tutoring the senior author in several specimen identifications. We also extend our gratitude to Steve Jones and Jane Gaddis for site information concerning Wildcat Creek and for directing us to important references. Peter H. Adler and Thomas M. Brown provided useful reviews of the manuscript. Three anonymous reviewers helped correct some of the citations in Tables 1 and 2 and made useful suggestions for improving the manuscript. This is Technical Contribution No. 3223 of the South Carolina Agricultural Experiment Station, Clemson University.

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## NEW DISTRIBUTIONAL RECORDS FOR *DILOTAXIS ATLANTIS* (COLEOPTERA: SCARABAEIDAE)<sup>1</sup>

Paul K. Lago<sup>2</sup>, Scott McCleve<sup>3</sup>

**ABSTRACT:** The distribution of *Diplotaxis atlantis* is extended north-westward to include North Dakota and Montana.

During a survey of the phytophagous Scarabaeidae of North Dakota (Lago, *et al.* 1979) 28 specimens of a species of *Diplotaxis* were collected on western wild rose (*Rosa woodsii* Lindl.) at Heart Butte Dam, Grant County, that could not be readily identified using the available literature. The name *D. tristis* Kirby was applied to the series and the specimens were sent to Mrs. Patricia Vaurie for verification. Although she agreed with the identification, she also indicated that minor discrepancies existed between this series and true *tristis* (Vaurie 1976, pers. comm.).

Recently, surface sculpture of the right mandibular mola was discovered by one of us (McCleve) to be of value in identifying *Diplotaxis*. After reexamining the North Dakota series, we have concluded that the species is, in fact, *D. atlantis* Fall, generally considered to be eastern in distribution (Vaurie 1956, 1960). The real problem in identifying these specimens using Vaurie's (1960) key rests with the interpretation of the clypeal emargination (couplet 4, p 356). Some species within the *brevicollis-haydenii* group may have the clypeus either emarginate or truncate and will key in either direction from couplet 4. Specimens of *D. atlantis* can be keyed only if the clypeus is said to be truncate; however, the North Dakota specimens, as well as some from eastern localities, have a slightly emarginate clypeus. This character state was mentioned by Vaurie (1960: 390; "very slightly sinuate"), but was not taken into account in the key.

While working through a large collection of *Diplotaxis* from Montana State University, five males of *D. atlantis* were discovered. Label data read: "Mont. Bighorn Co., Bighorn R., Ft. Smith, 25 May 1988, D.L. Gustafson col". These specimens are similar in all respects to those from North Dakota, including the slight clypeal emargination. None of these

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western specimens has the medio-basal pronotal line that Vaurie (1960) mentioned as being present on central Oklahoma representatives of *atlantis*.

Previously, the known range of *D. atlantis* extended from New England southward to Arkansas and westward to central Iowa, eastern Nebraska and central Oklahoma (Vaurie, 1960). The discovery of the two apparently disjunct populations reported here greatly extends this range to the northwest (southwestern North Dakota and southcentral Montana).

#### ACKNOWLEDGMENT

Brett Ratcliffe and Bill Warner offered valuable comments for the improvement of this paper.

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#### CORRECTION

In the paper "1990 Additions to the Annotated List of the Insects of Macau" (Ent. News 103 (1): 30-36, January and February, 1992), a name correction is needed on page 34 under "Diptera: Streblidae". The bat fly species of *Raymondia pagodarum* is incorrect. The correct species should have been identified as *Brachytarsina amboinensis* (Rondani). The author caught this correction too late for inclusion in the original paper and regrets this error.

## AN EFFICIENT AND INEXPENSIVE PITFALL TRAP SYSTEM<sup>1</sup>

William H. Clark<sup>2</sup>, Paul E. Blom<sup>3</sup>

**ABSTRACT:** An inexpensive pitfall trap system which allows for rapid and easy field collection of invertebrates is described. The system is constructed from metal cans and plastic jugs which are common household materials and would normally be discarded. Ethylene-glycol antifreeze works best for a preservative, protecting specimens for several years in the field. This system has proven successful in the western United States and Baja California, México.

Pitfall traps have been used over the years to collect a wide variety of animals (arthropods: Beirne 1955, Peterson 1959, Knudsen 1966, Freeman 1974, Borror *et al.* 1989, Dunn 1989; reptiles and amphibians: Gibbons and Semlitsch 1981, Corn and Bury 1990; and mammals: Smith *et al.* 1975, Gibbons and Semlitsch 1981, Clark and Yensen 1982, Williams and Braun 1983, American Society of Mammalogists 1987, to list a few). Variations in applications have included the addition of covers (American Society of Mammalogists 1987), ramps (Bostanian *et al.* 1983), funnels (Best 1977), and/or the use of drift fences (Gibbons and Semlitsch 1981, Clark and Yensen 1982); and baits (Greenlade and Greenlade 1971) to enhance efficiency of collecting specific taxa.

An inexpensive pitfall trap system constructed from readily available and usually discarded household materials is described which allows for rapid and easy field collection. We have used this system for ten years in the western United States and Baja California, México, with excellent success.

### MATERIALS AND METHODS

This pitfall trap design follows Morrill (1976) who used 16 oz. plastic Solo<sup>®</sup> cups. Our needs were for a more permanent trap of a larger capacity since the traps were to be left unattended for long periods of

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time. Traps were constructed from metal cans and plastic jugs (Fig. 1). The outer liner of the system was a 3 lb. 'coffee' can buried flush in the ground. A few holes were punched in the bottom to allow for drainage of excess rain water. The plastic lid, which comes with most three pound cans, was used to keep soil from falling into the outer liner during initial installation or later maintenance and for closing the trap during non-sampling intervals. The outer liner remained in the ground until the pitfall trap was discontinued. The inner liner was either plastic (i.e. bottom of 16 oz juice bottles) or metal (the bottom of a smaller 'coffee' can), filled with preservative and placed inside the outer liner. Invertebrates were channeled into the inner liner by a funnel cut from the top of a round, 1 gallon plastic jug (Fig. 1). A large cover (rock, board, etc.) helped in keeping out precipitation and excess debris and deterring larger animals attracted by the preservative (see Hall 1991). Additionally, the cover may have helped in attracting thigmotaxic invertebrates seeking covering objects. We selected an ethylene glycol-based anti-

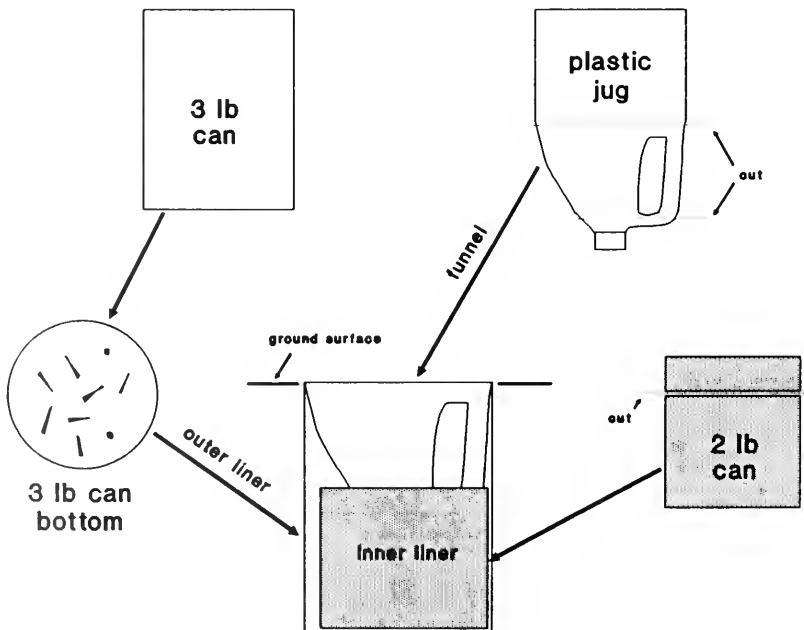


Figure 1. Assembly of the pitfall system from 'household' components.

freeze as the killing agent for its relatively slower rate of evaporation and preservation characteristics, protecting specimen integrity during several years of field exposure. Also, the antifreeze was readily available in a variety of outlets if the supply had to be supplemented in the field. Proper disposal of the ethylene glycol after its use and protection of vertebrates from pitfall traps containing it are recommended since it is an environmental hazard (Hall 1991).

To service the trap the contents were strained through a wire mesh household strainer. A fine fabric mesh (such as mosquito netting) was placed inside the strainer when collection of smaller invertebrates was desired. If the preservative was clean, it was collected in a container for reuse; if too dirty or diluted it was placed in a container to receive proper disposal. The sample and inner liner were rinsed with water, and the sample placed into a labeled jar with 70% ethyl alcohol (ETOH). T.D. Miller (pers. comm. April 1991) suggested a first rinse with soap and water to more thoroughly remove the ethylene glycol. The recharged liner and funnel were reset and the cover placed back over the trap. Time at the trap location was further reduced by exchanging old for new pre-charged liners, and straining the sample later.

A band saw was useful for trimming the inner liners and funnels. Storage of the components was facilitated by nesting the parts in the three pound can liners, which could then be stacked in boxes or on shelving. Components for approximately 100 traps were easily accumulated in one year via a standing request with friends and colleagues.

## RESULTS AND DISCUSSION

We have collected well preserved samples from traps that had been out for up to three years in the Central Desert of Baja California, México. When a long collection interval was anticipated the antifreeze was used undiluted, allowing for future dilution by precipitation, and thereby minimizing specimen deterioration. For shorter periods, the more common 50:50 antifreeze to water ratio was employed. When traps dried completely, a great many of the specimens could be successfully rewetted for processing with ETOH or water. In a few wetter locations some molding was encountered over longer periods of exposure (i.e. >1 yr), though this was usually of little consequence in the xeric habitats we sampled. The system works just as well over short time periods.

A major advantage of this system was the short time (five minutes or less) required to service. This both optimized field time and drew less attention to the trap location in populated areas. If field conditions dictated that the initial rinse be minimal, a more thorough rinse was



made before final pinning or alcohol storage. We have observed that generally, specimens taken in the ethylene glycol mixture tended to retain more flexibility even after pinning than insects killed in cyanide or ETOH. This was especially true of the medium to large sized beetles. In areas of high litter fall we encountered some filling and blockage of the funnel by leaves. Under such conditions the traps need to be serviced more frequently or screened in some fashion for optimal efficiency.

Our pitfall trap system has yielded many interesting species and distribution records (Papp 1989; Triplehorn *in prep*). Many other studies using specimens from this collection system will be published in time. While precise collection dates could not be determined when the traps were used for extended periods, they did provide information on the presence of species in various habitats. This preliminary information has served as the starting point for more detailed investigations.

#### ACKNOWLEDGMENTS

This research was supported, in part, by grants from EARTHWATCH and The Center For Field Research of Watertown, MA. Dave Ward, Jr., Mary Ellen, and Cindy Clark; Gary Shook; and others have assisted with the field testing of this pitfall trap system. Shook and Ward reviewed an earlier draft of this paper and James B. Johnson and Frank W. Merickel provided comments on a later draft. Albert Allen has sorted many pitfall samples and offered valuable suggestions. Published with the approval of the Director of the Idaho Agricultural Experiment Station as Research Paper #91766.

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## SOCIETY MEETING OF OCTOBER 23, 1991

### Sex, Flies and Videotape

David Funk

Mating swarms are a common behavior in several orders of insects, including Ephemeroptera, Trichoptera and Diptera, and characteristically are composed only of males; females enter a swarm, choose a male to mate with and the pair leaves the swarm. In many dance flies (Diptera: Empididae), males in a swarm may contain a "prenuptial" gift for the female, usually insuring that the female will be kept busy feeding on the gift long enough to allow successful transmission of the male's sperm. As determined by research presented by Dave Funk, Stroud Water Research Center, Avondale, PA, the long-tailed dance fly, *Rhizophomyia longicauda* Loew, shows a surprising variation on this swarming theme: the swarms are composed predominately of females, who compete within the swarms for visiting males bringing prey.

*Rhizophomyia longicauda* swarms are only found at dusk in late spring, always under an opening in the forest canopy, and composed of 10-100 females. Males approach the swarm carrying prey, fly under the females (observing the silhouettes of the females against the sky), and choose the largest female by hovering briefly beneath her. Of great interest is the female strategy for attracting (and fooling) the males. Females inflate their abdomens with air by closing a sphincter between the mid- and hindguts, inflating the midgut, therefore increasing the size of their silhouette (and apparently giving the males the appearance of a female carrying fully matured eggs). Dave Funk tested whether males actually do prefer larger females by stringing different-sized female models among an actual swarm of

(continued on page 64)

## SOCIETY MEETING OF NOVEMBER 20, 1991

### Spider Abundance and Diversity

Dr. Robert L. Edwards

Spiders are a most diverse group of arthropods, particularly in terms of their morphology, behavior and ecology. Their origins are ancient, extending at least to the Devonian. Therefore, it is only appropriate that a concentrated study of the group, even if derived from one's "own backyard" can have broad applications to the measurement and estimation of biological diversity.

Dr. Robert L. Edwards, Woods Hole, Massachusetts, an accomplished researcher with a long-term interest in population ecology and species diversity, initiated a study of spiders upon his retirement from fisheries science in the 1980's. He focused his attention on a 20 km<sup>2</sup> area on the southwestern corner of the Cape Cod peninsula. This area encompasses beach, dune, shrubland, bog and second growth forest habitats. Surprisingly, when adjusted for the size of the area, Cape Cod now has the highest recorded number of species (465+) of spiders in North America, and this total continues to increase. Using a quadrat sampling system, Dr. Edwards has examined other aspects of spider abundance and diversity with equally impressive results, including determining which microhabitat harbors the most species (coniferous litter) and which area the greatest number of individuals (mixed woods with red cedars topped the list with circa 30,000,000 spiders per hectare!). Other experimental approaches have examined the number of quadrats required for different habitat types to effectively measure species richness, the ideal size of quadrats and other aspects of sampling methodology. Contrary to the conventional wisdom, comparable studies in tropical Costa Rica have so far provided estimates of species richness similar to those determined for the Cape Cod region.

Several items of entomological interest were also presented by the members. Roger Fuester, who has been studying natural enemies of gypsy moth for some years, noted that larvae of an introduced species of predaceous *Calosoma* carabid beetle show a strong bias toward female gypsy moth pupae over males, probably because the female pupae are significantly larger than the males. Paul Schaefer noted that the introduced beneficial coccinellid *Harmonia*, established in Mississippi and possibly elsewhere in North America, is now entering houses for overwintering in great numbers; in its native Asia, the beetle overwinters in rock outcroppings. Chuck Mason also described the uncommon fall activity of carrion beetles on a dead squirrel.

About 40 members and guests were present.

Jon K. Gelhaus  
Corresponding Secretary

## FIRST RECORD FOR THE SOLDIER FLY, *NEMOTELUS KANSENSIS* (DIPTERA: STRATIOMYIDAE) IN NEW YORK STATE<sup>1</sup>

Carey E. Vasey<sup>2</sup>

**ABSTRACT:** Nine specimens of the soldier fly, *Nemotelus kansensis* were collected at three different sites in the towns of Geneseo and Avon, Livingston County, New York in June 1989. Three more specimens were found at a different site in Geneseo in June 1991. These collections represent new records for this species whose previous easternmost distribution was Michigan and Indiana.

In 1989 I collected nine specimens of *Nemotelus kansensis* Adams at three different sites in Livingston County, New York: On June 23, two males and two females were taken on the lower campus of the State University College of Arts and Science at Geneseo near NY route 63; five days later, two additional males were collected in a pasture near Fallbrook Creek about 0.5 miles SW of Geneseo near US route 20A; and, on July 5, 1989 three males were captured from vegetation near Conesus Creek on Triphammer Road in the Town of Avon, 5.5 miles NE of Geneseo. All specimens were collected from the flowers of *Chrysanthemum leucanthemum* L., the ox-eye daisy. In the first instance, the flies were taken at the edge of a swampy area while all remaining specimens were collected on daisies growing near the banks of slow running streams.

Three additional females and a lone male were collected from a site about 0.25 miles NW of the Geneseo Campus near the Genesee River on NY route 63 on June 3, 1991. As was true of other specimens, these were collected from the inflorescence of the ox-eye daisy.

*Nemotelus* Geoffroy encompasses a group of small Stratiomyidae that is characterized by a prominent cone-shaped projection on the face below the antennae. The genus is divided into two subgenera (James 1936, 1965, 1981). The twelve species listed under the subgenus *Nemotelus* Geoffroy have both  $R_4$  and  $R_5$  veins present in the wing. A key to the Nearctic species for this subgenus was provided by James (1936). The remaining twenty-six species of *Nemotelus* are listed under the subgenus *Camptopelta* Williston and in this group the  $R_4$  vein is lost. This assemblage of flies has been revised by Hanson (1958, 1963).

According to Hanson (1958) and James (1965), only three species of *Nemotelus* have been reported from New York. These include *Nemotelus*

<sup>1</sup>Received August 8, 1991. Accepted November 18, 1991.

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*glaber* Loew, *Nemotelus nigrinus* Falleñ, and *Nemotelus melanderi* Banks. The former has been recorded only from Long Island while the latter occurs only along the Atlantic Coast from Nova Scotia south to Florida (Hanson 1958 and by personal communication). *Nemotelus nigrinus* has a wider distribution and has been collected from several sites in New York (Vasey, unpublished data). All the above species are included in the subgenus *Camptopelta*, so that *Nemotelus kansensis* is the first record of the subgenus *Nemotelus* to occur in New York. The previous easternmost records for *Nemotelus kansensis* is Michigan and Indiana (Hanson, personal communication).

Adult females (Fig. 1) are dichoptic. The black abdomen is marked by



Fig. 1

Fig. 1. Adult female illustrating the triangles on the dorsal aspect of the abdomen and the dichoptic nature of the eyes.

single pale triangles on the dorsal median regions of segments two, three, and four. It is interesting to note that the triangle on segment four is expanded laterally; a characteristic of populations currently listed under the subspecies *trinotatus* Melander (James 1936, 1965). In the subspecies *kansensis* Adams, the triangle on segment four is like that of segment three. Adult males (Fig. 2) are holoptic and the abdomen is immaculate except for the basal region of segment five which bears a black band. Males are more typically *kansensis* (James 1936; Hanson personal communication).



Fig. 2

Fig. 2. Adult male showing immaculate nature of the abdomen. Note the black band on the basal region of segment 5. The eyes are clearly holoptic.

## ACKNOWLEDGMENTS

I wish to thank Robert C. Beason and George M. Briggs, Department of Biology, SUNY at Geneseo as well as Norman Woodley, USDA Systematics Laboratory, Washington, D.C. for their advice and suggestions after reading the manuscript. I am especially grateful to Wilford J. Hanson, Biology Department, Utah State University, Ogden, Utah who also critically reviewed the manuscript and verified my determinations of *Nemotelus kansensis* as well. A special thanks to Ronald Pretzer for his technical assistance in preparing the photographs used in this study.

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(continued from page 59)

females, and then noting the male responses on infrared videotape: the largest models (twice life size) elicited the majority of the male responses. This was clearly demonstrated to the audience by a spectacular clip of the infrared videotape, showing the males repeatedly pausing below the large models, waiting in vain for the appropriate female response of "dropping down" to the male!

There were several observations of entomological interest. Roger Fuester noted that a new serious pest in Florida is *Thrips palmi*, which shows resistance to many insecticides. R. "Tommy" Allen was introduced as the new head of the entomology department at the University of Delaware, and spoke briefly about his research plans on the systematics of *Diplura* and *Protura*.

About 25 members and guests were present.

Jon K. Gelhaus  
Corresponding Secretary

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# ENTOMOLOGICAL NEWS

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## NEW SPECIES OF LEAFHOPPERS IN THE GENERA *THAGRIA* (THAGRIINI) AND *THARRA* (THARRINI) FROM INDONESIA (HOMOPTERA: CICADELLIDAE: COELIDIINAE)<sup>1</sup>

M.W. Nielson<sup>2</sup>

**ABSTRACT:** Four new species of leafhoppers from Indonesia are described and illustrated. These are *Thagria checkettsi* and *T. excavata* in the tribe Thagriini and *Tharra bucina* and *T. emilyae* in the tribe Tharrini. The biogeography of the genera is briefly reviewed.

This paper describes two new species in each of the genera *Thagria* (Thagriini) and *Tharra* (Tharrini) as part of material collected by members of the 1985 project WALLACE sponsored by the Royal Entomological Society of London and the Indonesian Institute of Sciences (Results of Project WALLACE No. 134) (Knight 1988). Previous studies of *Thagria* covered 166 species (Kwon and Lee 1979b, Nielson 1977a, 1980a, 1980b, 1980c, 1980d, 1982c, 1986c, Zhang, 1990a) and of *Tharra*, 101 species (Nielson 1975a, 1982b). Speciation and biodiversity are extensive in both groups and they represent the most numerous among coelidiine leafhoppers in the Oriental and Australian regions.

*Thagria* has no known close relatives at the tribal level. The unique male genital and clypeal-clypellate characters set the group well apart from all other tribes in the subfamily. *Tharra* has affinities to the Neotropical Youngolidiini and it may represent the stem of that group which may have arisen during neocontinental development. The concealed male genital characters are uniquely different from all other tribes. The basal segmentation of the male plates and the head characters clearly place the group nearest to the tribe Youngolidiini.

Nearly two-thirds of the known species of *Thagria* occur in the Oriental region whereas nearly one-third occupy the Australian region. Four species have inroads into the Palaearctic region in the southern most islands of Japan and adjacent Korea. In the Oriental region proper, speciation reaches its highest level in the Indo-Malayan subregion followed by a moderate level in the Indo-Chinese subregion. The faunal species drop precipitously in the Srilankenese and Indian subregions. In the Australian region, speciation is

<sup>1</sup>Received November 19, 1991. Accepted March 10, 1992.

<sup>2</sup>M. L. Bean Life Science Museum, Brigham Young University, Provo, UT 84602.

epitomized in the Austro-Malayan subregion. Only two species have ventured into the Polynesian subregion and none are known for the Australian and New Zealand subregions.

In the genus *Tharra* about 90% of the species occupy the Australian region; the remainder are in the Oriental region. In the Australian region proper, speciation is most prevalent in and nearly equally divided between the Austro-Malayan and Polynesian subregions. Only four species occur in the Australian subregion and these are restricted to the northern state of Queensland. Only 10 species are known from the Oriental region and they are exclusive to the Indo-Malayan subregion.

Lack of host records has made it very difficult to clue into the origin of these groups and their speciation processes, particularly in the genus *Thagria*. The eastern Oriental region (Indo-Malayan subregion) and western Australian region (Austro-Malayan subregion), where equal numbers of species of *Thagria* are present, provide a puzzling scenario in the origin of the genus. The genus *Tharra* is likely of Austro-Malayan origin augmented by profuse speciation therein and in the Polynesian subregion.

### *Thagria checksettsi*, new species

(Figs. 1-4)

**Length.**—Male 7.70 mm.

General color piceous with numerous small ochraceous spots on pronotum, ochraceous markings in clavus and costa of forewings; crown piceous with large oval spot basally; face piceous. Similar to *similis* Nielson in male genital characters.

Head large, narrower than pronotum, somewhat conical in outline; crown narrow, basal width narrower than width of eyes, lateral margins converging basally, surface striate, depressed medially in basal 2/3; eyes large, elongate ovoid; pronotum and scutellum large, each longer than median length of crown; forewing and venation typical; clypeus long and narrow; clypellus narrow, base flattened.

**Male.**—Pygofer in lateral view with long broad caudoventral lobe, dorsal margin armed with long, narrow process ventrally and broad, ornate lobe dorsally, lobe with narrow curved process apically, small sharp spine ventrally; tenth segment with long narrow process, curved ventrally at middle (Fig. 1); aedeagus symmetrical, short, about 1/2 as long as ventral paraphysis; ventral paraphysis partially asymmetrical, long, broad basally and abruptly narrowed in distal 2/3 view (Fig. 3), narrowed and curved in lateral view with swelling subapically (Fig. 4); style long, reaching to apex of ventral paraphysis, apical 1/5 triangulate in dorsal view (Fig. 3).

**Female.**—Unknown.

**Holotype** (male).—INDONESIA: Sulawesi Utara, G. Magonipa summit, 1008 m., Dumogo-Bone N.P., 20.V.1985, Project WALLACE, Royal Ent. Soc. London, BM 1985-10 (BMNH).

**Remarks.**—This species, which keys near *similis*, can be distinguished by the more ornate and extra processes on the caudorsal margin of the pygofer and by the apically triangulate style. I name this species for my son-in-law, Daniel Scott Checketts.

### ***Thagria excavata*, new species**

(Figs. 5-8)

**Length.**—Male 7.70 mm., female 8.40 mm.

General color deep fuscous with several small to large faint ochraceous spots in cells of forewings, narrow transverse ochraceous band subapically. Similar to *pala* Nielson and *ventrocarina* Nielson in male genital characters.

Head large, narrower than pronotum; crown broad, about as wide as eye, surface longitudinally striate, depressed on either side of middle in basal half; eyes large, semiglobular; pronotum short, median length less than median length of crown; scutellum large, longer than crown; forewings and venation typical; clypeus long and narrow; clypellus narrow, base flattened.

**Male.**—Pygofer in lateral view with large caudoventral lobe, lobe excavated apically, with short dorsal spine on apicodorsal margin, long narrow process arising from ventral margin, caudodorsal margin with short broad arrow-shaped process (Fig. 5); tenth segment with two ventral processes; ventral paraphysis large and broad, with pair of laterobasal spines projecting mesally, pair of lateroapical processes projecting distally and median process excised distally (Fig. 6), paraphysis excavated subbasally in ventral margin and apically in lateral view (Fig. 7); style very short (Fig. 8).

**Female.**—Seventh sternum long, about twice as long as preceding segment, caudal margin sinuate.

**Holotype** (male).—INDONESIA: Sulawesi Utara, Dumoga-Bone N.P., —I.1985, lowland forest, 200-300 m., Royal Ent. Soc. London, Project WALLACE, B.M. 1985-10 (BMNH). Allotype female, same data as holotype except —III.1985 (BMNH).

**Remarks.**—This species keys near *pala* in my 1977 paper and can be easily separated by the excavation on the apex of the caudoventral lobe of the pygofer and apex of the ventral paraphysis.

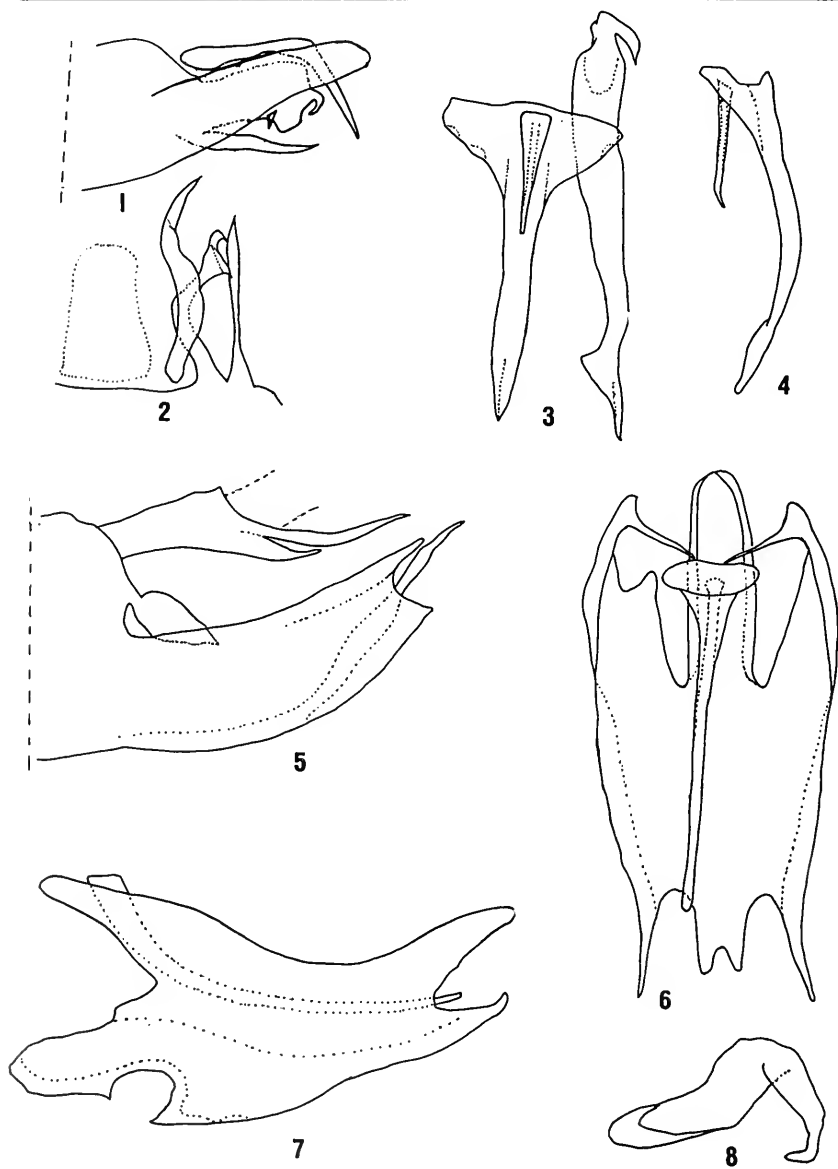
### ***Tharra bucina*, new species**

(Figs. 9-12)

**Length.**—Male 6.40 mm.

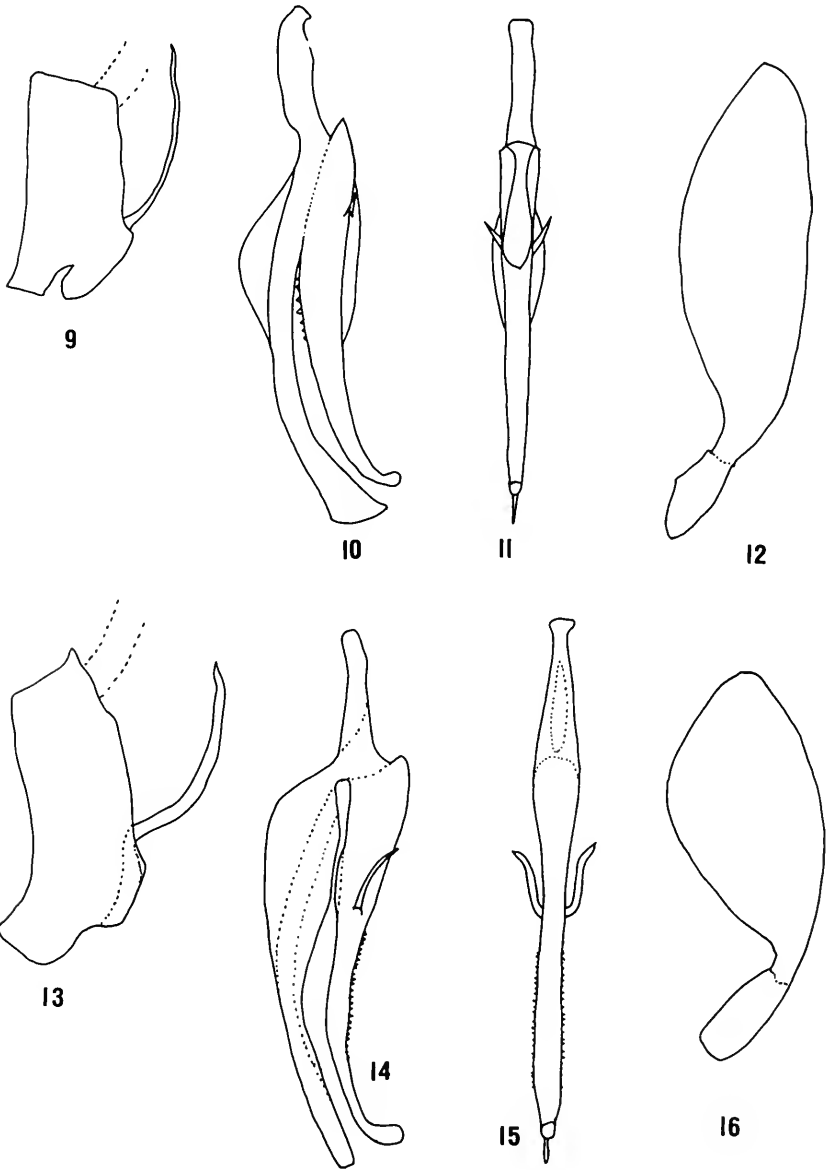
General color ochraceous to fuscous; clavus with triangular spot near middle, irregular pale area distad of clavus; pronotum with very small fuscous spots. Similar to *marlatti* Nielson in male genital characters.

Head narrower than pronotum, crown strongly produced beyond anterior margin of eyes, conical apically, elevated above level of eyes, surface striate, narrower than width of eye; pronotum shorter than crown; scutellum longer than pronotum; forewings and venation typical; clypeus and clypellus typical.



Figs. 1-4. *Thagria checksetsi*, n. sp. 1. Male pygofer & 10th segment, lateral view. 2. Pygofer and 10th segment processes, dorsal view. 3. Aedeagus, ventral paraphysis and style, dorsal view. 4. Aedeagus and ventral paraphysis, lateral view.

Figs. 5-8. *Thagria excavata*, n. sp. 5. Male pygofer, lateral view. 6. Aedeagus and ventral paraphysis, dorsal view. 7. Aedeagus and ventral paraphysis, lateral view. 8. Style, dorsal view.



Figs. 9-12. *Tharra bucina*, n. sp. 9. Male pygofer, lateral view. 10. Aedeagus, lateral view. 11. Aedeagus, dorsal view. 12. Plate, lateral view.

Figs. 13-16. *Tharra emilyae*, n. sp. 13. Male pygofer, lateral view. 14. Aedeagus, lateral view. 15. Aedeagus, dorsal view. 16. Plate, lateral view.



**Male.**—Pygofer in lateral view with long, very narrow caudoventral process, process with irregular margins and extending beyond dorsal margin of pygofer (Fig. 9); aedeagus symmetrical, dorsal appendage long and broad, with pair of spines near base on dorsal margin, flanged laterally along middle of dorsal margin, toothed along middle of ventral margin, ventral appendage long, trumpet-shaped distally with ventral keel in basal half (Figs. 10 & 11); plate long and elliptical (Fig. 12).

**Female.**—Unknown.

**Holotype (male).**—INDONESIA: Sulawesi Utara, Dumoga-Bone N.P., Torault nr. base camp, 200 m., —III.1985, J. H. Martin, Royal Ent. Soc. London, Project WALLACE, B.M. 1985-10 (BMNH). Paratype, 1 male, same data as holotype except Gng. Ambang nr. Kotamogagu, Fog 7, 1200 m., 18.II.1985 (author's collection).

**Remarks.**—This species can be distinguished from *marlatti* by its longer head, by presence of a dorsal flange on the dorsal appendage and ventral keel on the ventral appendage of the aedeagus.

### *Tharra emilyae*, new species

(Figs. 13-16)

**Length.**—Male 6.40 mm., female 7.30 mm.

General color fuscous with ochraceous head, pronotum, scutellum and basal half of clavus of forewings. Similar to *costata* Nielson in male genital characters.

Head narrower than pronotum; crown produced distally to about 1/3 of its entire median length beyond anterior margin of eyes, narrower than width of eye, elevated, surface striate; pronotum shorter than crown; scutellum longer than pronotum; forewings and venation typical; clypeus and clypellus typical.

**Male.**—Pygofer in lateral view with long narrow caudoventral process, process nearly reaching to dorsal margin of pygofer (Fig. 13); aedeagus symmetrical, dorsal appendage long, broad in basal 1/3, tapered toward slightly enlarged and curved apex, with long spine subbasally, arising from each side of lateral margin and projecting basally, dorsal margin dentate in middle 1/3, ventral appendage broad basally, tapered distally to truncate apex (Fig. 14, 15); plate broad in middle 1/3 (Fig. 16).

**Female.**—Seventh sternum large, about twice as long as preceding segment, caudal margin broadly rounded.

**Holotype (male).**—INDONESIA: Sulawesi Utara, Dumoga-Bone N.P., —V.1985, at light, Clark's camp, 1140 m., J. H. Martin, Royal Ent. Soc. London, Project WALLACE, B.M. 1985-10 (BMNH). Allotype female, same data as holotype (BMNH). Paratype, 1 male, 1 female, same data as holotype (author's collection).

**Remarks.**—This species can be distinguished from *costata* by the broader base of the ventral appendage of the aedeagus, by the dentate dorsal margin of the dorsal appendage, and by the broader plate. This species is named for my granddaughter, Emily Nicole Hammer.

## ACKNOWLEDGMENTS

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## DESTRUCTION OF YOUNG COLONIES OF THE RED IMPORTED FIRE ANT BY THE PAVEMENT ANT (HYMENOPTERA: FORMICIDAE)<sup>1</sup>

Thomas G. King, Sherman A. Phillips, Jr.<sup>2</sup>

**ABSTRACT:** The ranges of the red imported fire ant, *Solenopsis invicta*, and the pavement ant, *Tetramorium caespitum*, are now virtually contiguous in North Carolina, and these species have undoubtedly interacted. Our laboratory study shows that *T. caespitum* will destroy young *S. invicta* colonies placed within its foraging range. If *S. invicta* moves northward, interactions between these two species may intensify.

The pavement ant, *Tetramorium caespitum* (L.), and the red imported fire ant, *Solenopsis invicta* Buren, can both rapidly mobilize many workers to dominate large food sources. Often this attempt to dominate a resource results in conflict with other ant species which they eliminate or "extirpate" as the situation requires (Wilson, 1971). Interspecific conflicts between ant species resulting in numerous deaths rarely occur in temperate ecosystems (see MacKay and MacKay 1982 for exceptions), but can occur when more than one extirpating species cohabit in an ecosystem. These conflicts occurred when *S. invicta*, a native of South America, was introduced into Alabama in the 1940's (Hung and Vinson, 1978). It has since spread across most of the southern U.S.A., eliminating the native, dominant species from much of their former range. At present, territorial limits of *S. invicta* in North America are largely defined by abiotic factors, namely cold weather in its northernmost range and arid conditions in its westernmost range (Hung and Vinson, 1978).

Bhatkar *et al.* (1972) suggested that the northward expansion of *S. invicta* may have been slowed or halted by the presence of *Lasius neoniger* Emery, an aggressive and populous northern ant species. They stated that *L. neoniger* colonies, although numbering less than 1000 ants, maintained between 8,000 and 10,000 nests per acre in two study areas. This density, coupled with the distinctly superior combative capabilities demonstrated against *S. invicta*, may allow this ant to successfully compete with *S. invicta*. If so, *L. neoniger* could be one of the agents of

<sup>1</sup>Received October 1, 1991. Accepted March 10, 1992.

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indigenous biological control restricting the range of *S. invicta* in North America.

*T. caespitum* occurs throughout much of the Holarctic and Ethiopian faunal realms and has been reported on every continent except Antarctica (Creighton, 1950). In much of its extensive range, it maintains a prominent role, often sharing that position with *L. neoniger* in the Nearctic, and *L. niger* (L.) and *L. alienus* Forster in the Palearctic (Brian and Elmes, 1974; Creighton, 1950). Presently, the North American range of *T. caespitum* includes the Atlantic Coast south to North Carolina, and sporadic and occasionally extensive regions west to California (Creighton, 1950; Nuhn and Wright, 1980). In the Palearctic, *T. caespitum* lives in open areas, scavenging for insects and collecting seeds (Brian *et al.*, 1967; Brown, 1957; Smith, 1943). In the Nearctic, the species is usually confined to areas near human habitations (Brown, 1957; Creighton, 1950).

The present ranges of *T. caespitum* and *S. invicta* are now contiguous in North Carolina, and the assumption that some contact has occurred between these two highly successful species is not unreasonable. Contact should continue to occur because the potentially northernmost range of *S. invicta* (Pimm and Bartell, 1980) overlaps with the southernmost range of *T. caespitum* (T.G.K., personal observation). The present laboratory study describes the reaction of *T. caespitum* to repeated introductions of both young colonies and single foundress queens of *S. invicta* placed within its foraging range. Although the final results obtained from the interaction of *T. caespitum* and *S. invicta* are restricted to conditions imposed by a controlled environment, the actual responses observed resulting from the forced interactions should simulate normal behaviors of *T. caespitum* to repeated incursions by *S. invicta* under more natural conditions.

## MATERIALS AND METHODS

A colony of approximately 15 workers and one queen of *T. caespitum*, collected in late summer of 1988 from Bucks County, Pennsylvania, was reared in an artificial nest placed within a four square meter, Fluon-coated plastic enclosure. The ants were fed insects and sugar water (50% sucrose), supplied with a source of free water, and kept at a temperature of approximately 25°C. After six months, the colony numbered more than 2,000 workers. Polygyne colonies (two or more queens per colony) of *S. invicta* from Kerr County, Texas, were collected in early spring of 1989 and divided into six sub-colonies, each containing two queens, between 100 and 200 workers, and brood. Test tube nests were used to house the

sub-colonies. All artificial nests were constructed according to Banks *et al.* (1981). Once daily for three days, a sub-colony was placed 20 cm from the mature *T. caespitum* nest within the four square meter enclosure, and the sequence and timing of the sub-colony's destruction were recorded. Subsequently, the three other sub-colonies were introduced sequentially as previously described, but this time at one meter distances. Finally, three *S. invicta* queens were placed within the foraging area, and interspecific interactions were observed and recorded.

## RESULTS

When the *S. invicta* sub-colonies were placed 20 cm from the *T. caespitum* nest, several *S. invicta* workers made contact with *T. caespitum* foragers within one minute. *S. invicta* attacked *T. caespitum* during this initial contact, grasping them with their mandibles and repeatedly stinging the foreign workers. Curiously, individual *T. caespitum* workers rarely engaged *S. invicta* workers unless supported by nestmates, often waiting for additional workers to arrive before advancing toward the *S. invicta* nest. These supporting *T. caespitum* workers arrived within 10 minutes. Isolated *T. caespitum* workers that became surrounded by *S. invicta* usually ceased their movement and subsequently retreated to an area where *T. caespitum* formed a sizeable majority. Due to this technique, *T. caespitum* approached the *S. invicta* nest as a mass of approximately 100 workers slowly moving toward the source of aggression. *S. invicta* workers that entered the mass of approaching *T. caespitum* were captured by single *T. caespitum* workers that grabbed one of the *S. invicta* worker's appendages. Other *T. caespitum* workers then grabbed other appendages, pulling in opposite directions and causing the severing of the seized appendages. The *T. caespitum* workers would also sting, but the sting appeared to have little effect on the *S. invicta* workers.

Between five minutes and one-half hour passed before *T. caespitum* had incapacitated all *S. invicta* workers in the foraging area and began entering the *S. invicta* nest. When encountering the test tube nest, *T. caespitum* workers lunged inward, attempting to grab the gasterflagging *S. invicta* workers at the nest entrance. Gasterflagging, a process of spraying venom on enemies, caused *T. caespitum* to spasm for approximately 10 seconds before returning to normal. If a *T. caespitum* worker succeeded in grabbing a *S. invicta* worker, it would quickly withdraw, dragging the *S. invicta* worker into the mass of *T. caespitum* where it would be dismembered. In this slow fashion, *T. caespitum* pulled *S. invicta* workers, one at a time, out of their nest to be killed by the mass of

beleaguered *T. caespitum*. The *T. caespitum* progression into the *S. invicta* nest continued until all *S. invicta* were dead. The captured *S. invicta* brood were taken back to the *T. caespitum* nest, presumably to be eaten.

When *S. invicta* nests were placed one meter from the *T. caespitum* colony, the sequence was the same but required more time. Contact between the species occurred within 2 minutes, and more than 10 *T. caespitum* workers gathered within 15 minutes to attack the *S. invicta* aggressors. More *S. invicta* workers had time to leave the nest; and as a result, the *T. caespitum* workers took longer to encircle the *S. invicta* nest site. Also, the *S. invicta* colony was able to escape to a new location shortly after *T. caespitum* workers began penetrating its nest. This reaction prolonged the conflict, since approximately 15 minutes passed before *T. caespitum* discovered the *S. invicta* colony's new nesting site. The rediscovery of the *S. invicta* colony resulted in a second attack, following which *S. invicta* scattered. Within one day, all *S. invicta* were killed. *T. caespitum* suffered less than two dozen fatalities per trial, with death resulting primarily due to numerous *S. invicta* stings.

A single queen of *S. invicta* was capable of killing a *T. caespitum* worker. Actual capture of *S. invicta* queens therefore required several *T. caespitum* workers acting together, pulling at the queen's appendages and stinging repeatedly. None of the *S. invicta* queens were captured after 10 minutes, but all were killed within 24 hours.

## DISCUSSION

The ranges of *T. caespitum* and *S. invicta* are now contiguous in North Carolina, and the two species have probably encountered one another. This study shows that *T. caespitum* may have the potential of delaying expansion of *S. invicta*. In North America the success of *T. caespitum* has been limited primarily to human inhabited areas. These areas already occupy large portions of the Atlantic seaboard and continue to gain in size.

*T. caespitum* is extremely territorial, a trait evidenced by frequent conspecific wars (Wilson, 1971; Brian *et al.*, 1966). As a result, destruction of the young *S. invicta* colonies by *T. caespitum* was expected. Not expected was the efficiency of attack by *T. caespitum* because more than five *S. invicta* workers died for every *T. caespitum* worker killed. The success of the *T. caespitum* attack depended on cooperation between workers and the ability to maintain a homogeneous mass of attacking workers within which *S. invicta* workers would be dismembered. In England, these skillful attack methods enable *T. caespitum* to "rout" large

colonies of *L. alienus*, and defeat colonies of *L. niger* (Brian *et al.*, 1966).

Colonies of *T. caespitum* contain an average of approximately 10,000 workers (Brian, 1979); whereas mature *S. invicta* colonies maintain in excess of 60,000 workers (Tschinkel, 1986). Conflicts between mature colonies, therefore, could result in *S. invicta* overwhelming *T. caespitum*. Colder temperatures retard colony growth in laboratory colonies of *S. invicta* (Porter, 1988); and as a result, the average colony size of *S. invicta* and *T. caespitum* may be more comparable in the northernmost range of *S. invicta*. If not, *T. caespitum* may dominate its habitat only if it destroys young *S. invicta* colonies in the field as it did in the laboratory.

Our study simply identifies one potential biotic factor which may impose mortality on *S. invicta*. However, the results we obtained (destruction of *S. invicta*) are limited to conditions inherent in laboratory studies of this type. Therefore, although the responses of *T. caespitum* to *S. invicta* are accurate, caution should be exercised regarding the effectiveness of *T. caespitum* as a controlling agent until field studies are conducted to substantiate our laboratory findings.

#### ACKNOWLEDGMENTS

We thank A. P. Bhatkar, M. V. Brian, J. C. Cokendolpher, M. L. Peek, and H. G. Thorvilson for their critical reviews. This manuscript is contribution T-4-286, College of Agricultural Sciences, Texas Tech University.

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### CALVERT AWARDS FOR 1991 AND 1992

In 1987 the American Entomological Society initiated the Calvert Award to be presented annually to a young person in the greater Delaware Valley for an outstanding insect-related project. The Award was named in honor of Dr. Philip P. Calvert who joined the Society as a teenager, later became its president, and was a member for 74 years. As a professor of biology at the University of Pennsylvania and an associate of the Academy of Natural Sciences of Philadelphia, Dr. Calvert played an important role in stimulating an interest in insects among young people.

This year the Calvert Award was presented to Amy Dorfman, a tenth grade student at Central High School in Philadelphia—the same school from which Calvert graduated in 1888! Her project was entitled, "Farnesol vs. Natural Predation: Will the Benefits of a Larvacide Outweigh the Advantages of Interaction in a Food Chain?" President Joseph Sheldon presented Miss Dorfman with one-year memberships in the American Entomological Society and the Young Entomologists' Society, a one-year subscription to *Entomological News*, and a check for \$50. Amy's project and those of three other students at the Delaware Valley Science Fairs were displayed at the April 22 membership meeting at the Academy of Natural Sciences.

First runner-up was Dawn Riddle, a ninth grade student also from Central High School, whose project was on, "The Effects of Chemicals on the Pheromone Trails of Ants." Two honorable mentions were awarded, both to juniors from Ocean Township High School, Oakhurst, New Jersey. Gisela Insvaste studied the "Effect of Protozoan *Lambornella clarki* on Larval Populations of the Mosquito *Aedes aegypti* in the Laboratory" and Denis Shmuler made a "Comparison of Stem and Leaf Growth of European Violets Germinated in Harvester Ant Nests."

Last year Amy Dorfman's project was first runner-up to that of Helen Glezos, then a sophomore at Woodstown High School, Woodstown, New Jersey, who addressed the question, "Does Captive Feeding Increase the Growth and Life Span of the Praying Mantis?" Second runner-up in 1991 was presented to Kevin Bonner, a ninth grade student at Archbishop Wood High School, Warminster, Pennsylvania. He studied "Substance Preference among Carpenter Ants." The awards were presented on April 24 at a Society meeting featuring Dr. Thomas Donnelly, a particularly appropriate guest speaker. Dr. Donnelly had met Philip P. Calvert through their mutual interest in dragonflies. At the beginning of his talk he related some of his memories of Dr. Calvert.

Harold B. White



## OCCURRENCE OF *FITTKAUIMYIA* (DIPTERA: CHIRONOMIDAE: TANYPODINAE) IN TEXAS<sup>1</sup>

Jack R. Davis<sup>2</sup>

**ABSTRACT:** Recent collections of *Fittkauimyia* larvae from three localities in Texas constitute the first documented Nearctic occurrence of the genus outside Florida. Larvae were found in shallow, slack water areas of small prairie streams, in association with submerged wood. The nature of occurrence suggests that *Fittkauimyia* is widespread, although not abundant, in eastern Texas.

The little known chironomid genus *Fittkauimyia* Karunakaran appears to be of tropical-subtropical origin (Fittkau and Roback, 1983). It has been reported from scattered localities in Indonesia, Australia, Africa, and South America, with previous Nearctic records restricted to Florida (Roback, 1982; Fittkau and Roback, 1983; Hudson *et al.*, 1990). The genus is not yet known from the Palearctic (Ashe *et al.*, 1987; Ashe and Cranston, 1991).

During recent water quality studies, I have collected *Fittkauimyia* larvae on five occasions from three localities in Texas:

TARRANT COUNTY: West Fork Trinity River at Beach Street in Fort Worth, 25 July 1987, 6 October 1987, 21 June 1988; DALLAS COUNTY: Elm Fork Trinity River at SH 356 in Dallas, 11 October 1988; GUADALUPE COUNTY: Geronimo Creek off FM 20N Seguin, 10 April 1990.

*Fittkauimyia* larvae are distinguishable from other Tanypodinae by characteristics of the mandible, ligula, and dorsomentum. No other larvae have a similar arrangement of teeth on the mandible (Fig. 1) (*Derotanypus* also possesses accessory mandibular teeth, but only on the dorsal side). The inner teeth of the ligula are incurved on the outer margins, and thus appear inclined toward the middle tooth (Fig. 2). The dorsomental plates are joined mesially as in *Tanypus*, but differ in that adjacent, lateral plates are present (Fig. 3).

In most morphological respects, the Texas specimens closely resemble *Fittkauimyia* sp. 2 Roback (1982), which is known only as larvae from Florida and is a possible synonym of *F. sertae* (Roback). The latter species originally was ascribed to *Parapelopia* Roback (1971), now tentatively considered a junior synonym of *Fittkauimyia* (see Roback,

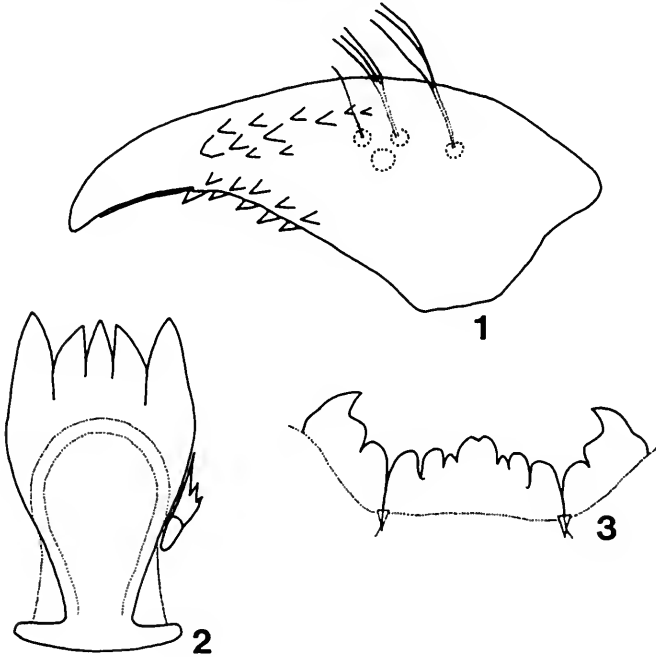
<sup>1</sup>Received September 9, 1991. Accepted March 10, 1992.

<sup>2</sup>Texas Water Commission, P.O. Box 13087, Capitol Station, Austin, Texas 78711.

1982). *Fittkauimyia sarta* is known only as adult males from Florida; larvae and pupae have not been associated with the adults.

*Fittkauimyia* larvae have been reported from streams and the littoral of lakes (Fittkau and Roback, 1983), and in Florida have been found primarily in shallow water with mixed emergent vegetation, particularly freshwater marshes (Hudson *et al.*, 1990). The Texas records are from small prairie streams less than 10 m wide and 1 m deep, with base flows < 0.5 m<sup>3</sup>/s. Specimens were found in glides or shallow pool environments with slow current velocities. Water quality was generally good, and associated macrobenthic communities were healthy. The Trinity sites, which are near one another, are channelized and slightly influenced by urban runoff. The Geronimo Creek site, about 350 km to the south, is unmodified and relatively pristine.

*Fittkauimyia* larvae were relatively scarce in the five collections, with total numbers obtained ranging from 3 to 47. Specimens were collected



Figures 1-3. Features of fourth instar *Fittkauimyia* larvae from Texas. 1. Mandible. 2. Ligula and paraligula. 3. Mentum.

on modified Hester-Dendy artificial substrates at the Trinity sites, and by handpicking from submerged wood, primarily underneath loose bark on logs, in Geronimo Creek. At the latter site, none occurred in kick net samples from riffles or sweep net samples from stream margins. Based on personal observations and information from the literature, the preferred microhabitat appears to be in association with emergent macrophytes or decomposing wood in shallow, quiet waters.

The aforementioned successful collecting techniques have not been widely employed in the state, which may partially account for the lack of previous records. The paucity of selective collecting and the substantial distance between the Trinity and Geronimo Creek sites suggest that *Fittkauimyia* is widespread in eastern Texas, although in relatively low numbers. Its presence further substantiates the importance of Neotropical influence on derivation of the aquatic invertebrate fauna of Texas.

#### ACKNOWLEDGMENTS

Appreciation is extended to David R. Lenat and Broughton A. Caldwell for reviewing the initial draft of the manuscript.

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## DISJUNCT DISTRIBUTION AND A NEW RECORD FOR AN ANTHOPHORID BEE, *XENOGLOSSODES ALBATA* (HYMENOPTERA: ANTHOPHORIDAE), IN SOUTHEASTERN UNITED STATES<sup>1</sup>

M. W. MacGown<sup>2</sup> and T. L. Schiefer<sup>2</sup>

**ABSTRACT:** *Xenoglossodes albata* (Anthophoridae: Eucerini) is reported from a remnant of the Black Belt Prairie in Oktibbeha County, Mississippi. Although all flowering plants in prairie remnants were sampled during June, 1991, females with pollen were collected only on flowers of *Petalostemum purpureum*. Collections of this oligolectic bee in Mississippi represent the first record of the genus in southeastern United States and a disjunction of the species from its previously known range in the midwestern plains states.

The Mississippi Entomological Museum is currently conducting a survey of selected arthropods, including bees and their floral hosts, in remnants of the Black Belt Prairie in northeastern Mississippi and the loessal hills in Grenada County, Mississippi. More than 900 specimens of bees have been collected in these unique habitats since June, 1991, and among these is the first record of *Xenoglossodes albata* (Cresson) in the southeastern United States.

*Xenoglossodes* includes 18 species, of which all but *X. albata* occur in the western United States. *Xenoglossodes albata* previously was known to occur only in the midwestern plains states from Colorado to Texas and South Dakota and as far east as Illinois, where it has been reported as a visitor to *Petalostemum purpureum* (Vent.) Rydb. (Fabaceae) (Hurd, 1979; Robertson, 1929).

In our survey of bees in prairie remnants in Mississippi, we collected the following specimens of *X. albata* in Oktibbeha County: 2 females and 3 males, 14 June 1991, on *P. purpureum* (T.L. Schiefer); 5 males, 22 June 1991, on *P. purpureum* (R.L. Brown); and 1 male, 1 July 1991, on *P. candidum*, (Willd.) Michx. (J.R. MacDonald). Females were carrying pollen, whereas males were assumed to be gathering nectar. This species appears to be oligolectic on *Petalostemum purpureum* in Mississippi as females with pollen were not collected from any of the other flowering plants in the prairie remnants, which were extensively sampled during this time period. All of the specimens were collected approximately 6 miles north of Starkville in the southeastern quadrant of Section 36,

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<sup>2</sup>Mississippi Entomological Museum, Drawer EM, Mississippi State, MS 39762.

T20N, R 14E. Two visual sightings of this species were made during June in Lowndes County, near Crawford, in Section 34, T 17N, R 16E.

The Black Belt Prairie was once one of the largest prairies in the eastern United States, extending on Cretaceous Selma Chalk from northern Mississippi to near the Alabama-Georgia border. Although most of the prairie was lost to agriculture by the early 1900's, several small remnants have survived, including 6 of our survey sites that range in size from 100 to 350 acres. These remnants have suffered some erosion and incursion of *Juniperus* and hardwoods, and their deterioration is probably due to lack of fires. The flora, which consists of *Bouteloua*, *Liatris*, *Blephila*, *Sipplium*, *Petalostemum*, and other genera characteristic of prairie habitat, has flowering peaks in mid-June and again in mid-September. Although visits to these remnants were made weekly or twice weekly from the first of June to the end of September, *X. albata* was detected only on 2 sites, associated with the mid-June blooming peak of *Petalostemum*.

*Petalostemum purpureum* is not recorded from Mississippi in most general texts. Rickett (1967) lists it as a prairie inhabitant from Indiana to Saskatchewan and Montana, southward to Tennessee and New Mexico, and occasionally further eastward, and Bailey and Bailey (1976) list it as occurring from Indiana to Saskatchewan, south to Tennessee and New Mexico. However, during June through early August it was one of the predominant plants of all six prairie sites under investigation.

#### ACKNOWLEDGMENTS

The survey of arthropods in unique and threatened habitats is supported by NSF Grant No. BSR-9024810 (Richard L. Brown, Principal Investigator). The identification of *Xenoglossodes albata* was confirmed by Robert W. Brooks, University of Kansas.

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NEW NEOTROPICAL CONOPIDAE (DIPTERA)<sup>1</sup>Sidney Camras<sup>2</sup>

ABSTRACT: Three new species are described: *Psysoconops nigroclavatus* from Brazil; *Myopa metallica* from Chile, the first record of *Myopa* south of Mexico; and *Stylogaster iviei* from the Dominican Republic, the first record of *Stylogaster* from the West Indies.

The following new species, especially the unexpected generic range extensions, show that much remains to be known of this family.

*Psysoconops (Psysoconops) nigroclavatus*, sp. nov.

**Holotype.** ♂ BRAZIL: Nova Teutonia, Santa Catarina, 27° 11' N, 52° 23' W, 300-500m., I.1965, Fritz Plaumann, in kopula. (author's collection, ex. Donald Pearson Collection.)

Vertex and frons black. Opaque black triangular area on side of frons. Face and cheek black. Facial grooves and parafacials gold pollinose. Antenna mainly black. First segment four times as long as wide. Second segment two times as long as the first. First and third segments subequal. Occiput black. Gold pollinose above and at margins.

Thorax black. Gold pollinose stripe medial to humerus and on pleura. Dorsum indistinctly yellow pollinose leaving three dark lines in some views. Legs black. Trochanters and base of tibiae reddish. Dark wing pattern from costa to fourth vein and vena spuria. Costal cell paler. Fifth vein without dark margin. Pattern fills the first posterior cell. Halter yellow, knob black.

Abdomen black. Light yellow on side of third tergite at base. Fourth, fifth and sixth tergites diffusely gold pollinose. Length: 14 mm.

**Allotype.** ♀ same data, in kopula. Similar to holotype. More reddish on legs. Theca black, one-half longer than wide. Length: 12 mm.

**Paratypes.** 12♂♂, same data, XI, XII, I, II, 1952 to 1966. Similar to holotype. Yellow pollinose at the upper frons more distinct in some. Length: 11-13 mm. 4♀♀, same data, XII, I, II, 1965 and 1966. Similar to allotype. Length: 11 to 14 mm.

There is a faint brown margin along the fifth vein in a few specimens, and in one male it is more distinct.

This species keys to *nigromarginatus* which differs by having no black on the halter, a distinct black margin along the fifth vein anteriorly, and distinct yellow pollinose posterior margins on the apical abdominal segments.

Donald Pearson's Conopidae were willed to me. His Diptera collection otherwise went to the Field Museum in Chicago.

<sup>1</sup>Received August 5, 1991. Accepted March 10, 1992.

<sup>2</sup>4013 North Milwaukee Avenue, Chicago, Illinois, 60641.

*Myopa metallica*, sp. nov.

**Holotype.** ♂ CHILE: Quebradu, Ramon, Prov. Stgo., Nqv. 1969. L. Peña. (Field Museum).

Head rufous. Black ocellar tubercle, proboscis, parts of the upper occiput, hairs on the antenna, apex of arista, and sparse hairs on cheek. Second and third antennal segments short, subequal, nearly as wide as long. Cheek nearly as high as eye height. Proximal segment of proboscis shorter than head height. Distal segment and palpis about two-thirds of proximal segment.

Thorax, femora, and apical three-fifths of tibiae metallic blue-green black. Anterior spiracle of thorax, trochanters, and tarsi rufous. Basal two-fifths of wing rufous, remainder dusky. Halter reddish brown.

Abdomen yellow rufous on second tergite. First tergite and most of the third tergite brownish rufous. A narrow apical transverse stripe on third tergite brownish rufous. A narrow subapical transverse stripe on third tergite, and remainder of abdomen and genitalia metallic blue-green black. Length: 9 mm.

The metallic color is unique in this genus as far as I know. This specimen was brought to my attention by Phillip P. Parrillo, a coleopterist at the Field Museum.

*Stylogaster iviei*, sp. nov.

**Holotype.** ♂ DOMINICAN REPUBLIC: Prov. Pedernales, 24 kn N.Cabo Rojo, 610 m., 20-25 Aug. 1988, wet forest, malaise trap, M.A. Ivie, T.K. Philips, K.A. Johnson.

Vertex and frons rufous. Ocellar triangle black, longer than wide and relatively pointed. Antenna rufous. Arista black. First antennal segment very short. Third segment one-fourth longer than second. Proboscis black, yellow at base. Labella white pollinose. Occiput black, white pollinose.

Mesonotum dark rufous with black submedian lines and row of sublateral spots. Pleural stripe and metacoxa dark brown. Procoxal hairs black. Legs yellow. Metafemur with two black bands. Metatibia white on basal three-fifths. Basal two-fifths black haired. Middle fifth white haired. Distal two-fifths and metatarsus black. Wing hyaline. Costal hairs very short. Halter yellow, knob black.

Abdomen rufous, long and narrow. Second to fifth segments about twice as long as wide. Narrow black posterior margin on segments two, three and six. Wide posterior black band on segment four and five. Fourth segment white pollinose on the pale basal area. White hairs on sides of second segment. Fifth sternite whitish, with two black marks containing black hairs. Genitalia yellow. Length: 6 mm.

**Allotype.** ♀ same data as holotype, 20 Aug—09 Sept 1988. Similar to holotype. Dark marks on mesonotum less distinct. Fourth and fifth tergites not elongated and pollen present on both tergites. Ovipositor yellow rufous; blackish centrally on sides of second segment. Apical (third) segment black except for narrow anterior margin. Egg guides yellow, nearly reaching tip of median process. Estimated length: 7.5 mm. of which the ovipositor is 2.5 mm.

**Paratypes.** 4♂♂, same data, 20-25 Aug—09 Sept 1988. Pernaes, 13.5 km N.Cabo Rojo, 140 m., 21 Aug—10 Sept 1988, cactus thorn scrub, flight intercept trap. Similar to holotype. Dark lines on mesonotum somewhat less distinct. Length: 6—7 mm. 2♀♀, same data and similar to allotype. These have a rufous area on the mesonotum anterior to the shortened and less distinct paramedian lines. One has very distinct transverse lines in this area.

This species belongs to the *stylata*-group but is atypical in that the first posterior cell is not as wide, and the ocellar triangle is longer and more pointed anteriorly. The male keys to *sedmani*, while the female keys to *biannulata*, both of which have the mesonotum mainly black.

A pair has been retained by the author. Dr. Ivie of Montana State University, Bozeman, informed me that the types will eventually go to the U. S. National Museum. He will also place specimens in the National Museum in Santo Domingo, Dominican Republic.

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#### BOOK REVIEW

REVISION OF THE WORLD SPECIES OF *SPALANGIOPELTA* (HYMENOPTERA: CHALCIDOIDEA: PTEROMALIDAE: CEINAE). D. Christopher Darling. 1991. Life Science Contrib. 155, Royal Ontario Museum, Toronto. 43 pp. \$11.00 (paper).

This revision recognizes 10 species, 6 from the Nearctic and Neotropical regions and 4 from the Palearctic. Three of the species are described as new, all from the Americas. Diagnoses for the subfamily and the genus are provided, as are a key to species and excellent illustrations, including SEMs. Males are unknown or uncertain for half of the species and the host, a leafmining fly larva, is known for only one species. Both of these lacks are probably a consequence of the very small size (1-2 mm length) of these wasps, and are evidence that there is much yet to be learned about parasitic Hymenoptera.

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Beneficial Insects Lab., USDAS, ARS.  
Newark, DE



## AN ALCOHOL TRAP FOR CAPTURING VESPIDIDS AND OTHER HYMENOPTERA<sup>1</sup>

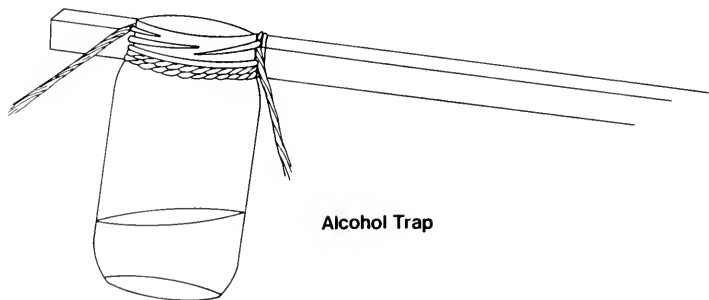
Jeffery W. Bentley<sup>2</sup>

**ABSTRACT:** A jar filled with alcohol and tied to a pole can be used to capture social wasps and other Hymenoptera. The method may be safer for some highly aggressive wasp species. Since the trap can be made from simple materials it is easily accessible to field workers in the tropics, and is a good way of getting specimens in alcohol for shipping. The technique was invented with the collaboration of Honduran small-scale farmers.

Some entomologists capture social wasps by gently laying the rim of an aerial net on the nest surface until a few workers crawl onto it out of "curiosity", then remove the net and sweep the wasps as they fly off it to return to the nest. Although if done carefully this method almost never alarms the colony, contact with the nest is necessary and that means slip-ups can occur (Robert Jeanne, personal communication). If the net bumps the nest the wasps may become alarmed and can attack (Jeanne 1981).

An alcohol trap solves the problem of how to capture vespids without risk of touching the nest and alarming the wasps, some of which are aggressive and their sting painful. A wide-mouthed container (like a fruit jar) is tied to the end of a pole and filled with 70% alcohol (Figure 1). I use

Figure 1



<sup>1</sup>Received July 27, 1991. Accepted March 10, 1992.

<sup>2</sup>Crop Protection Department. Escuela Agrícola Panamericana. Apartado Postal 93. Tegucigalpa, Honduras. Central America.

isopropyl (rubbing) alcohol because it is easier to get in Honduras. When the trap is placed below the opening of the nest the field worker is (depending on the length of the pole) much farther away than if holding an aerial net. The alcohol trap is held still at the entrance to the nest, as close as possible without touching it so the wasps are not excited. As the wasps approach the jar (either in flight or from within the hive), the alcohol fumes intoxicate them and, depending on the species, individuals begin falling into the trap. A glass jar can be used, although clear plastic is lighter, which is important since the jar can seem heavy if held from the end of a long pole.

The method has been successfully used on several vespid species. *Agelaia cajennensis* (F.), *Polybia occidentalis* (Olivier), *P. diguenterana* R. du Buysson and other *Polybia* spp. fall into the alcohol within a few seconds. Some *Mischocyttarus* species are so readily intoxicated by the fumes that care must be taken to withdraw the trap quickly before the entire population of the colony falls to its death. *Polistes major* Palisot de Beauvois and *P. instabilis* de Saussure, are somewhat more resistant to the alcohol fumes. They become intoxicated but often fail to fall from the nest. Although they may have to be prodded from the nest, the alcohol fumes still slow the *Polistes* spp. down and make them easier to capture. Hymenoptera die almost instantly in the alcohol, and since they are already in alcohol it is quite safe and easy to transfer the wasps from the trap to vials for shipping. One disadvantage of capturing social bees in alcohol is that the specimens' dense setae become matted.

The author, a cultural anthropologist, invented this method in stages, working with an entomologist and several Honduran farmers on an ethnoentomological study of Hymenoptera. After I brought back several decomposing specimens from the remote Río Plátano area in January, 1991, Ronald D. Cave, the entomologist, suggested bringing specimens back in vials of alcohol. On a later collecting trip, in Dulce Nombre de Culmí, Olancho, Honduras, while transferring live Hymenoptera from a net to vials, Oscar Lagos (farmer and forest guard) and I noticed that the stingless bees *Scaptotrigona pectoralis* (Dalla Torre), *Plebeia latitarsis* (Frieser) (Hymenoptera: Apidae) and the social wasp *Protopolybia acutiscutis* (Cameron) (Hymenoptera: Vespidae) became intoxicated by alcohol fumes and we started using the alcohol vials instead of the net to capture other bees, including *Melipona beechei* (Bennett), *M. fasciata panamica* Cockerell, *Trigona pallens* (Fabricius), *T. jaty* Smith, *T. testacea orizabensis* (Stran), *T. amalthea* (Olivier) and *T. fulviventris* Guérin (Hymenoptera: Apidae). A vial of alcohol was held near the hive opening and the bees approached it and fell in.

In March, 1991, in El Quebrachal, Olancho, Honduras, another farmer, Santos Inestroza, noticed me collecting *Trigona* sp. with a vial and suggested that aggressive wasps could be collected in a similar way by tying a jar to a pole, to allow the person to be further away. Later that month in El Zamorano, Francisco Morazán, Honduras, a farm worker, Santos Carrasco, made the trap at my suggestion.

While there is a growing body of literature which suggests that agricultural scientists should work with farmers to design agricultural technology appropriate to farmers' conditions (Altieri 1984, Bentley and Andrews 1991, Biggs and Clay 1981, Chambers and Jiggins 1987, Marlton *et al.* 1988, Rhoades 1987, Richards 1989, to name just a few), apparently no one has ever suggested that farmers' innate knowledge and creativity can be tapped for developing tools for basic scientific research.

#### ACKNOWLEDGMENTS

Thanks to Ronald D. Cave for identifying the wasps, to S.W. Batra for identifying *T. jaty*, *T. testacea orizabensis*, *T. amalthea*, and to Charles D. Michener for identifying the other bees. The intellectual contributions of Ronald D. Cave, Oscar Lagos, Santos Inestroza and Santos Carrasco in the development of the alcohol trap are much appreciated. Ronald D. Cave, Robert L. Jeanne, Abelino Pitty, Paul Richards and Luis Vásquez read and commented on earlier versions of this paper. The drawing in Figure 1 is by Ana Isabel Acosta.

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## SOCIETY MEETING OF FEBRUARY 26, 1992

### DYAR'S "PETS": SLUG CATERpillARS IN MOTION

Dr. Marc Epstein, Dep't. of Entomology,  
Smithsonian Institution, Washington, D.C.

Harrison G. Dyar was a colorful character in North American entomology in the early part of this century, and notable for major taxonomic accomplishments in various families of Lepidoptera in addition to mosquitoes. He also was a major force in the development of the Smithsonian Lepidoptera Collection and initiated and edited the journal *Insecutor Inscitiae Menstruus* for a number of years. Aspects of his personality are equally legendary, ranging from pointed exchanges in print with other lepidopterists, including nomenclatural barbs (*corpulentrus* and *Dyaria* come to mind), stories concerning his having two families concurrently and tunneling between the two houses, and his 31 years of work for the USDA without a cent of compensation. Dr. Marc Epstein, of the Smithsonian Institution, has researched Dyar's life and work extensively (a biographical piece written by Dr. Epstein and Dr. Pamela Henson will appear in a forthcoming *American Entomologist*) and presented a lively and entertaining talk examining the stories, and sorting the fact from the fiction. At the same time, Dr. Epstein seamlessly weaved in the results of his own remarkable research on the behavior and phylogenetics of the Limacodidae (slug caterpillars), a group in which both Dyar and Epstein had and have particular interest.

The family Limacodidae, with about 1000 species worldwide, possesses a broad range of larval morphologies, of which the most notable feature is a lack of prolegs and crochets. The larvae are polyphagous, feeding on tough leathery leaves most caterpillars would reject, and take several months to mature; consequently, Dyar, who reared these larvae extensively, referred to them as his "pets". Dr. Epstein also has reared numerous species, many from eggs collected from females, and has developed an impressive knowledge of the ontogeny of many larval features. He incorporates this knowledge along with morphological characters of all life stages into his reconstructions of the phylogeny of this family and of the related groups, Megalophygidae, Aididae and Dalceridae. The audience was particularly captivated by the showing of videotape illustrating larval locomotion (shot through a pane of glass), silk production and cocoon formation (including a cocoon that mimics parasitoid emergence holes). Approximately 35 members and their guests attended the lecture.

Preceding the meeting, the Academy's Department of Entomology held an "Open Collection" for members and visitors to tour the collection and facilities. About 15 people went along on the tours given by Donald Azuma and David Koenig.

Jon K. Gelhaus,  
Corresponding Secretary

## SOCIETY MEETING OF MARCH 25, 1992

### FORENSIC ENTOMOLOGY: THE USE OF INSECTS IN THE INVESTIGATION OF VIOLENT CRIMES

Dr. Wayne Lord, FBI Academy, Quantico, VA

An overflow audience was present for a fascinating lecture by Dr. Wayne Lord, a forensic specialist with the Federal Bureau of Investigation (FBI), on a "gruesome but important business," forensic entomology. Dr. Lord stressed that success in forensics depends on contributions from a variety of specialists and research fields, with his own experience equally varied in ecology (particularly of carrion insects), medicine and forensics. He emphasized that forensic entomologists must first be well-trained entomologists, zoologists and ecologists, and also have extensive training in forensic pathology and criminology. His initial work at the FBI was as a street agent, learning all facets of violent crime investigation and crime scene analysis, not just those dealing with insects.

Forensic entomologists must have a firm knowledge in how human bodies decompose under different conditions, e.g., when decomposers are excluded from the body (saponification or mummification) or when they have access (putrification). Decomposers include bacteria, fungi and vertebrates, but insects are by far the most important. Diptera such as Calliphoridae, Muscidae and Sarcophagidae are the first to colonize the body, and beetles such as Staphylinidae, Silphidae, and much later, Dermestidae, follow in succession. An examination of insect evidence can estimate the postmortem time period, show whether a body has been moved, help determine where injuries were inflicted, and demonstrate the presence of poisons or drugs. In fact, the insect evidence is often the only data to pinpoint the time of death if the body has remained undiscovered for more than 72 hours. A striking set of photographic slides showed the progression of decomposition on a corpse without trauma (head tissues disappear quickly because flies lay eggs into natural openings) and on corpses with injuries (in these cases flies lay preferentially around the wounds).

A knowledge of the ecology, behavior and life histories of these insect decomposers can help determine if a violent crime took place even if years have elapsed since the death. Dr. Lord told of criminals who were caught over minute but compelling evidence such as a broken grasshopper leg in a pants cuff or weevil larvae in a cocklebur on a ski mask. The details that can be gleaned from a thorough examination of the body and crime scene (which can take many hours) can lead to such a thorough reconstruction of the crime that suspects have confessed, believing that "someone" must have watched them commit the crime. As Dr. Lord stressed, in some sense, the body and the decomposers are "telling" you what happened, if you can only understand the language.

There were a few notes of local interest. Chuck Mason announced that Field Day will be September 19 at Fair Hill, MD, instead of the usual spring date. Vince Ventre noted that collections from a recent trip to French Guiana included previously unknown, presumed hybrids of several species of heliconid butterflies.

About 60 members and their guests were present at this meeting which was held at the University of Delaware.

Jon K. Gelhaus,  
Corresponding Secretary

## BOOK REVIEW

TRAP RESPONSES OF FLYING INSECTS. R. C. Muirhead-Thomson. 1991. Academic Press, London. 287 pp. \$63.00.

It is difficult enough to write a good comprehensive "big" book about a single topic of encompassing interest, but R. C. Muirhead-Thomson has gone beyond this in attempting to write a good "little" book about two such topics, i.e. the responses by insects to traps studied in the two artificially separated fields of medical and agricultural entomology. Published materials appearing in the book relating to both areas of interest have been carefully selected by the author in an effort to illuminate salient discoveries and applications in the general area of insect responses to traps. He has attempted to achieve within the covers of his book "an objective overall review" of a very large area of knowledge so as to make this information available to interested people on both sides of the insect trap-attractant fence.

The book is logically arranged into nine chapters that discuss traps on the basis of "how they work". These chapters include; Light traps, Suction traps, Pheromone-based and sex-lure traps, Light traps versus pheromone traps, Flight traps and interceptor traps, Plant pest responses to visual and olfactory 'sticky' traps, Responses of blood-sucking flies to visual traps, Animal-baited traps and animal odours, and Attraction of blowflies and their allies to carrion-based traps. In each of these chapters the author carefully discusses the uses of the different kinds of traps and the principles associated with their effectiveness. The examples presented in the book are accompanied by a wealth of illustrations of specific experimental procedures and comprehensive and lucid explanations of methods and results. Pertinent references are gathered together at the end of the book.

Insofar as *Trap Responses of Flying Insects* goes, it is a good "little" book about a very large field. The author, however, could have gone a little farther. No mention is made of the use of natural or artificial food-type lures in traps in agricultural entomology. A large body of literature exists on this subject and it is difficult to understand why the author chose not to discuss this diverse group of attractive substances. Furthermore, many of this type of lure are used to attract Coleoptera, but references to attractants for this large and extremely important order are almost completely lacking in the book. This is a serious weakness considering the many economic coleopteran pests, i.e., boll weevil, corn rootworms, Japanese beetle, rice and grain beetles and weevils, Colorado potato beetle, etc., that afflict the world. Moreover, it is among Coleoptera where sex pheromones with but a single active component are most commonly found and where the principle of attractant synergy between sex pheromones and food-type attractants was probably first demonstrated.

Despite its weakness, this is a good little book. The fundamental principles of the responses of insects to traps are presented in a readable and coherent fashion. This tome would fit well on the bookshelves of an insect ecologist, a graduate student, or a serious researcher of insect attractants.

T. L. Ladd, Jr.  
USDA, ARS., OARDC.  
Wooster, Ohio

## BOOK REVIEW

## PLANT KAIROMONES IN INSECT ECOLOGY AND CONTROL.

Robert L. Metcalf and Ester R. Metcalf. 1992. Chapman and Hall. 168 pp.

Insects are in a much more chemically diverse oriented world than most other animals, especially those insects that use the atmosphere as a medium in which to live. The presence of elaborate chemosensory antennae in the insects serves as evolutionary evidence of this. Plants are virtual factories for producing a large array of chemicals, a large portion of which are volatile. For example, 68 volatiles have been identified thus far from corn silk. Insects associated with plants at all trophic levels depend on a keen perception of plant chemicals. Much can be gained by having a thorough understanding of the relationships associated with insects and the plant chemicals they perceive. The book reviewed here, covering a number of the aspects of plant kairomones (biochemicals perceived by insects that serve an adaptive advantage to the insect receiver), is timely since much emphasis is currently being placed on developing insect control strategies which have minimal impact on the environment. Research is being directed more in this area of chemical ecology to gain a better understanding of plant-insect interactions and to search for more suitable alternatives to chemical insecticides.

This book is a synthesis of knowledge representing more than 40 years of research and reviews on plant kairomones. Research in this area of chemical ecology has been a life time pursuit for the Metcalfs who have contributed extensively to the contemporary knowledge on plant kairomones. This work nicely blends the basic and applied aspects of plant kairomone research.

The Metcalfs have worked a great deal with two groups of insects; the Dacinae fruit flies and the Diabroticites rootworm beetles. As might be expected, both groups are covered extensively in the book. However, other groups treated include the Ceratiinae and *Rhagoletis* fruit flies and the Japanese beetle. The synomones, mostly associated with odors that attract pollinators to flowers, are discussed in one short chapter. This latter area of chemical ecology holds some of the more interesting and diverse stories on coevolution of insects and plants, yet it is virtually unexplored by the research community. The book includes a chapter on general aspects of chemical ecology. This chapter discusses insect coevolution, host plant selection, detection, and behavior in relationship to kairomones, and includes a nice review of volatile plant kairomones as insect attractants. Another chapter reviews the volatile kairomones as lures for insects which includes a significant amount on the quantitative aspects of active odor space, behavioral thresholds, effective distance, and release rates, and discusses the effectiveness of various trap designs.

The book does not include plant kairomones for insects in trophic levels above the primary consumers. A significant amount of research has been conducted which examines the effect of plant kairomones on natural enemies of herbivores, particularly parasitoids. This would have been a valuable addition.

The book serves as a good general review on plant kairomones. Those with an interest in this field will find the book valuable. It is well written, well illustrated, and abounds with references.

Charles E. Mason,  
Dep't. of Entomology & Applied Ecology  
University of Delaware, Newark, DE

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# ENTOMOLOGICAL NEWS

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**NEW SPECIES OF NEOTROPICAL  
LEAFHOPPERS IN THE TRIBE COELIDIINI  
(HOMOPTERA: CICADELLIDAE: COELIDIINAE)  
WITH A REVISED KEY TO SOME SPECIES<sup>1</sup>**

M. W. Nielson<sup>2</sup>

**ABSTRACT:** Five new species in five genera of the tribe Coelidiini are described and illustrated. These include *Dicodia kleini*, *Boliviela sarcula*, *Omanolidia globosa*, *Tinocripus elongatus* and *Evansolidia tumida*. A revised key to species in *Dicodia* is also given.

Since the revision of the tribe Coelidiini (Nielson, 1982e), 27 additional new taxa have been described from the Neotropical region (Nielson, 1983i, 1986d, 1988a). Five new species, one in each of the genera *Dicodia*, *Boliviela*, *Omanolidia*, *Tinocripus* and *Evansolidia*, are described and illustrated in this paper. A revised key to the species in *Dicodia* is also included.

Speciation in this group has not been as extensive as in its sister group, the Teruliini, in the Neotropical region. Reasons for the difference are unknown but it is possible that the phenomena may be related to the origin of the tribes. Members of the Coelidiini occur in the tropical zoogeographical regions whereas the teruliines are restricted to the Neotropical region except for two adventive genera in the Nearctic region and one introduced species in the Ethiopian region. The coelidiines may have originated in the Oriental region, elements of which reached the Neotropical and Ethiopian regions via neocontinental development. Some intrusions into the southern and far eastern Palearctic region have been made by a few species. All of the known genera in these zoogeographical regions are indigenous to their respective regions including *Calodia* which has moved extensively into the Australian region (Austro-Malayan subregion) from the Oriental region (Nielson, 1990b).

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<sup>1</sup> Received December 10, 1991. Accepted March 30, 1992.

<sup>2</sup> Monte L. Bean Museum, Brigham Young University, Provo, UT 84602.

Key to species of *Dicodia*

1. Pygofer with long, prominent caudoventral and caudodorsal processes, caudoventral process sharp apically (Fig. 668, Nielson 1982); aedeagus with a single apical spine . . . . . 2
- Pygofer with short caudodorsal process and long, broad, caudoventral process (Fig. 662, Nielson 1982); aedeagus with 2 apical spines (Fig. 666, Nielson 1982) . . . . . *rhombifer* (Linnavuori)
- 2(1). Pygofer with caudodorsal process exceeding apex of caudoventral process (Fig. 668, Nielson 1982) . . . . . 3
- Pygofer with caudodorsal process even with apex of caudoventral process (Fig. 673, Nielson 1982) . . . . . *variegata* (Germar)
- 3(2). Pygofer with caudoventral process closely appressed to caudodorsal process (Fig. 668, Nielson 1982); aedeagus broad throughout most of its length (Figs. 671 & 672, Nielson 1982) . . . . . *germari* Nielson
- Pygofer with caudoventral process removed from caudodorsal process (Fig. 1); aedeagus narrow throughout most of its length (Figs. 2 & 3) . . . . . *kleini* n. sp.

*Dicodia kleini*, n. sp.

(Figs. 1-5)

**Length.** Male 9.00 mm.

General color deep ochraceous with irregular, dark fuscous transverse band medially and subapically on forewings; head, pronotum and scutellum with dark fuscous markings; veins of forewings marked with short piceous and flavous stripes. Similar to *germari* Nielson in male genital characters but larger in size.

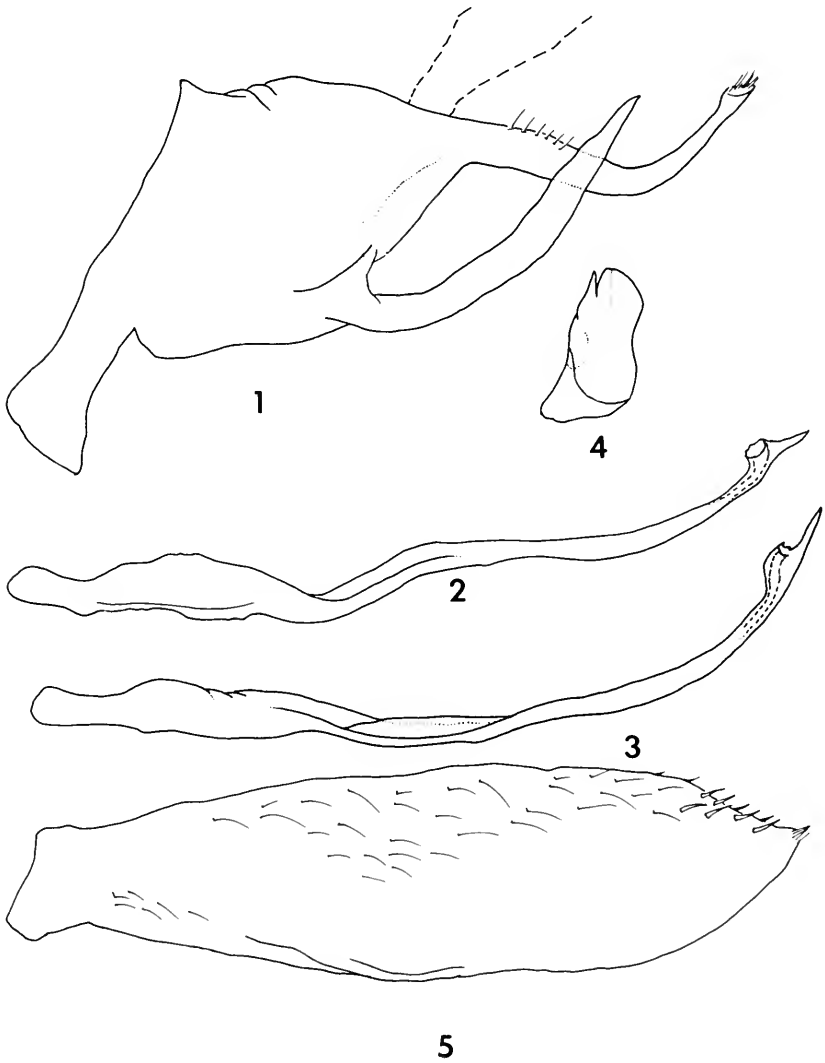
Head in dorsal view moderately large, subconical in outline; crown broad, much wider than eye, produced distally and elevated, slightly carinate laterally; eyes large, elongate ovoid, occupying less than 2/3 of entire dorsal area of head; pronotum very large, much longer than crown; scutellum moderately large, about as long medially as pronotum; forewings and venation typical; clypeus long and very broad; clypellus broad and swollen basally.

**Male.** Pygofer in lateral view with two very long caudal processes, caudodorsal process curved dorsally at middle, caudoventral process curved dorsally from base (Fig. 1); aedeagus long and narrow in dorsal and lateral views with apical spine, shallow longitudinal excavation near middle, gonopore subapical (Figs. 2 & 3); style very short (Fig. 4); plate long and rather broad throughout, abruptly pointed distally (Fig. 5).

**Female.** Unknown.

**Holotype.** (male). BRAZIL: Rondonia, 7 km. E. Costa Marques, 21-31.I.1987, Malaise Trap, T. Klein (CAS). Paratype, 1 male, same data as holotype (author's collection).

**Remarks.** This species is much larger than *germari* (7.20 mm.), has a narrower aedeagus and different configuration in the caudoventral process of the pygofer. I name this species for Terry Klein who has collected a number of new taxa of coelidiine leafhoppers from Brazil, which has measurably added to our knowledge of the biodiversity of the group.



Figs. 1-5. *Dicodia kleini*, n. sp. 1. Male pygofer, lateral view. 2. Aedeagus, ventral view. 3. Aedeagus, lateral view. 4. Right style, dorsal view. 5. Plate, ventral view.

*Boliviela sarcula*, n. sp.

(Figs. 6-9)

**Length.** Male 8.90 mm.

General color fuscous with broad, piceous transverse bands on forewings; crown, pronotum and scutellum piceous with fuscous markings; veins of forewings with ivory longitudinal spots. Similar to *retrorsa* Nielson in male genital characters.

Head in dorsal view narrower than pronotum, somewhat angular in outline; crown narrow, produced distally, foveate medially, narrower than width of eye; eyes large, semiglobular, occupying more than 2/3 of entire dorsal area of head; pronotum very large, longer than crown, with bullae on surface; scutellum moderately large, little longer medially than pronotum; forewings narrow, venation typical; clypeus long and broad; clypellus with broad, swollen base.

**Male.** Pygofer in lateral view with two, long, narrow caudal processes, caudoventral process longer, extending beyond apex of caudodorsal process (Fig. 6); aedeagus long, shaft tubular, with ventral angulate projection subbasally and long spine subapically in lateral view, gonopore apical; dorsal apodeme bifurcate basally and attached laterally to near base of aedeagus (Figs. 7 & 8); style very long and very narrow in distal 4/5 (Fig. 9).

**Female.** Unknown.

**Holotype** (male). ECUADOR: Napo, Yuca, 50 km. E. Coca, 8.III.1983, L. Huggert, (LU).

**Remarks.** This species keys to couplet 2 in my 1988a paper. It can be distinguished from *retrorsa* by the much longer and narrower caudodorsal pygofer process, by the position of attachment of the dorsal apodeme to the aedeagus and by the much longer and narrower apophysis of the style.

*Omanolidia globosa*, n. sp.

(Figs. 10-13)

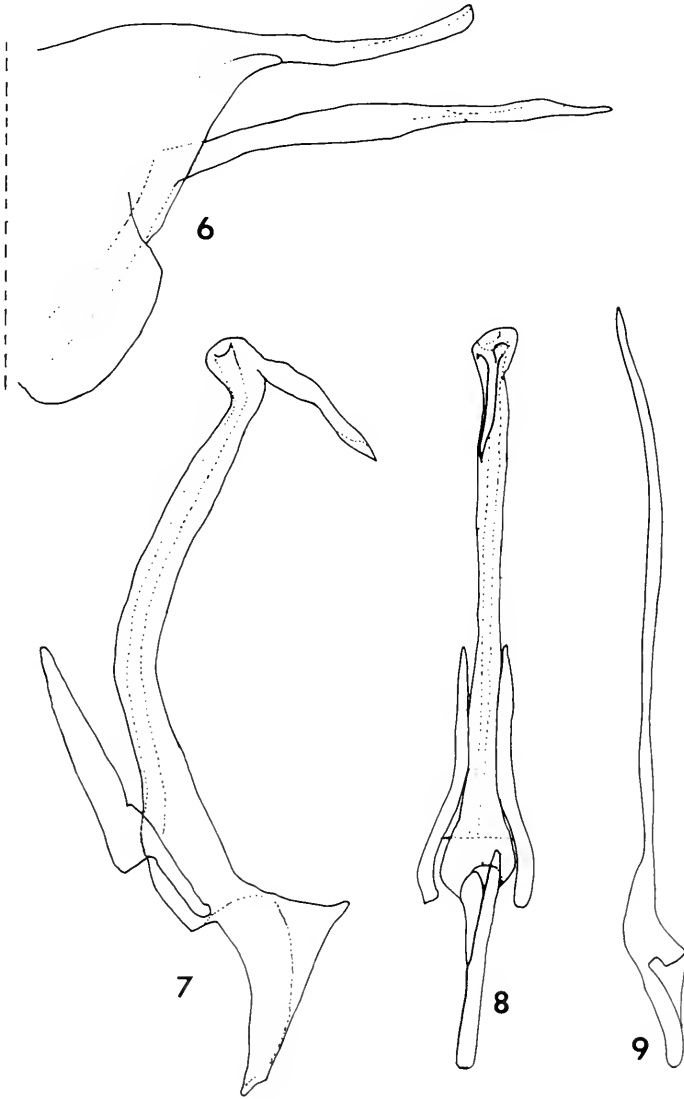
**Length.** Male 7.00-7.30 mm.

General color piceous with two, large, flavous spots each on clavus and middle of costa of forewings; head ochraceous; pronotum and scutellum piceous, tiny flavous specks on forewings; a beautifully marked species. Similar to *keiferi* Nielson in male genital characters.

Head in dorsal view narrower than pronotum, subconical in outline; crown narrow, narrower than width of eye at base, lateral margins convergent basally; eyes large, semiglobular, occupying about 2/3 of entire dorsal area of head; pronotum short, slightly longer than crown; scutellum moderately large, longer medially than pronotum; forewings and venation typical; clypeus long and broad; clypellus narrow.

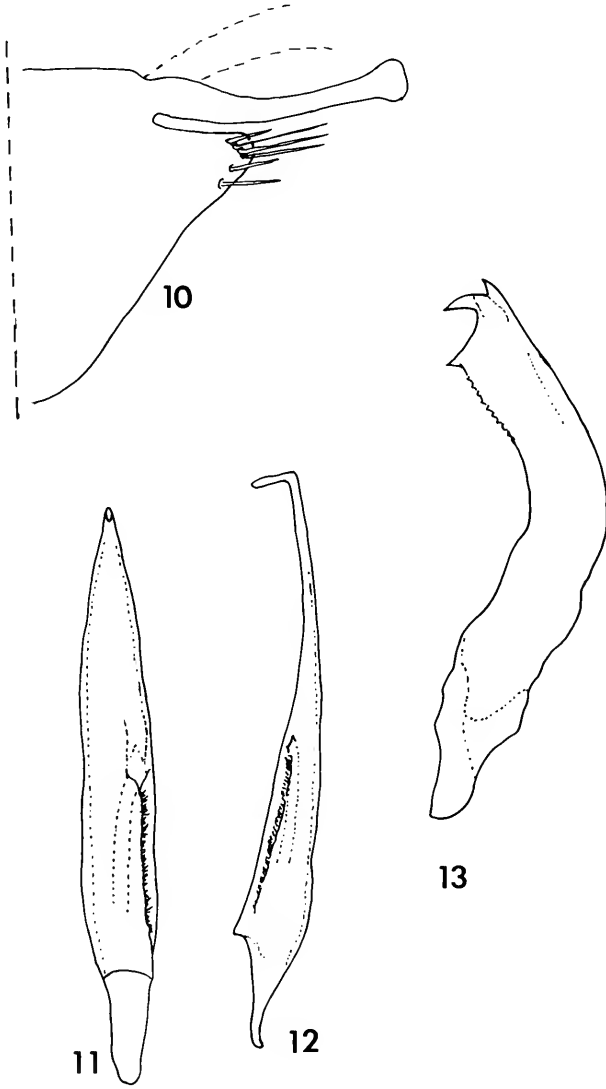
**Male.** Pygofer in lateral view with very long caudodorsal process, process nearly globular apically (Fig. 10); aedeagus in dorsal view broad, slightly tapered distally, in lateral view shaft narrowed in distal 1/3, apex abruptly angled dorsally, numerous short spines in row near lateral margin in basal half of shaft, gonopore laterodorsal near middle of shaft (Figs. 11 & 12); style broad, curved, with three short projections apically and row of short teeth on outer lateral margin in apical 1/3 (Fig. 13).

**Female.** Unknown.



Figs. 6-9. *Boliviela sarcula*, n. sp. 6. Male pygofer, lateral view. 7. Aedeagus, lateral view. 8. Aedeagus, dorsal view. 9. Right style, dorsal view.





Figs. 10-13. *Omanolidia globosa*, n. sp. 10. Male pygofer, lateral view. 11. Aedeagus, dorsal view. 12. Aedeagus, lateral view. 13. Right style, dorsal view.

**Holotype** (male). MEXICO: Michoacan, 7 mi. E. Sahuayo, 20. X.1981, M. W. Nielson (author's collection). Paratype, 1 male. Jalisco, El Colli, 3.VIII.1990, G. Moya-R. (CAS).

**Remarks.** This species keys to couplet 4 in my 1982 paper. It can be distinguished from *keiferi* by the nearly globular apex of the caudodorsal process of the pygofer and by the configuration of the apical projections of the style. The marked forewings, which are absent in *keiferi*, will also separate the species.

*Tinocripus elongatus*, n. sp.

(Figs. 14-17)

**Length.** Male 8.00 mm.

General color ochraceous throughout, shiny. Similar to *gladius* Nielson in male genital characters.

Head in dorsal view narrower than pronotum, conical in outline; crown produced distally, narrow, much narrower than width of eye, elevated and slightly carinate laterally; eyes large, elongate ovoid, occupying more than 2/3 of entire dorsal area of head; pronotum large, much longer than crown; scutellum moderate size, slightly longer medially than pronotum; forewings long and narrow, venation typical; clypeus very long and narrow; clypellus narrow.

**Male.** Pygofer in lateral view with two caudal processes, caudodorsal process short, curved, nearly U-shaped in outline, caudoventral process very long, narrow, reaching to apex of caudodorsal process (Fig. 14); aedeagus long, narrow, tube-like, curved in lateral view, apex flared (Fig. 15); style very long and narrow, swollen before apex and sharply pointed apically (Fig. 16); plate long and narrow, triangulate in distal 1/3, with numerous fine setae along outer lateral margin (Fig. 17).

**Female.** Unknown.

**Holotype.** (male). BRAZIL: Nova Teutonia, Santa Catarina, 13.VII.1964, no collector (NCSU).

**Remarks:** This species keys to couplet 2 in my 1988 paper. It can be distinguished from *gladius* by the configuration of the aedeagus and by the very long, narrow style.

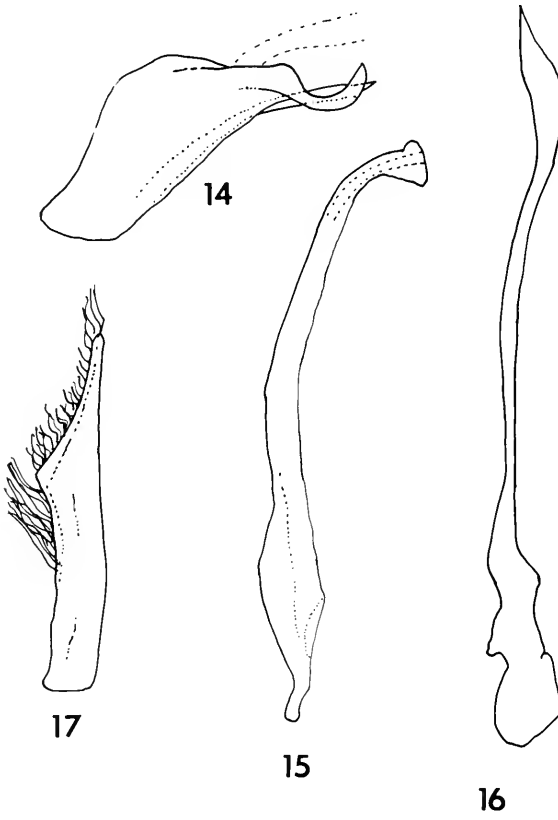
*Evansolidia tumida*, n. sp.

(Figs. 18-21)

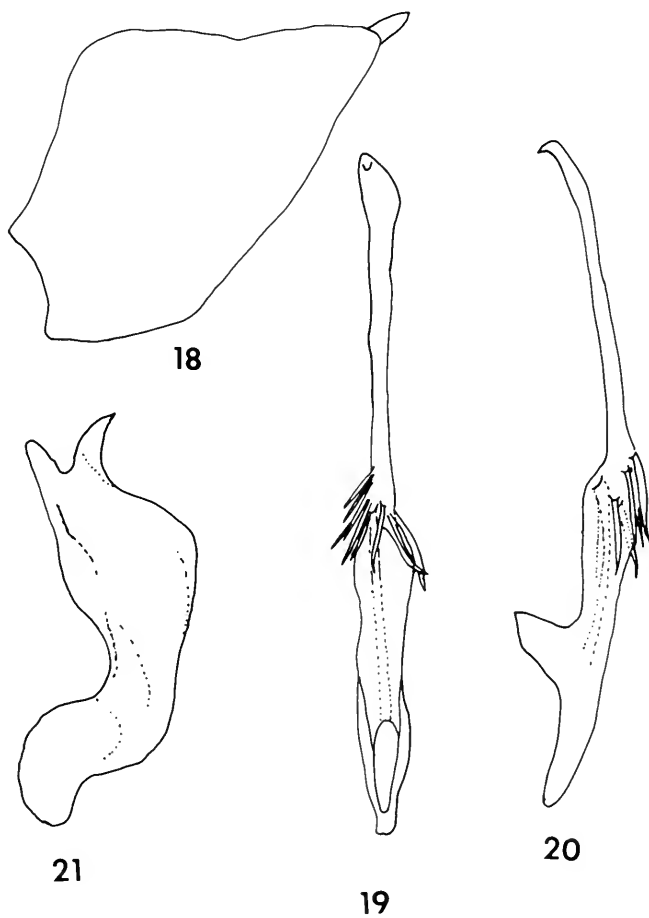
**Length.** Male 7.80-8.00 mm.

General color dark fuscous with ivory and flavous markings; crown piceous with flavous border and median flavous stripe; pronotum and scutellum piceous with irregular flavous markings; forewings dark fuscous with irregular ivory to flavous transverse band below clavus and narrow disconnected transverse ivory band near middle of clavus, cells basad of antepical cells with long, narrow, ivory to flavous markings; clypeus flavous with broad fuscous border. Similar to *bispinosa* Nielson in male genital characters.

Head in dorsal view narrower than pronotum, broadly rounded anteriorly; crown narrow, width less than width of eye, lateral margins slightly convergent basally; eyes very



Figs. 14-17. *Tinocripus elongatus*, n. sp. 14. Male pygofer, lateral view. 15. Aedeagus, lateral view. 16. Right style, dorsal view. 17. Plate, ventral view.



Figs. 18-21. *Evansolidia tumida*, n. sp. 18. Male pygofer, lateral view. 19. Aedeagus, dorsal view. 20. Aedeagus, lateral view. 21. Right style, dorsal view.

large, semiglobular, occupying more than 2/3 of entire dorsal area of head; pronotum short, about as long as crown; scutellum large, longer medially than pronotum; forewings and venation typical; clypeus long, narrow; clypellus moderately broad and swollen basally.

**Male.** Pygofer in lateral view with small caudodorsal lobe (Fig. 18); aedeagus long, broad basally and narrow in distal half in dorsal and lateral views, several stout spines near middle of shaft directed basally, gonopore near middle of shaft (Figs. 19 & 20); style very broad in dorsal view, inner lateral margin expanded below middle, apex bifurcate (Fig. 21).

**Female.** Unknown.

**Holotype (Male).** BRAZIL: Rondonia, 7 k. E. Costa Marques, 11-13.IV.1988, Terry Klein (CAS). **Paratype.** 1 male, same data as holotype except 2-3.I.1988, (author's collection).

**Remarks.** This species keys to couplet 3 in my 1988a paper. It can be separated from *bispinosa* by the much broader style and more numerous stout spines on the aedeagus.

#### ACKNOWLEDGMENTS

I am grateful to the following individuals for loan of specimens described in this study: Roy Danielsson, Zoological Institute, Lund University, Lund, Sweden; Lewis Deitz, North Carolina State University, Raleigh (NCSU); Paul Freytag, University of Kentucky, Lexington, and Paul W. Oman, Oregon State University, Corvallis. Type specimens from the latter two institutions are deposited in the California Academy of Sciences, San Francisco (CAS) at the request of the donors. I thank Ray Gill for reviewing the manuscript and offering useful suggestions for improvement. This research was supported in part by endowment funds from the Monte L. Bean Life Science Museum.

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## FIVE NEW SPECIES OF *BALERA* FROM ECUADOR (HOMOPTERA: CICADELLIDAE)<sup>1,2</sup>

Paul H. Freytag<sup>3</sup>

**ABSTRACT:** Five new species are added to the genus *Balera*: *B. myersi* n. sp., *B. ecuadora* n. sp., *B. obtusa* n. sp., *B. napoensis* n. sp. and *B. plagata* n. sp. These are described and illustrated from Ecuador and compared to the known species, with a key to all species of the genus.

The genus *Balera* (Typhlocybinae: Alebrini) was described by Young (1952) and reviewed by Young (1957); he included four species from Panama, Brazil, Bolivia and Trinidad. One additional species has been described from Colombia by Ruppel (1959). Five new species are described at this time from Ecuador and are compared with their closest relatives.

All species described fit the generic characters, having the unusual apodemes of the first abdominal segment, the unusual small hook at the apex of the male genital plate, the same forewing venation and the general appearance of an *Empoasca* species. The color pattern varies from a general straw yellow to yellow green. Some species have the same overall color, with some or all of the following: an ivory spot on the hind margin of the head, an ivory medial dash on the basal part of the meso-scutellum and dark brown spots or dashes in the apical cells of the forewing. Also some species have yellow dashes in the basal half of the forewing. The color pattern varies some within a species and varies so little between species that the male genitalia must be relied upon to separate species of this genus.

All specimens in this study are preserved in 80% ethyl alcohol with the abdomen cleared and preserved in glycerin. Holotypes are deposited in the California Academy of Science Collection. I wish to thank David Neill for the opportunity to collect these very interesting leafhoppers at the Jatun Sacha Biological Station, Napo, Ecuador.

<sup>1</sup> Received March 16, 1992. Accepted April 21, 1992.

<sup>2</sup> The investigation reported in this paper (No. 92-7-46) is in connection with a project of the Kentucky Agricultural Experiment Station and is published with approval of the Director.

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### Key to the species of *Balera*

1. Aedeagus without apical processes ..... 2
- 1'. Aedeagus with apical processes ..... 4
2. Aedeagus short, inflated, with three apical lobes (Bolivia) ..... *pellucida* (Osborn)
- 2'. Aedeagus long and narrow ..... 3
3. Aedeagus bifurcate on apical half (Colombia) ..... *bracata* Ruppel
- 3'. Aedeagus not bifurcate, with pair of lateral keels on apical half (Panama) ..... *pusilla* Young
4. Aedeagus with two pair of apical processes ..... 5
- 4'. Aedeagus with one pair of apical processes ..... 6
5. Aedeagus with dorsal pair of apical processes thicker and longer than ventral pair (Figs. 1 & 2) (Ecuador) ..... *myersi* Freytag n. sp.
- 5'. Aedeagus with ventral pair of apical processes thicker and about same length as dorsal pair (Bolivia) ..... *emarginata* (Osborn)
6. Style sharply pointed at apex (Fig. 11) ..... 7
- 6'. Style bluntly truncate at apex (Fig. 7) (Ecuador) ..... *obtusa* Freytag n. sp.
7. Aedeagus with apical ends of processes converging, in ventral view, near base of shaft (Fig. 17) (Ecuador) ..... *napoensis* Freytag n. sp.
- 7'. Aedeagus with apical ends of processes parallel or slightly diverging (Figs. 9 & 21) ..... 8
8. Aedeagus with apical processes nearly straight, in lateral view (Fig. 22); pygofer apex nearly pointed (Fig. 24) (Ecuador) ..... *plagata* Freytag n. sp.
- 8'. Aedeagus with apical processes sinuate, in lateral view (Fig. 14); pygofer apex rounded, more robust (Fig. 16) ..... 9
9. Apex of aedeagus, in ventral view, rounded, robust (Fig. 13); style not strongly angled on apical half (Fig. 15) (Brazil) ..... *caraguatae* Young
- 9'. Apex of aedeagus, in ventral view, narrow, nearly pointed (Fig. 9); style strongly angled on apical half (Fig. 11) (Ecuador) ..... *ecuadora* Freytag n. sp.

### *Balera myersi* n. sp.

(Figures 1-4)

Length of males 3.2-3.3 mm, width of head 0.6 mm; female unknown. Similar to *caraguatae* in size and color, except only dark spots on apical area of forewing present.

Overall color yellow green. Forewings with apical tip of clavus dark brown, usually five more large brown spots in various cells apical to clavus.

Male genitalia: Genital plates long, narrow, exceeding pygofer only slightly. Pygofer triangular in lateral view with a sharp upturned apex. Style short, hooked at apical end, bent dorsad near middle. Aedeagus broad at base in lateral view, narrowed near apex with two pairs of apical processes, dorsal pair larger than ventral pair.

Holotype male: ECUADOR — Napo, Estación Biológica Jatun Sacha, July 31, 1989, blacklight trap, Paul H. Freytag and Tom Myers (CAS). Paratype male: ECUADOR — same data as holotype, except August 2, 1989, deposited in the University of Kentucky Collection.

This species has two pairs of processes as in *emarginata*, however the larger of the two is dorsal, not ventral as in *emarginata*. The style is also thicker and the pygofer apex is less abruptly narrowed. It is an honor to name this species after Tom Myers, President of All-Rite Pest Control, Lexington, KY and an excellent collector and photographer of insects.

***Balera obtusa* n. sp.**

(Figures 5-8)

Length of males 3.6-3.7 mm, width of head 0.6-0.7 mm; female unknown. Size slightly larger than *caraguatae*, color similar.

Overall color yellow green. Head with a white medial spot on posterior margin, ocelli white, eyes reddish white. Basal area of scutellum with a medial white dash. Small white spot on mesopleural area. Forewing with apical tip of clavus brown, five more small brown spots in various cells apical to clavus.

Male genitalia: Genital plates long, narrow, slightly longer than pygofer. Pygofer triangular and bluntly pointed at apex. Style robust with apex dark and bluntly truncate. Aedeagus similar to *caraguatae* except processes are sinuate with apical tips close together on ventral side of shaft.

Holotype male: ECUADOR — Napo, Estación Biológica Jatun Sacha, August 2, 1989, blacklight trap, Paul H. Freytag and Tom Myers (CAS). Paratypes: two males, same data as holotype, deposited in the University of Kentucky Collection, and two males, same data as holotype, except August 1, 1989, at light, deposited in the National Collection, Quito, Ecuador.

This species is closest to *caraguatae*, but the blunt styles will easily separate these two species.

***Balera ecuadora* n. sp.**

(Figures 9-12)

Length of males 3.3-3.6 mm, width of head 0.6 mm; female unknown. Size and color similar to *caraguatae*, except spots on apical end of forewing elongate, not rounded.

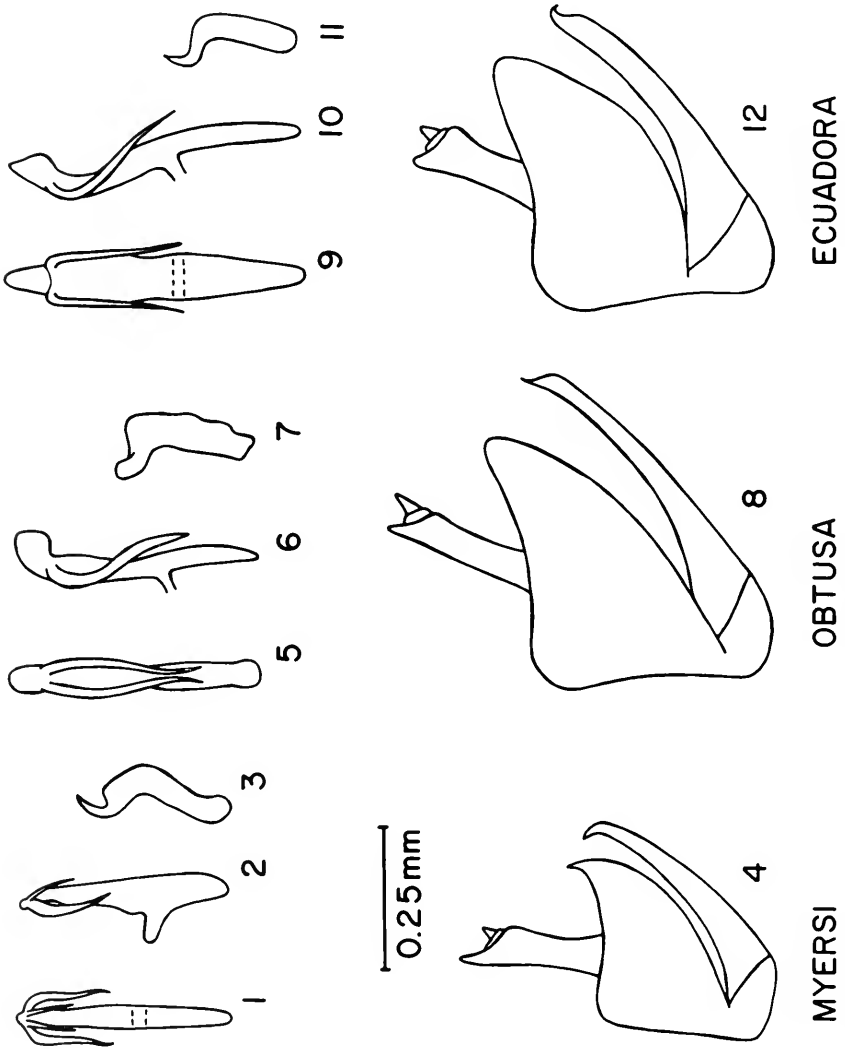
Overall yellow green. Head with a white medial spot on posterior margin. Mesopleural area with a small white spot. Forewing with tip of clavus brown, with five brown elongated spots in various cells apical to clavus.

Male genitalia: Genital plates long, narrow, slightly shorter than pygofer. Pygofer with apex broadly rounded. Style small, hook-shaped at apex. Aedeagus long, processes half length of shaft, slightly sinuate.

Holotype male: Ecuador — Napo, Estación Biológica Jatun Sacha, August 2, 1989, blacklight trap, Paul H. Freytag and Tom Myers (CAS). Paratypes: two males, same data as holotype, except dated July 31, 1989, one deposited in the University of Kentucky Collection and the other in the National Collection, Quito, Ecuador.

This species is closely related to *obtusa* but can be separated by having the genital plates of the male shorter than the pygofer and the normal type of style.





Figures 1-4 *Balera myersi* n. sp. 1. aedeagus, ventral view, 2. Aedeagus, lateral view, 3. style, lateral view, 4. male genital capsule, lateral view, setae omitted. Figures 5-8 *Balera obtusa* n. sp. 5. aedeagus, ventral view, 6. aedeagus, lateral view, 7. style, lateral view, 8. male genital capsule, lateral view, setae omitted. Figures 9-12 *Balera ecuadora* n. sp. 9. aedeagus, ventral view, 10. aedeagus, lateral view, 11. style, lateral view, 12. male genital capsule, lateral view, setae omitted. All drawn to the same scale.

***Balera caraguatae* Young**

(Figures 13-16)

*Balera caraguatae* Young, 1957, p. 172.

Length of male 3.3-3.6 mm, width of head 0.6 mm.

Overall color yellow green. Head with a white medial spot on posterior margin, ocelli white. Mesopleural area with a small white spot. Forewing with six yellow orange dashes arranged in four rows from base to near apex of clavus, apical brown spots as in *obtusata*.

This species is illustrated for comparative purpose, and to attempt to further clarify some of the male genitalic features which Young illustrated in his original description. The specimen from which the drawings were made is labeled as follows: "BRAZIL — Rondonia, 82 km. S. Frazenda, Rancho Grande, 10°32'S, 82°48'W, November 13, 1991, at light, Tom Myers", and is in the University of Kentucky Collection.

***Balera napoensis* n. sp.**

(Figures 17-20)

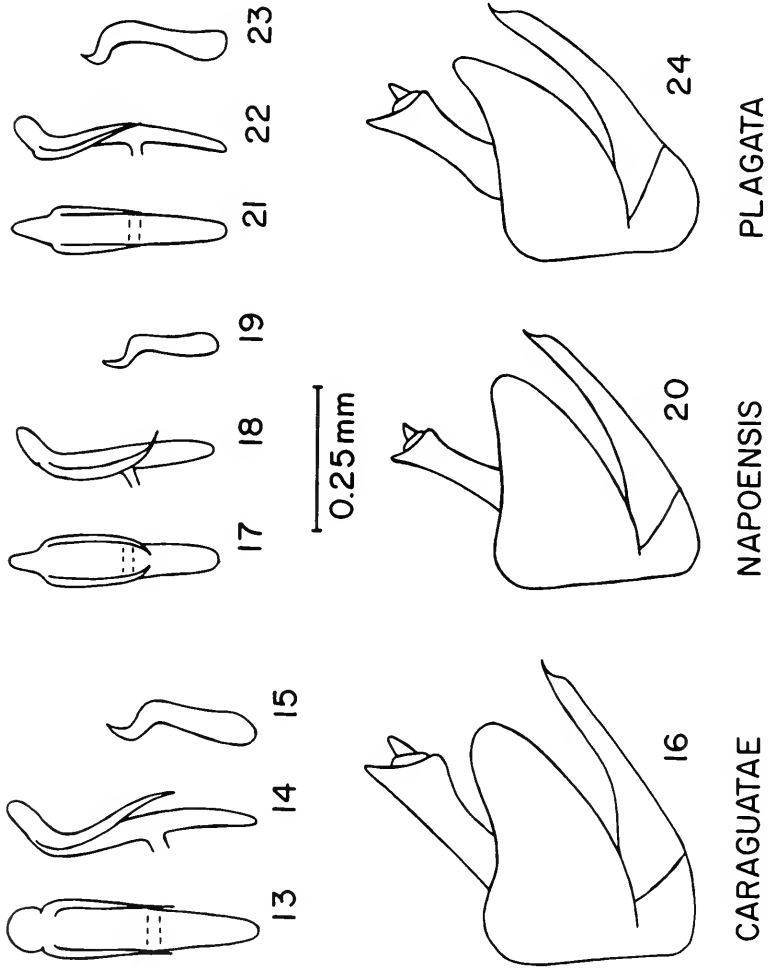
Length of males 3.3 mm, width of head 0.6 mm; female unknown. Similar to *caraguatae*, except male genitalia smaller with distinct differences.

Overall color yellow green. Head with median white spot on posterior margin, ocelli white, eyes red. Forewing with tip of clavus brown, apical spots brown, apical margin brown.

Male genitalia: Genital plate long, narrow, slightly longer than pygofer. Pygofer triangular with a bluntly pointed apex. Style small, hook-shaped at apex. Aedeagus short, processes extending two thirds distance to base of shaft, each with apex turning slightly toward shaft.

Holotype male: ECUADOR — Napo, Estación Biológica Jatun Sacha, August 1, 1989, at light, Paul H. Freytag and Tom Myers (CAS). Paratypes: one male, same data as holotype, except July 31, 1989, blacklight trap, in the University of Kentucky Collection, and one male, same data as holotype, except August 2, 1989, blacklight trap, in the National Collection, Quito, Ecuador.

This species is closely related to *ecuadora* but smaller and with the aedeagal processes not sinuate.



Figures 13-16 *Balera caraguatae* Young 13. aedeagus, ventral view, 14. aedeagus, lateral view, 15. style, lateral view, 16. male genital capsule, lateral view, setae omitted. Figures 17-20 *Balera napoensis* n. sp. 17. aedeagus, ventral view, 18. aedeagus, lateral view, 19. style, lateral view, 20. male genital capsule, lateral view, setae omitted. Figures 21-24 *Balera plagata* n. sp. 21. aedeagus, ventral view, 22. aedeagus, lateral view, 23. style, lateral view, 24. male genital capsule, lateral view, setae omitted. All drawn to the same scale.

*Balera plagata* n. sp.

(Figures 21-24)

Length of males 3.1-3.2 mm, width of head 0.5 mm; female unknown. Similar to *caraguatae*, but slightly smaller, and with smaller male genital structures.

Overall color yellow green. Head with median white spot on posterior margin, ocelli white, eyes red. Mesopleural area with a small white spot. Forewing with faint yellow patches on basal half, apical spots similar to previous species with the addition of one spot on vein bordering appendix and three on apical margin.

Male genitalia: Genital plates long, narrow, about same length as pygofer. Pygofer triangular with a bluntly pointed dorsally projecting apex. Style narrow with a hook-like apex. Aedeagus short, with a pair of processes extending basad half distance to base of shaft.

Holotype male: ECUADOR — Napo, Estación Biológica Jatun Sacha, August 2, 1989, blacklight trap, Paul H. Freytag and Tom Myers (CAS). Paratypes: two males, same data as holotype, deposited in the University of Kentucky Collection; one male, same data as holotype, except July 31, 1989, deposited in the National Museum, Quito, Ecuador.

This species is closest to *napoensis*, but can be separated by the narrower apex of the male pygofer and the processes of the aedeagus being closely appressed to the shaft and not curved at their apices.

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## TRICHOPTERA OF HEADWATER STREAMS IN THE FERNOW EXPERIMENTAL FOREST, MONONGAHELA NATIONAL FOREST, WEST VIRGINIA<sup>1</sup>

Michael B. Griffith, Sue A. Perry<sup>2</sup>

**ABSTRACT:** In support of several ongoing studies on the ecology of streams in the Fernow Experimental Forest, West Virginia, adult Trichoptera were identified from emergence and light trap samples taken from six experimental catchments. Thirty-seven species from 24 genera and 13 families were collected, including four species that were previously unrecorded from West Virginia.

Our research at the Fernow Experimental Forest, West Virginia, on the effects of acid precipitation and on the nontarget effects of the application of the forest pesticide diflubenzuron, has included work on the macroinvertebrate communities of second order streams draining several headwater catchments (Griffith and Perry, 1991). Only two previous studies have produced species lists for streams in the Fernow Experimental Forest. Harris (1973) collected benthic samples from the streams and weir ponds in Watersheds 1, 3, 4, 6, and 7, and Case (1983) collected kick samples of aquatic nymphs from Watersheds 1, 4, and 6. Both studies identified the insects primarily to genus.

Tarter (1990) provided a checklist for the Trichoptera of West Virginia. This checklist includes 176 species from 60 genera and 15 families.

To facilitate ongoing and future research at the Fernow Experimental Forest, we conducted a survey of aquatic insects in the streams draining the catchments used in our studies. We present a species list of the Trichoptera collected in this survey.

### STUDY SITES

The Fernow Experimental Forest is a U.S. Forest Service research preserve located 5 km south of Parsons in Tucker County, West Virginia,

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<sup>2</sup>U.S. Fish and Wildlife Service, West Virginia Cooperative Fish and Wildlife Research Unit<sup>3</sup>, Division of Forestry, West Virginia University, Morgantown, WV 26506-6125.

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in the northern part of Monongahela National Forest (39°3'N, 79°40'W; Figure 1). Established in 1951, the 1474-ha experimental forest includes the entire catchment of Elklick Run, a fourth order tributary of the Black Fork of the Cheat River. The experimental forest includes nine gauged experimental catchments and several ungauged catchments. We conducted surveys on six second order streams draining catchments designated as Watershed 1 (WS1), Watershed 3 (WS3), Watershed 4 (WS4), Watershed 7 (WS7), Watershed 13 (WS13), and North Fork of Hickman Slide Run (HSR). WS3, WS4, and HSR are reference catchments that have undergone little disturbance since about 1910, whereas WS1, WS3, and WS7 are experimental catchments that were last logged in 1958, 1969, and 1969, respectively. WS1, WS3, WS4, WS7, and WS13 are underlain by shales and siltstones of the Hampshire formation, whereas HSR is underlain by limestones and shales of the Greenbriar and Mauch Chunk formations. Because of the presence of limestone in the catchment, HSR is characterized by higher pH and alkalinity than the other streams. A more detailed description of the study sites may be found in the works of Griffith and Perry (1991, 1992).

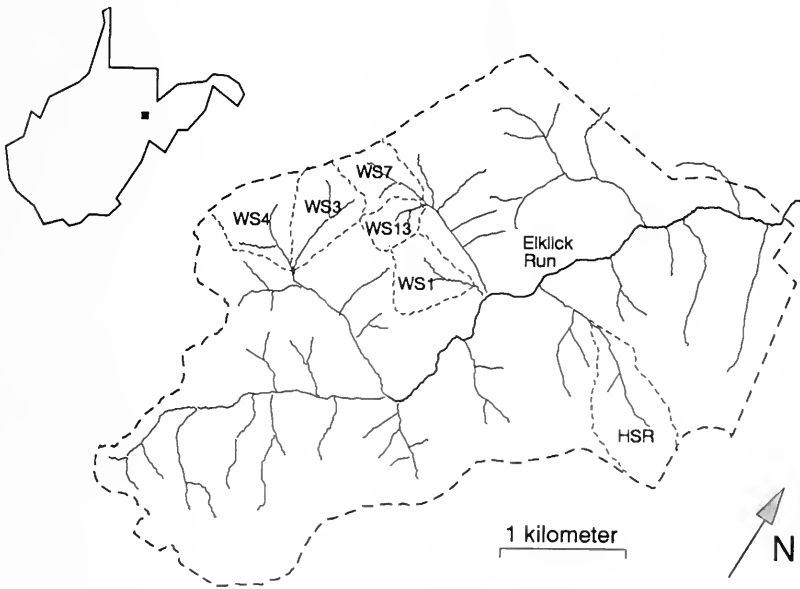


Figure 1. Fernow Experimental Forest with locations of the study catchments.

## MATERIALS AND METHODS

The surveys were conducted from June 1989 through August 1991 using primarily emergence traps modified from the WEEK design of LeSage and Harrison (1979). These collections were supplemented by periodic light trapping with blacklight traps and collections by hand when adults were observed during other sampling. A more detailed description of sampling may be found in Griffith and Perry (1992).

All collected material was preserved in 85% ethanol. Voucher specimens have been placed in the collection of the West Virginia Cooperative Fish and Wildlife Research Unit in the Division of Forestry at West Virginia University.

## RESULTS AND DISCUSSION

We collected 37 species from 24 genera and 13 families of Trichoptera (Table 1). The most diverse families were the Rhyacophilidae, with seven species all from the genus, *Rhyacophila*, and the Hydropsychidae with six species from four genera. We collected four species which were previously unreported for the state of West Virginia.

In general, the species list is characteristic of the small lotic habitats in the Fernow Experimental Forest, but some species seem to be from other larval habitats. Examples include the limnephilid, *Nemotaulius hostilis* (Hagen), the larvae of which have been reported by Stout and Stout (1989) from small remnant boreal wetlands in West Virginia. When the methods by which different species were collected were examined, the obvious conclusion was that we probably collected some species from outside these headwater streams with the light traps. Although the combination of survey methods we used worked well for Plecoptera (Griffith and Perry 1992), Trichoptera tend to be stronger fliers and may be attracted to lights far from their larval habitats (Waringer 1991). Other species that were only collected using light trapping and probably came from other larval habitats included *Ptilostomis ocellifera* (Walker), *Hydropsyche sparna* Ross, and *Rhyacophila fuscula* (Walker). *Ptilostomis ocellifera* larvae also occur in lentic habitats whereas *H. sparna* (M. Griffith, pers. obs.) and *R. fuscula* (Sykora and Weaver 1979) tend to occur in larger streams. Most other species that we collected seem to match well with generic identifications from our benthic samples and are characteristic of the fauna of headwater Appalachian streams. This observation is particularly true for the four species and one genus that are new state records, which seems to suggest that these small stream habitats have been undercollected in West Virginia.

Two species, *Adicropheps hitchcocki* Flint and *Palaegepetus celsus* (Ross), have been reported to occur in association with aquatic mosses and liverworts in Appalachian streams (Wiggins 1977) and to use these plants for case-building materials. The co-occurrence of these two species in streams in the Fernow appears to be unusual, but these streams support a diverse assemblage of aquatic mosses and liverworts (S. Stevenson, Fairmont State University, unpubl. data).

In a survey of Plecoptera in these streams, several species appeared to exhibit distributions among streams that were related to water chemistry or catchment management history (Griffith and Perry, 1992). No species of Trichoptera were limited to the more alkaline stream, HSR, but one species, *Homoplectra monticola* (Flint), was only collected from WS4 and WS13, the two reference catchments.

TABLE 1. Checklist of Trichoptera collected from headwater catchments in the Fernow Experimental Forest, Tucker County, West Virginia. (E—collected in emergence traps, L—collected in light traps only, X—collected in larval collection only)

Stream	HSR	WS1	WS3	WS4	WS7	WS13
Order Trichoptera						
Family Philopotamidae						
Subfamily Philopotaminae						
<i>Dolophilodes distinctus</i> (Walker)	E	E	E	E	E	E
<i>Wormaldia moesta</i> (Banks)	E	E	E	E	E	
Family Psychomyiidae						
Subfamily Psychomyiinae						
<i>Lype diversa</i> (Banks)	E	E	E	E		E
Family Polycentropodidae						
Subfamily Polycentropodinae						
<i>Polycentropus cinereus</i> Hagen	E		E	E	E	
<i>P. maculatus</i> Banks	E	E	E	E	L	E
Subfamily Dipseudopsinae						
<i>Phyloctropus lucidus</i> (Hagen)	L			E		
Family Hydropsychidae						
Subfamily Arctopsychinae						
<i>Parapsyche apicalis</i> (Banks)			E	E	E	E
Subfamily Dipletroninae						
<i>Dipletrona modesta</i> Banks	E	E	E	E	E	E
<i>Homoplectra monticola</i> (Flint)				E		E



Stream	HSR	WS1	WS3	WS4	WS7	WS13
Subfamily Hydropsychinae						
<i>Hydropsyche morosa</i> Hagen			E			
<i>H. sparna</i> Ross	L	L	L	L	L	L
<i>H. ventura</i> Ross	E		L	L		
Family Rhyacophilidae						
Subfamily Rhyacophilinae						
<i>Rhyacophila banksi</i> Ross	E	E		E		E
<i>R. carolina</i> Banks	L	E	E	L	E	E
<i>R. carpenteri</i> Milne	L	E		L		
<i>R. fuscula</i> (Walker)	L			L		
<i>R. glaberrima</i> Ulmer			E	L	E	E
<i>R. nigrita</i> Banks	E		E	E		E
<i>R. vibox</i> Milne	E		E	L		
Family Glossosomatidae						
Subfamily Glossosomatinae						
<i>Glossosoma nigrrior</i> Banks	E		E			
Family Hydroptilidae						
Subfamily Ptilocolepinae						
<i>Palaeagapetus celsus</i> (Ross)		L	L	E		
Subfamily Hydroptilinae						
<i>Stactobiella delira</i> (Ross)					L	
Family Phryganeidae						
Subfamily Phryganeinae						
<i>Ptilostomis ocellifera</i> (Walker)				L		
Family Brachycentridae						
<i>Adicrophleps hitchcocki</i> Flint*			X	X		E
<i>Micrasema rusticum</i> (Hagen)*		L				
Family Limnephilidae						
Subfamily Pseudostenophylacinae						
<i>Pseudostenophylax uniformis</i> (Betten)	L			L		E
Subfamily Limnephilinae						
<i>Nemotaulius hostilis</i> (Hagen)			L			
<i>Pycnopsyche gentilis</i> (McLachlan)	E	E	E	E	E	E
<i>P. scabripennis</i> (Rambur)	E	E	E			E
Subfamily Goerinae						
<i>Goera stylata</i> (Ross)*			L			

Stream	HSR	WS1	WS3	WS4	WS7	WS13
Family Uenoidae						
Subfamily Thremmatinae						
<i>Neophylax aniqua</i> Ross	E	E	E			
<i>Neophylax wigginsii</i> Sykora and Weaver		E	E		E	
Family Lepidostomatidae						
<i>Lepidostoma griseum</i> (Banks)	E	E		E		E
<i>L. togatum</i> (Hagen)				E		
<i>L. vernale</i> (Banks)				L		
Family Molannidae						
<i>Molanna ulmerina</i> Navas*			E	E		
Family Leptoceridae						
Subfamily Leptocerinae						
<i>Oecetis cinerascens</i> (Hagen)			E			

\*New state records

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## SAWFLIES (HYMENOPTERA: ARGIDAE) FROM DOMINICAN AMBER<sup>1</sup>

David R. Smith<sup>2</sup>, George O. Poinar, Jr.<sup>3</sup>

**ABSTRACT:** Six sawfly specimens discovered in amber deposits from the Dominican Republic are represented by five adults and one larva. The five adults represent five new species of the Central and South American genus *Didymia*, a genus that no longer occurs in the West Indies. Species described are *D. dominicana*, *D. davisii*, *D. protea*, *D. poinari*, and *D. ebena*. The larva belongs to the Argidae but cannot be identified further.

Six specimens of sawflies, five adults and one larva, have been discovered in Dominican amber. Four adults and the larva were found by the junior author, and the other adult was discovered in the amber collection of the Smithsonian Institution. All specimens belong to the family Argidae and all adults show differences that justify separate species.

This is an unusual discovery. Only about six species of Symphyta currently occur in the West Indies (Smith, 1969), and only one, *Sericoceros krugii* (Cresson), is known from Hispaniola (Smith, 1992). The amber adults belong in the subfamily Sterictiphorinae and in the extant genus *Didymia* that includes about 20 species distributed from Panama to southeastern Brazil. The presence of these Symphyta in Dominican amber, believed to be 20 to 40 million years old (Davis, 1989; Manley and Poinar, 1991), indicates that sawflies were, at one time, much more widespread and diverse in the West Indies.

Little is known of the habits of *Didymia*, and the host plants of only two species are recorded. *Didymia connarusae* Smith has been reared from *Connarus fulvus* in D.F., Brazil (Smith, 1992), and *D. unifasciata* Smith has been reared from *Rouria glabra* in Panama (Kimsey and Smith, 1985). Both plants are in the Connaraceae. *Didymia* has been recorded from Brazil (Amazonas, D.F., Goias, Espirito Santo, Mato Grosso, Minas Gerais, Pará, Rio de Janeiro, Santa Catarina, São Paulo), Panama, Peru, and Surinam (Smith, 1992).

All of the adult amber species have the following characters in common: tibiae without preapical spines; tarsal claws simple; forewing with radial cell closed, with long accessory vein; forewing with crossvein 3r-m

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curved, cell 2rs longer on Rs than on M (complete forewing venation visible only in *D. poinari* and *D. ebena*, but the others are probably similar according to the parts that are visible); one or more of the maxillary or labial palpal segments expanded, much broader than the other segments; maxillary palpus longer than eye length; lower interocular distance subequal to or shorter than eye length. The hindwing venation is partially visible only in *D. ebena*, but the anal cell is probably closed in the specimens. These characters plus the short female antennae and general habitus place them in *Didymia*, according to Smith's (1992) definition, and none fit the species in his key. Since the sexes of many Argidae are very different in antennal structure and color, it is possible some of these described are opposite sexes of the same species. This, however, is impossible to determine.

All amber specimens treated here are from the Dominican Republic. More specific locality information is not available.

### *Didymia dominicana* Smith, new species

(Fig. 1)

**Female.** Length, 7.0 mm. Yellow to orange with antenna, abdominal dorsum except downturned lateral margins of terga, apical 2 terga entirely, sheath, indistinct streaks on inner surfaces of femora, and extreme apex of hindtibia black. Antennal length subequal to head width. Clypeus shallowly, circularly emarginated; malar space linear; interantennal carina short, not extending onto supraclypeal area; maxillary palpus uniformly slender with 4th segment only slightly broader than others; 2nd and 3rd segments of labial palpus enlarged, 3rd segment largest; eye length about equal to lower interocular distance. Hindbasitarsus subequal in length to following tarsal segments combined. Only apex of forewing visible, veins 2r-m and 2m-cu interstitial. Sheath rounded at apex in lateral view, appearing slender in dorsal view, without scopae.

**Holotype.** Numbered "H-10-48-A", deposited in the Poinar Amber Collection, Museum of Paleontology, University of California, Berkeley; Musco. Palco. 39852.

### *Didymia davisii* Smith, new species

(Fig. 2)

**Female.** Length, 4.5 mm. Antenna and head black; thorax and legs appearing reddish; abdomen with basal terga and sterna appearing yellowish, with lateral stripe and apical 3 segments and sheath black. Antennal length slightly longer than head width. Clypeus nearly truncate; malar space linear; interantennal carina bisecting supraclypeal area to clypeus; segments of maxillary palpus appearing uniformly slender; at least 3rd segment of labial palpus enlarged; eye length subequal to or slightly longer than lower interocular distance. Hindbasitarsis subequal in length to following tarsal segments combined. Wing



Figs. 1, 2. 1, *Didymia dominicana* (H-10-48-A). 2, *D. davisi* (#10500).

venation poorly visible, but radial cell of forewing closed with long accessory vein. Sheath rounded at apex in lateral view, appearing slender in dorsal view, without scopae.

**Holotype.** With label "Smithsonian Institution Entomology Department, Brodzinsky/Lopez-Penha Collection, Reg. #10500." In the National Museum of Natural History, Washington, D.C.

*Didymia protera* Smith, new species

(Fig. 3)

**Male.** Length, 5.0 mm. Entirely black. Antennal length 2.5X head width. Clypeus subtruncate; malar space linear; sharp interantennal carina bisecting supraclypeal area to clypeus; maxillary palpus 1.7X eye length, all segments uniformly slender; 3rd segment of labial palpus enlarged, 2nd only slightly broader than apical segment; lower interocular distance subequal to eye length. Hindbasitarsus subequal in length to following tarsal segments combined. Only apex of forewing evident; radial cell closed at apex with long accessory vein.

**Holotype.** Numbered "H-10-48-B", deposited in the Poinar Amber Collection, Museum of Paleontology, University of California, Berkeley; Museo. Paleo. 39853.

*Didymia poinari* Smith, new species

(Figs. 4, 5)

**Male.** Length, 5.5 mm. Black, with apparent reddish marks on pronotum, mesoprescutum, and mesonotal lateral lobes. Antennal length 1.8X head width. Clypeus subtruncate, malar space linear; interantennal carina short, not bisecting supraclypeal area; 4th segment of maxillary palpus slightly broader than other segments; 3rd segment of labial palpus enlarged, 2nd segment apparently enlarged (difficult to see) but narrower than 3rd segment; lower interocular distance subequal to eye length. Hindbasitarsus slightly shorter than length of remaining tarsal segments combined, about equal to following 3-1/2 segments. Forewing as in Fig. 4; veins 2r-m and 2m-cu interstitial.

**Holotype.** Numbered "H-10-48-C", deposited in the Poinar Amber Collection, Museum of Paleontology, University of California, Berkeley; Museo. Paleo. 39854.

*Didymia ebena* Smith, new species

(Fig. 6)

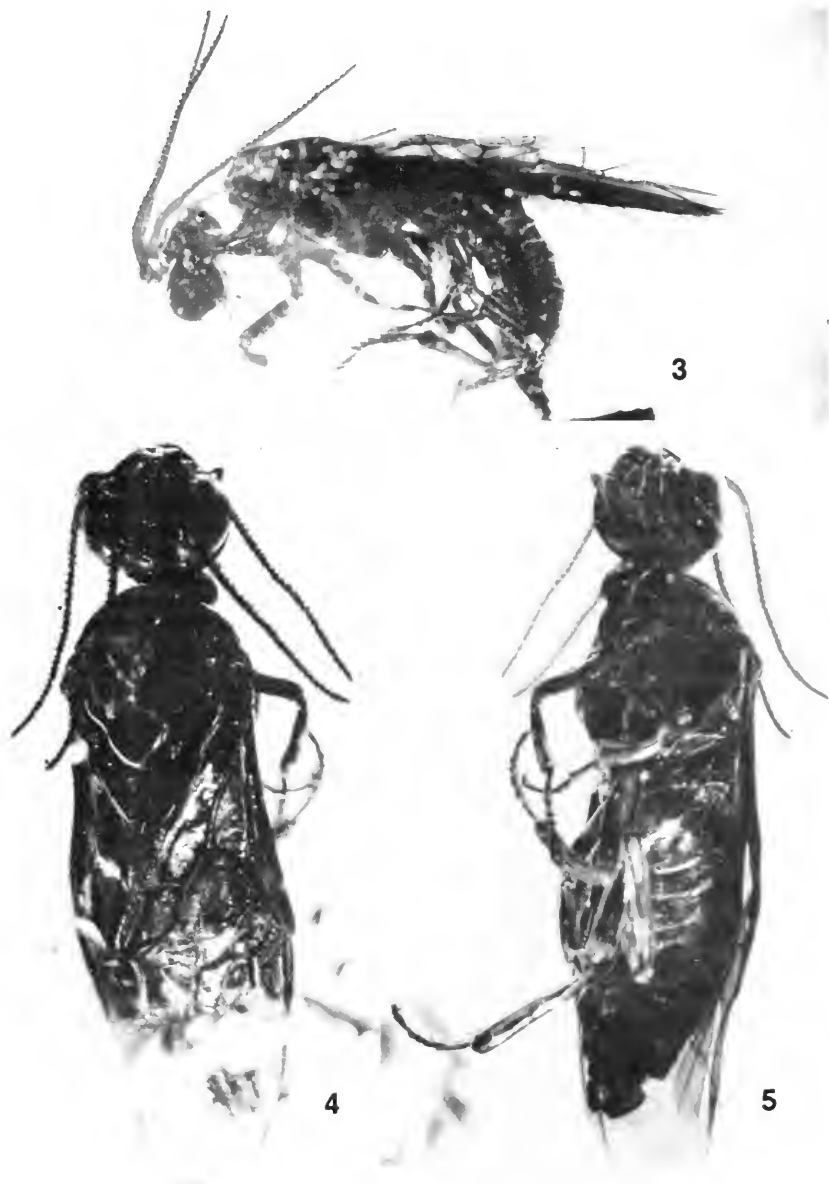
**Male.** Length, 3.0 mm. Entirely black. Antennal length 1.4X head width. Clypeus subtruncate; malar space linear; interantennal carina short, not bisecting supraclypeal area; segments of maxillary palpus uniformly slender; 3rd segment of labial palpus enlarged; lower interocular distance subequal to eye length. Hindbasitarsus subequal in length to remaining tarsal segments combined. Most of forewing visible; vein 2m-cu meets M about midway between 2r-m and 3r-m; apex of radial cell appearing open, but faintly closed and with accessory vein. Hindwing with anal cell.

**Holotype.** Numbered "H-10-36", deposited in the Poinar Amber Collection, Museum of Paleontology, University of California, Berkeley; Museo. Paleo. 39855.

## Argidae Larva

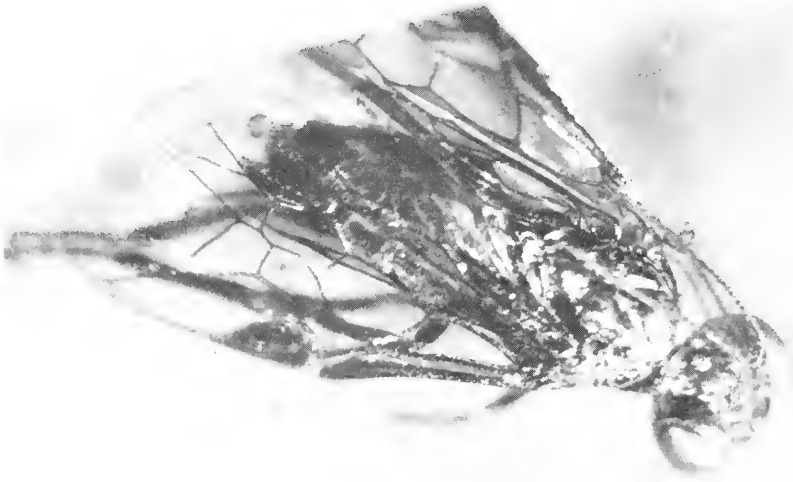
(Figs. 7-9)

It is rare to find larvae in amber. Characters such as the lobes adja-

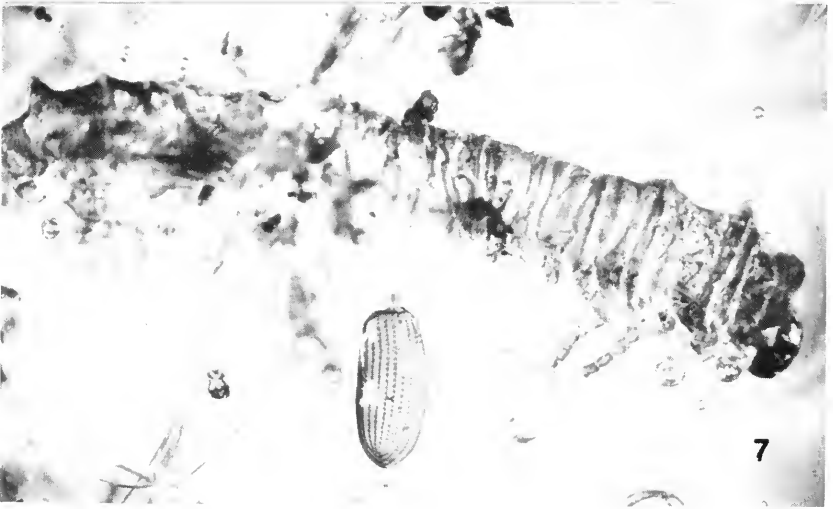


Figs. 3-5. 3, *Didymia protera* (H-10-48-B). 4, *D. poinari* (H-10-48-C) dorsal view. 5, *D. poinari* (H-10-48-C), ventrolateral view.



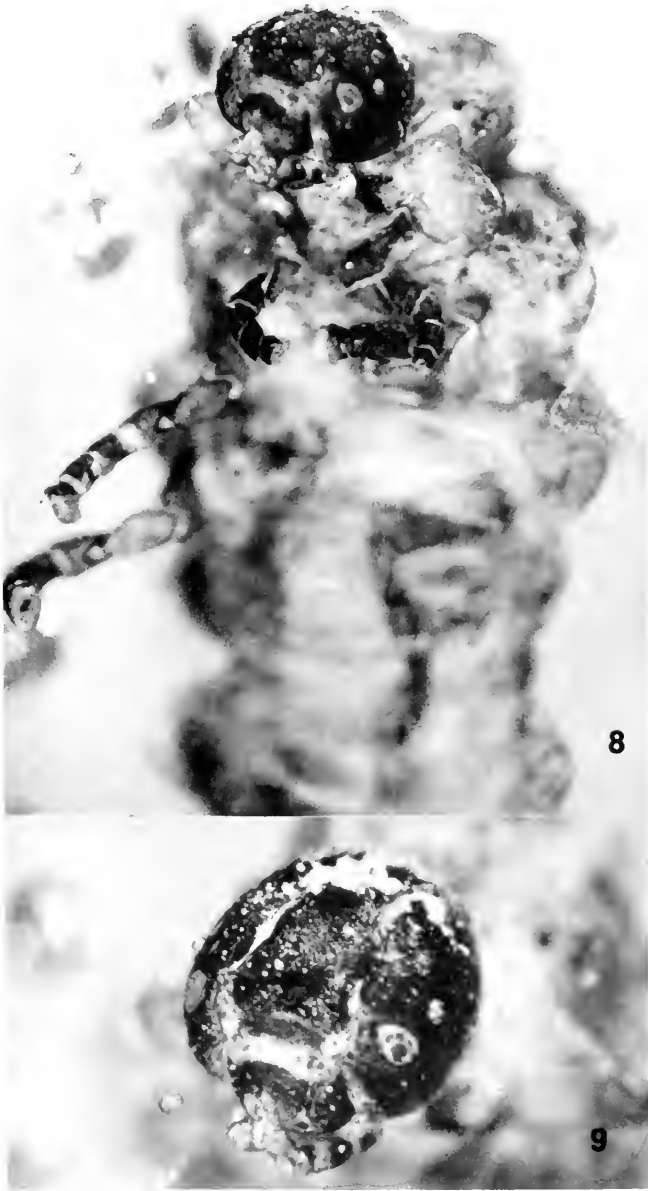


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7

Figs. 6, 7. 6, *Didymia ebena* (H-10-36). 7, Argidae larva, dorsolateral view.



Figs. 8, 9. Argidae larva. 8, Ventral view of head and thorax. 9, Head.

cent to the tarsal claws place it in Argidae, but it cannot be identified further. Too few larvae are known from Central and South America to adequately place this specimen. It is cited and figured here for reference.

## DISCUSSION

The species described here, the only ones known from Dominican amber, may be separated by the following key:

1. Female..... 2  
Male ..... 3
2. Yellow; antennal length subequal to head width; interantennal carina short, not bisecting clypeus; length 7.0 mm ..... *dominicana* Smith  
Head black, thorax and legs reddish, abdomen yellowish with black lateral stripe and apical segments; antennal length slightly greater than head width; interantennal carina bisecting supraclypeal area; length, 4.5 mm ..... *davisi* Smith
3. Length about 3.0 mm (vein 2m-cu meets M about midway between 2r-m and 3r-m; hindbasitarsus subequal in length to following tarsal segments combined; interantennal carina short, not bisecting supraclypeal area; antennal length 1.4X head width) ..... *ebena* Smith  
Length 5.0-5.5 mm ..... 4
4. Antennal length 1.8X head width; interantennal carina not bisecting supraclypeal area; hindbasitarsus slightly shorter than remaining tarsal segments combined (forewing with veins 2r-m and 2m-cu interstitial) ..... *poinari* Smith  
Antennal length 2.5X head width; interantennal carina bisecting supraclypeal area to clypeus; hindbasitarsus subequal in length to remaining tarsal segments combined..... *protera* Smith

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## ARTHROPOD PARASITES OF *COCCINELLA SEPTEMPUNCTATA* (COLEOPTERA: COCCINELLIDAE); WORLD PARASITE LIST AND BIBLIOGRAPHY<sup>1</sup>

Paul W. Schaefer<sup>2</sup>, Valentin P. Semyanov<sup>3</sup>

**ABSTRACT:** The literature and recent North American collection records indicate that at least 16 species of insects (ca. 14 Hymenoptera from 6 families, and 2 Diptera from 2 families) and two ectoparasitic mites are known as parasites or hyperparasites of *Coccinella septempunctata*. Lists include names of actual parasites or hyperparasites, other names and synonymies, as well as misidentifications or improper host associations, and all are referenced to new collection data or bibliographic citations.

The sevenspotted ladybeetle, *Coccinella septempunctata* L., is an important predator of aphids in the Palearctic region. It became established in North America in 1973 (Angalet & Jacques, 1975; Larochelle 1979, Larochelle & Larivière, 1979), extended its distribution rather slowly at first (Hobeke & Wheeler, 1980), and then spread more rapidly south and west aided in part by humans (Angalet *et al.* 1979). By August 1986, its distribution included the eastern 2/3 of the United States and southern Canada (Schaefer *et al.* 1987). It has continued to spread and has now been recovered west of the Rocky Mountains in Utah due to natural spread and also it was intentionally released in California and Washington in 1988, with additional west coast releases in 1989 and 1990, and, with confirmed recoveries first in 1990, it is now present in all U.S. states (R. Flanders, USDA, APHIS, personal communication.). Because this species has been so successful in expanding its range and because it is a potentially beneficial agent in the biological control of aphids, we focused on the parasitic insects associated with *C. septempunctata*, especially those that might reduce the benefits gained from its presence in North America. Our initial efforts were to construct a world list of parasites of *C. septempunctata*. Beginning with the published (Richerson 1970) and unpublished supplemental works of J. V. Richerson (pers. comm.), published lists by Johnssen (1930) and Thompson (1943), published account of parasites in Asia by Semyanov (1986), and a very useful unpublished card catalog of parasites and hosts housed (but no

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longer updated) at the USDA, Systematic Entomology Laboratory, located at the U. S. National Museum, Washington, D.C., we updated (as of January 1992) the list of known arthropod parasites of *C. septempunctata*. Included are previously unpublished records of North American parasites in which we have keyed our source to the collector and provided collection data. All North American parasites were identified by Michael E. Schauff (USDA, Systematic Entomology Lab., Beltsville, MD). Included are some references in which authors cite other sources. The resulting world list of *C. septempunctata* parasites, stages attacked, and information sources is presented in Table 1. As many species appear in the literature under various names, Table 2 lists known synonymies and other name combinations that we believe refer to the same insect.

In our literature search we found that several published records of parasites attacking *C. septempunctata* are in error. These are listed in Table 3, along with our reasons for removing them from the current master list of parasitic arthropods.

In the bibliography, we include known abstracting journal citations regardless of whether we viewed the original article or not. These are referred to as: RAE — Review of Applied Entomology; BA — Biological Abstracts, and BNI — Biocontrol News and Information.

We hope that this compilation of parasitic arthropods associated with *C. septempunctata* will stimulate others to be alert for additional associations, especially in North America, where this beetle is a recent invader and most capable disperser. As it invades new geographic areas, the potential for new associations is great and in time we may see many new species added to this list of arthropod parasites.

TABLE 1. Parasitic arthropods associated with *Coccinella septempunctata* L.

TAXON	STAGE ATTACKED <sup>a</sup>	TYPE <sup>b</sup>	REFERENCE
ACARINA			
Podapolipodidae			
<i>Ectoparas</i> sp.	A	E	64
<i>Podapolipus</i> sp.	A	E	30
DIPTERA			
Phoridae			
<i>Phalacrotophora fasciata</i> (Fallén)	L,P	Pa	14, 15, 16, 17, 26, 30, 35, 44, 55, 57, 63, 70, 73, 76, 77, 83
<i>Phalacrotophora</i> sp.	L,P	Pa	31, 36, 70

TAXON	STAGE ATTACKED <sup>a</sup>	TYPE <sup>b</sup>	REFERENCE
Tachinidae			
<i>Medina luctuosa</i> Meigen	A	Pa	76, 77
<b>HYMENOPTERA</b>			
Braconidae			
<i>Dinocampus coccinellae</i> (Schrank)	A.L	Pa	1, 3, 6, 7, 8, 9, 10, 13, 16, 17, 18, 19, 22, 23, 24, 25, 26, 27, 28, 30, 31, 35, 36, 39, 41 42, 43, 44, 46, 47, 48, 49, 50, 51, 53, 54, 60a, 60b, 61, 65, 66, 68, 69, 70, 72, 75, 76, 77, 78, 79, 80, 81, 83, 84, 85, 86
Ichneumonidae			
<i>Metastenus townsendi</i> (Ashmead)	?	?	82
<i>Syrphoctonus tarsatorius</i> Panzer	?	H	17, 44
<i>Gelis melanocephalus</i> Schrank	?	?H	44
Unidentified species	?	?	4, 37
Eulophidae			
<i>Tetrastichus coccinellae</i> Kurdjumov	L.P	Pa	2, 3, 8, 12, 16, 22, 26, 30, 31, 35, 40, 45, 47, 56, 58, 61, 64, 70, 74, 76, 77, 83
<i>Tetrastichus epilachnae</i> Giard	L.P	Pa	38, 52, 62, 70
<i>Tetrastichus melanis</i> Burks	P	?	20, 72
<i>Tetrastichus</i> sp. (not <i>melanis</i> )	P	?	29
<i>Tetrastichus</i> sp.	?	?	8, 36
Encyrtidae			
<i>Homalotylus flaminus</i> (Dalman)	L.P	Pa	3, 17, 30, 31, 32, 33, 34, 35, 47, 58, 61, 64, 67, 70, 76, 77, 83
<i>Homalotylus terminalis</i> (Say)	L	Pa	21
<i>Homalotylus eytelweini</i> (Ratzburg)	L.P	H	15, 35, 44
<i>Homalotylus</i> sp.	L.P	Pa	4, 59, 70
Proctotrupidae			
<i>Lygocerus</i> sp. (via <i>H. flaminus</i> )	L	H	31
Pteromalidae			
<i>Pachyneuron solitarium</i> (Hartig)	L	H	64
<i>Pachyneuron syrphi</i> Ratzburg	?	H	58, 70
<i>Pteromalus</i> sp.	P	?	81
Unidentified sp.	?	?	35, 61

<sup>a</sup> L = Larvae, P = Pupae, A = Adult, ? = Uncertain of life stage.

<sup>b</sup> E = Ectoparasite, H = Hyperparasite, Pa = Parasite (= endoparasite or parasitoid),  
? = Uncertain status.

TABLE 2. List of synonymies and other name combinations used for parasite species listed in Table 1.

## Name and alternate names or synonymy and source or reference.

*Medina luctosa* Meigen 1824Other genera: *Degeeria*.Source: Herting, B. 1982. Catalogue of Palearctic Tachinidae (Diptera).  
Stutt. Beitr. Naturkd. (A), 369, 228 pp.*Dinocampus coccinellae* (Schrank, 1802)Other genera: *Ichneumon*, *Perilitus*.Synonymy: *Bracon terminatus* Nees, 1811  
*Euphorus sculptus* Cresson 1872  
*Centistes americana* Riley 1888  
*Perilitus terminatus* (Nees) 1812  
*Microctonus terminatus* Wesmael 1835  
*Dinocampus terminatus* Foerster 1862  
*Perilitus americanus* Riley 1889Source: Cushman, R. A. 1922. The identity of *Ichneumon coccinellae*  
Schrank (Hym.). Proc. Ent. soc. Wash. 24(9):241-242;  
Marsh, 1979. (See entry no. 53)*Gelis melanocephalus* Schrank 1781Other genera: *Pezomachus*; *Hemimachus*, *Mutilla*, *Ichneumon*, *Cryptus*,  
*Hemiteles*.Synonymy: *Ichneumon fasciatus* F. 1973*Hemiteles leuiventris* Gravenhorst 1829Source: Dalla Torre, C. G. De, 1901/1902. Catalogus Hymenopterorum.  
Lipsiae, Sumptibus Guilelmi Engelmann.*Homalotylus eytelweinii* (Ratzburg, 1852)Other spelling: *eitelweinii* Ratzburg 1852

Source: Schauf, Mike (pers. comm. 3/90)

*Homalotylus flaminus* (Dalman) 1820Other genera: *Encyrtus*Synonymy: *Lepidaphycus bosqui* Blanchard 1936*Mendozaniella mirabilis* Brethes 1913

Source: Gordh, 1979 in Krombein &amp; Hurd (See entry no. 39)

*Homalotylus t. terminalis* (Say, 1828)Other genera: *Serlion*Synonymy: *Eutelus? scymnae* Shimer 1869*Homalotylus obscurus* Howard 1885

Source: Gordh, 1979 (Same as above)

*Phalacrotophora fasciata* (Fallen, 1823)Other genera: *Trineura*, *Phora*, *Aphiochaeta*, *Phalacrotophora* (*Omatessara*).Synonymy: *Phora atricapilla* Curtis 1828Source: Borgmeier, T. 1968. Catalogue of the Phoridae of the world  
(Diptera: Phoridae). Studia Entomol. 11(1-4): 1-366.*Syrphoctonus tarsatorius* (Panzer) 1809Other genera: *Bassus*.Synonymy: *Bassus exsultans* Gravenhorst 1829*B. insignis* Gravenhorst 1829*B. flavus* Desvignes 1862

- B. pulchellus* Desvignes 1862  
*B. indicus* Cameron 1909  
*Homoporus flavitrochanterus* Uchida 1956  
 Source: Carlson, 1979 in Krombein & Hurd (See entry no. 39)  
*Tetrastichus coccinellae* Kurdjumov 1912  
 Synonymy: *T. scaposus* Thomson 1878  
 Source: Domenichini, 1966 (See entry no. 12).  
*Tetrastichus epilachnae* (Giard) 1896  
 Other genera: *Lygellus*  
 Synonymy: *Tetrastichus jablonowskii* Szelenyi 1940  
 Source: Domenichini, 1966 (See entry no. 12).

TABLE 3. Species or names erroneously recorded as parasites of *Coccinella septempunctata* L.

HYMENOPTERAN TAXON	REFERENCE	JUSTIFICATION
<b>Braconidae</b>		
<i>Eucorystes</i> sp.	71	Improper host association. A parasite of <i>Agrilus viridis</i> L. (Buprestidae).
<i>Spathius</i> sp.	71	Improper host association. Parasite of larvae (Anobiidae, Ipidae, Cerambycidae) living under tree bark.
<b>Eulophidae</b>		
<i>Pediobius foveolatus</i> Crawford	5	Probably a misidentification of <i>Homalotylus</i> sp. Laboratory rearing shows <i>P. foveolatus</i> will only attack species in the Epilachninae (Coccinellidae), not other subfamilies (Schaefer, unpubl. data).
<i>Tetrastichus neglectus</i> Domenichini	11, 12, 70	Improper host association. Actually a parasite of <i>Chilocorus</i> , <i>Exochomus</i> and <i>Scymnus</i> and not of <i>Coccinella</i> despite reports to the contrary (ref. #12).
<b>Pteromalidae</b>		
<i>Pteromalinarum</i> sp.	35, 61	Improper interpretation of original Russian report <sup>a</sup> .

<sup>a</sup> Relying on the interpretations of George Steyskal and E. E. Grissell (Systematic Entomology Lab., USDA, Beltsville, MD), we conclude that in the original article by Oglobin (in Russian), who recorded "Pteromalid'a" in italics, meaning simply a species of pteromalid (or the familiar form of the family). This should not have been italicized but in Russian is commonly done for the familiar form of family names. Johnsen confused the issue further by using the latinized, italicized form "Pteromalinarum sp.", meaning "of pteromalid." Therefore, *Pteromalinarum* is not a generic name and this notation should only be considered as "a species of pteromalid."



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\* Contains parasite-host information which is erroneous, questionable, or which needs further verification.

\*\* Represents recent North American collection records, previously unpublished.

## ***EPHEMERELLA AOPSIS*, A NEW SPECIES FROM ROCKY MOUNTAIN HIGH (EPHEMEROPTERA: EPHEMERELLIDAE)<sup>1,2</sup>**

W. P. McCafferty<sup>3</sup>

**ABSTRACT:** A new species of mayflies, *Ephemerella aopsis* McCafferty, is described from male adults taken at 11,000 feet elevation in Colorado in 1947. The species is evidently closely related to the eastern species *E. needhami* McDunnough, both sharing deeply forked, spineless penes and a small body size. It is an apparent anomaly that larvae of the new species, which are predictably much different than larvae of other *Ephemerella* known from the mountain West, have evidently not been recognized or reported by western stream biologists.

During an intensive study of the Ephemeroptera fauna of Colorado, being conducted by myself and Boris C. Kondratieff and Richard S. Durfee of Colorado State University, a new species of the genus *Ephemerella* was discovered among pinned material housed in the Purdue Entomological Research Collection (PERC). Several factors associated with this new species make it noteworthy. First, this genus (both sensu stricto and sensu lato) is one of only a few groups of mayflies that are presently very well known in North America, especially in the western half of the continent, thanks to the revisionary work of R. K. Allen and G. F. Edmunds, Jr. in the 1960's (esp., Allen and Edmunds 1965). Second, male adults of the new species possess distinctive, deeply forked penes. Only in *E. aurivillii* (Bengtsson) in the West (two more species in the East) are males known to possess this type of genitalia, but this much larger species is different in all details from the new species and could not be confused with it. Third, the specimens of the new species were taken at 11,000 feet elevation at Chasm Lake in Colorado in 1947.

These data, together with the fact that aquatic macrobenthic populations in Colorado have been sampled and studied intensively by many freshwater ecologists and biologists for many years, seem to suggest a couple of possible explanations for this new species being discovered only now. Apparently, it is either very rare and limited with respect to acceptable habitat (it may even be extinct), or its larvae—the life stage of mayflies that has historically been most sampled in Colorado—have been taken but misidentified as another species of Colorado *Ephemerella*. Other species of *Ephemerella* that have been

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found in Colorado are *E. inermis* Eaton and *E. infrequens* McDunnough. Probability for the latter explanation may be diminished somewhat, however, by one further observation. Both *E. inermis* and *infrequens* lack dorsal abdominal tubercles as larvae, whereas larvae of all previously described species of *Ephemerella* having deeply forked penes, such as the new species, possess dorsal abdominal tubercles. Thus, it is unlikely that the two larval types would be confused.

In any case, I describe this material as a new species with the hope that additional specimens, especially reared larva-adult associations, will be sought by stream biologists in the mountain West. Only with such an effort will this anomalous set of circumstances possibly be resolved.

### *Ephemerella apopsis* new species

**Description of male adult.** Body length 6 mm. Forewing length 7 mm. Body ranging from light to dark brown. Thorax dark brown dorsally, medium brown ventrally. Wings hyaline, venation hyaline. Middle and hind legs light/cream colored (forelegs missing). Abdomen chestnut brown dorsally, considerably lighter laterally, and light brown/tan ventrally with no apparent markings, except pair of faint black, sublateral, longitudinal stripes on terga 9 and 10. Genitalia as in Fig. 1 forceps without subapical expansion on segment 2, otherwise typical of *Ephemerella*; penes lacking any spines, deeply forked, slender apically, with more expanded portion between narrowest apical portion and fused portion, and with fork V-shaped from base. Caudal filaments missing.

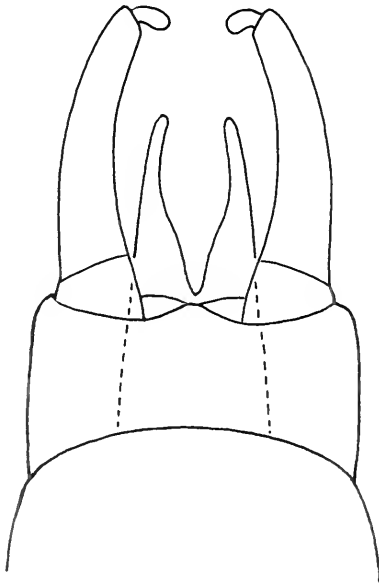


Fig. 1. *Ephemerella apopsis* male adult holotype, genitalia, ventral view.

**Material.** HOLOTYPE: male adult (pinned), Colorado, Chasm Lake [Boulder Co., Rocky Mountain National Park], VII-24-1947, C. P. Alexander, deposited in PERC, West Lafayette, Indiana. Other material; 4 male adults, same data and deposition as holotype.

**Etymology.** The trivial epithet is a Greek noun used in apposition and meaning "a lofty spot or eminence that gives a commanding view."

### Diagnosis

A couplet (3A) needs to be interjected into Allen and Edmunds' (1965:247) key, "Keys to the North American species of the subgenus *Ephemerella*," as follows regarding male adults of western species:

- |        |  |                   |
|--------|--|-------------------|
| 3(2).  | Penes with long apical lobes and a deep median notch .....     | 3A                |
|        | Penes with short apical lobes and a shallow median notch ..... | 4                 |
| 3A(3). | Penis lobes with dorsal and medial spines; forewing more       |                   |
|        | than 11 mm long .....  | <i>aurivillii</i> |
|        | Penis lobes with no spines; forewing 6-8 mm .....              | <i>apopsis</i>    |

### DISCUSSION

Larvae of *Ephemerella* are stream dwellers. Although the type locality for this new species is Chasm Lake, the represented adult specimens of *E. apopsis* most probably were associated with larvae that had developed in a local alpine stream (most probably Roaring Fork, which drains Chasm Lake).

There is no doubt that *E. apopsis* and *E. needhami* McDunnough are closely related species, most probably sister species. Because of the short series of *E. apopsis*, it is difficult to know exactly the extent of color differences between the two. Allen and Edmunds (1965) stated that the dorsal abdomen of *E. needhami* was purple (terga 1-7) and brown (terga 8-10). No purple is evident on the pinned specimens before me. Allen and Edmunds (1965) also did not mention any stripes on the posterior terga (which seem to be faintly present on the new species), and I have not seen such in specimens of *E. needhami* from Indiana and Michigan. There also are no markings on the venter of the abdomen of the new species as was described for *E. needhami*. Traver (1935) indicated that the base of the forewings in *E. needhami* were somewhat smoky, but Allen and Edmunds (1965) evidently did not see this variation. The forewings of the new species show no sign of this tinge.

Even if all of the possible color differences cited above were corroborated with additional materials as being consistent, they are not necessarily substantial variations of interspecific significance (based on my experience with color variation in Ephemeroptera populations). Perhaps the most provocative possible difference between the two



species is the shape of the penes. In *E. needhami*, the penes are juxtaposed up to the point of abruptly narrowing [Fig. 17 in Allen and Edmunds (1965)]. In *E. apopsis*, the penes are clearly separated from each other to the base of the fork (Fig. 1). Also in *E. apopsis*, the penes appear to be shorter relative to the length of the forceps [compare Fig. 1 herein with Fig. 17 in Allen and Edmunds (1965)]. The differences I report, however, may be a function of the specimens being fluid preserved vs. pinned. Finally, there appears to be a slight difference in the relative size of the terminal segment of the genital forceps of the two species, being smaller in *E. apopsis* (see Figs. cited above).

Very few transcontinental species of ephemerellids are known, *E. aurivillii* being one example, but it is certainly possible that the new species actually represents a western population or variant of *E. needhami*. However, the larvae of *E. needhami* are among the most distinctive of any ephemerellids, due to the two rows of well-developed, curved tubercles along the dorsum of the abdomen and the dorsal dark stripe down the abdomen [see photographs in McShaffrey and McCafferty (1991)]. Also, *E. needhami* larvae are among the most commonly collected where they occur (this has been my experience in Indiana and Michigan). Their distinctive biology and ecology, particularly with reference to their relationship to the filamentous alga *Cladophora*, was recently treated by McShaffrey and McCafferty (1991).

Considering all this, it is difficult to believe that they have never been taken or recognized in stream studies in Colorado. It, of course, could be argued that it is difficult to believe that any atypical western *Ephemerella* larvae have gone unnoticed during the current era of ecological surveys and research on streams in Colorado and other states and provinces in western North America.

If the species under study happens to be extremely rare or extinct, however, we may never adequately address these particular questions.

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**NEW RECORDS OF  
*ECTOBIUS LAPPONICUS* IN NORTH AMERICA  
(DICTYOPTERA: BLATTELLIDAE)<sup>1,2</sup>**

Donald S. Chandler<sup>3</sup>

**ABSTRACT:** New collection records for the introduced "Dusky Cockroach" indicate that it has now extended its range through northern New England and into the maritime provinces of Canada. Adult males and nymphs, and to a lesser extent adult females, were found on low vegetation, with two new records of adult males in buildings.

In 1984 the "Dusky Cockroach," *Ectobius lapponicus* (L.), was found in southeastern New Hampshire by Chandler (1985), the first North American record of this European immigrant. A subsequent collection in eastern Vermont was noted by Nielsen (1987), and this species has now been collected several times in coastal and central New Hampshire. During a recent trip I found this species at Acadia National Park in Maine, and on Prince Edward Island for the first Canadian record of this species. It is clear that this cockroach is expanding its range, and now occurs throughout northern New England and the maritime provinces of Canada. As noted by Atkinson *et al.* (1991), the distribution of the species in Europe indicates that it could spread over much of northern North America. This note documents the range extension of this species, and includes information on its association with vegetation in North America.

This species was initially brought to my attention because several specimens were found inside a house (Chandler 1985). An additional specimen since has been found in a kitchen in Bradford, New Hampshire, and another in a motel room in Waterville, Maine. However, all other specimens have been found outside, primarily in association with herbaceous vegetation. In Europe, nymphs and adult males of the "Dusky Cockroach" are found on low vegetation, with adult females more commonly found on the ground in leaf litter (Roth and Willis 1960). Nielsen (1987) found adults moving about on flowers of wild raspberries. I found adult males and females commonly on tansy (*Tanacetum vulgare* L.) in coastal New Hampshire, with males pre-

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dominating with a sex ratio of about 2:1. Twenty-two adult males and only one adult female were taken along with 10 first and second instar nymphs when sweeping an herbaceous plant on Prince Edward Island that had not yet flowered and could not be identified. Adults were seen at or near the tops of these various plants on flowers or leaves, and when disturbed quickly dropped to the ground.



Figure 1. Collection sites of *Ectobius lapponicus*.

New records: U.S.A.: *New Hampshire*: Strafford Co.: 2 mi SE Durham, VI-10-1987 (2♂), VI-11-1987 (3♂), VI-14-1987 (1♂), J. F. Burger, sweep; 1 mi SW Durham, VII-14-1987 (2♂), VII-18-1988 (1♂), VIII-5-1989 (1♂), W. J. Morse, water tower. Merrimack Co.: Bradford, VI-

20-1990 (1♂), D. C. Nepreau, in kitchen. Rockingham Co.: Odiorne Point St. Park, VII-8-1990 (7♂, 2♀), D. S. Chandler, on tansy. *Maine*: York Co.: West Lebanon, VII-17/23-1990 (1♂), VI-24/30-1991 (1♂), D. W. Barry, UV trap. Kennebec Co.: Waterville, VI-15-1991 (1♂), J. D. Nielsen, in motel room. Hancock Co.: Acadia National Park, Blackwoods Cmpgd., VII-28-1991 (1♂), D. S. Chandler, ex: vegetation by road. *Vermont*: Windsor Co.: Norwich, Route 5, VI-11-1987. G. R. Nielsen, on wild raspberry flowers. *CANADA*: *Prince Edward Island*: Prince Edward Island Nat. Park, Stanhope Cmpgd., VIII-13-1991 (22♂, 1♀, 10 nymphs), D. S. Chandler, sweep.

Specimens are in the insect collections of the University of New Hampshire, the University of Vermont, and the Lyman Entomological Museum (McGill University, Quebec).

#### ACKNOWLEDGMENTS

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## UNUSUAL PREY CAPTURE AND TRANSPORT BY *DOLICHOVESPULA MACULATA* (HYMENOPTERA: VESPIDAE)<sup>1</sup>

Frank E. Kurczewski<sup>2</sup>

**ABSTRACT:** Capture of *Tabanus sulcifrons* by a worker *Dolichovespula maculata* is described. The prey was atypically large, being about the same size as the wasp. Partial mutilation of the prey and an atypical method of prey transport, possibly related to large prey size, are detailed.

*Dolichovespula maculata* (L.), the baldfaced hornet, is one of the most common vespids in the eastern United States (Akre *et al.* 1980, Greene 1991). Little is known about the biology, ecology, and physiology of this species, and observations of unusual behavior are noteworthy. This species is an opportunistic forager and captures a variety of insects, including workers of other yellowjacket species, but adult flies seem to be the preferred prey (Duncan 1939, MacDonald and Deyrup 1989). MacDonald and Deyrup (1989) noted that workers are "particularly adept at capturing adult flies," and observed them taking adult Calliphoridae, Muscidae and Sarcophagidae, with one wasp collecting up to 17 flies per hour.

On 30 July 1991 in a backyard in Auburn, Cayuga County, New York, I observed a worker baldfaced hornet capturing, mutilating and transporting toward her nest an adult horse fly of about her own size. The *D. maculata* flew in and pounced upon a female *Tabanus sulcifrons* Macquart which was resting on a twig of a northern white cedar (*Thuja occidentalis*), ca. 1 m above ground. The wasp grasped the fly by its neck, using the mandibles, and maintained this hold for ca. 25 sec. She then released this grasp and, still straddling the horse fly head forward and dorsal side up, moved anteriorly on it and began to mutilate the fly's head with the mandibles. She masticated the fly's head for nearly 2 min. until it was unrecognizable as such and then began to do likewise to the fly's prothorax. The horse fly's right foreleg was removed in the process. Then, still holding the fly head forward and dorsal side up, the wasp grasped it with all legs and flew at an angle to the ground. During flight she resembled a *Sphecius speciosus* (Drury) (Sphecidae) transporting a *Tibicen* sp. (Cicadidae) to her nest! The baldfaced hornet proceeded to

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transport the horse fly, head forward and dorsal side up, on the ground in a series of flights, 5-10 cm long and 1-2 cm high. The wasp's wings beat continually, and they produced a barely audible buzzing sound during flight. About every 40-50 cm she paused and, remaining atop the fly, mutilated the anterior part of its thorax. After several such pauses and mutilations and a journey of nearly 5 m, she reached the base of one of many cedars growing in a row and began walking up its trunk at which time I collected the pair. Her nest was located two-thirds of the way up the 15 m-high cedar. The wasp weighed (wet) 234 mg and the partly mutilated fly, 179 mg (ratio of wet wgt. of wasp to prey, 1.3:1). The following day two other *D. maculata* workers were seen landing on this cedar, one with a nearly complete thorax of and the other with a thoroughly mutilated thorax and partial abdomen of *T. sulcifrons*.

## DISCUSSION

Duncan (1939) noted that vespines often discard the prey's legs and wings "because of their high percentage of heavily sclerotized integument and their relatively non-nutritious character." Schaefer (1991) found that worker baldfaced hornets would often amputate the wings, heads, legs, and parts of the abdomens of male gypsy moths and a damselfly prior to taking these prey to the nest. The thoracic musculature was, in all cases, saved and fed to the larval wasps. In the case of one female gypsy moth the hornet made no attempt to fly with this heavy prey but, instead, severed and discarded the head and much of the prothorax and abdomen before taking flight (Schaefer 1991). The question remains, therefore, whether or not the worker baldfaced hornet I observed would have continued to mutilate the head, thorax and abdomen of her horse fly as she ascended the cedar or take this unusually large prey item intact to the nest.

## ACKNOWLEDGMENTS

I am indebted to M.F. O'Brien, Museum of Zoology, The University of Michigan, for reading this manuscript critically and to L.L. Pechuman, Cornell University, for confirming the identity of the horse fly.

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## BOOK REVIEW

**BIOLOGY OF BLOOD-SUCKING INSECTS.** M.J. Lehane. 1991. Harper, Collins Academic, London. 228 pp. \$50.00 cloth, \$29.95 paper.

Topics studied include location of the host, host-insect interactions, ingesting and managing the blood meal, and transmission of parasites by blood-sucking insects. These topics are prefaced by a brief introduction to the importance of these insects and by a review of the current theories of how their specialized lifestyle evolved. The last chapter in this book provides an overview of the insect groups studied, a section that I believe would have been much better situated as the first chapter. While the book is intended for advanced students or for researchers seeking to broaden their base, I think that even these people would benefit by having an introductory chapter that reviews the pertinent groups, not to mention the benefit to those of us who are not entomologists and who spent a great deal of time flipping to the last chapter and frantically skimming the pages until locating the desired group!

Any book that is intended to be primarily a review of the major aspects and findings in a field as diverse as this will by nature be somewhat incomplete, and Mr. Lehane's book is no exception. The documentation is somewhat sketchy at times, leaving one to wonder whether the information presented is a summary of the cited authors or an opinion or conclusion drawn by Mr. Lehane. However, it appears that this is mainly due to the paucity of information available. What I found to be the most remarkable aspect of this book was how little is known about many of the important species of blood sucking insects. While it is true that much research has been done on mosquitoes and tsetse flies, both important disease vectors, there are a great many important things still unknown about these insects. And of the information that has been discovered, the findings very often cannot be generalized to include other genera, and frequently they do not apply to other species within a given genus.

As Mr. Lehane pointed out in his introduction, this book is not intended as a primary textbook for students of medical or veterinary entomology. The focus is on topics of biological importance to the specific task of hemophagia. So while the reproductive patterns of certain blood-sucking insects are discussed at some length, this is done so only in light of how a blood meal will affect such behavior. Very little is discussed of reproductive anatomy or behavior unless it contributes to the blood-sucking way of life. This approach is employed for all topics addressed, so for details on such matters one must turn to one of the numerous books dealing with such issues. As such the book is very interesting and useful for those seeking a synthesis of current information on a broad number of species, but it cannot and should not replace a textbook on a given disease or insect group.

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## EXPERIMENTAL MICROHABITAT CHOICE IN *PSEUDICIUS PIRATICUS* (ARANAE: SALTICIDAE)<sup>1</sup>

Bruce Cutler<sup>2</sup>

**ABSTRACT:** In a substrate-choice test arena, individuals of *Pseudicius piraticus* spent significantly more time on branches than on leaves of mesquite. This is in concordance with field-collecting information, i.e., beating mesquite produces more individuals than sweeping mesquite. Female and immature coloration closely resembles the color of mesquite branches and is probably cryptic.

The jumping spider, *Pseudicius piraticus* (Peckham and Peckham), is found on shrubs and trees in the southwestern United States and northern Mexico. This species does not belong in the genus *Pseudicius*, but in a genus related to *Marpissa*. Correct placement will result from a future revision. Individuals of this salticid spider are abundant in southern New Mexico on mesquite, *Prosopis glandulosa* Torr. While collecting specimens, it was noted that sweep netting produced relatively few *P. piraticus*, whereas beating garnered larger numbers. Three antepenultimate and two penultimate specimens from the vicinity of Las Cruces, Doña Ana Co., New Mexico were kept alive in the laboratory and tested with the substrate-choice arena shown in Figure 1. Spiders were released onto the sand and observed for 30 min. The total time spent on each of the possible substrates in the arena was noted. Three repetitions were done with each spider over three consecutive days. Pooled results are shown in Table 1. A Chi-square test indicated significant difference ( $P < 0.005$ ) from expected time at each location. Although not presented here, the same test for each individual spider was also significant at  $P < 0.005$ . Thus, the hypothesis that all substrates were equally attractive is rejected. Much more time was spent on the branches than on any other individual substrate.

There has been essentially no experimental work on microhabitat choice in Salticidae. Almost all that we know about habitat preferences in this family comes from field-habitat associations noted on museum specimen labels, or from ecological studies about such associations, but not directly concerned with habitat choice [see such papers as Dondale (1961) and Drew (1967)]. Similarly, experimental data is lacking for other non-snare-building spiders (Cutler *et al.* 1977, Greenstone 1980, Jen-

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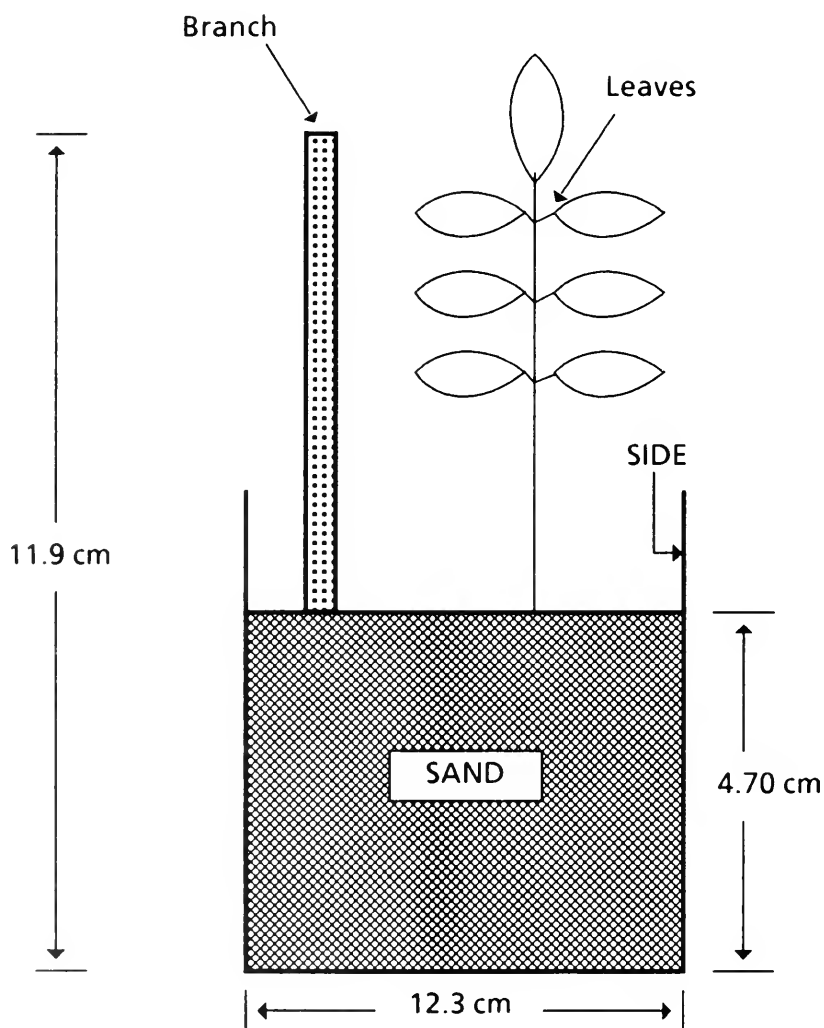


Fig. 1. Diagram of substrate-choice arena used to test *Pseudicium piraticus*.

nings 1971, Lowrie 1973). Greenquist and Rovner (1976) studied responses of two *Lycosa* species and two *Schizocosa* species (Lycosidae) to three types of artificial leaf structures constructed out of cardboard. They found differences among the species in time spent on the foliage vs. on the ground, as well as on the different "leaf" types.

As for *P. piraticus*, the experimental results coincide with field observations, i.e., that beating, which shakes limbs, is more effective than sweep netting, which primarily samples foliage. When mature, *P. piraticus* is about 7 mm long with an elongated, flattened body. Females and immatures of this species are cryptically colored with a heavy grey, white, and black vesture of scales. Males are striking, being predominantly black with a white central stripe. The cryptic coloration of the females and immatures matches the coloration of mesquite branches so well that immobile individuals are very difficult to detect even when their general location on the branch is known.

**Table 1.** Time spent (in minutes) in residence on locations in test environment by five *Pseudicius piraticus*.

	Branch	Leaves	Sand	Side	Total
Actual time	289	73	62	26	450
Expected time	112.5	112.5	112.5	112.5	450

#### ACKNOWLEDGMENTS

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## BOOK REVIEW

**DIVERSITY IN THE GENUS *APIS*.** Deborah Roan Smith, ed., 1991. Westview Studies in Insect Biology. Westview Press, Boulder, Co \$59.95.

Is cavity nesting in honey bees a primitive or a derived character? Has eusociality a dual or single evolution? What can a comparative ethological approach to the dance languages of the genus *Apis* reveal? These and other questions are discussed in *Diversity in the Genus Apis* recently available from Westview Press.

The book grew out of a symposium at the 1989 Entomological Society of America annual meeting. Expanded chapters based on the presentations of six participants are offered along with five additional chapters. Two of these additional chapters are by program participants on another topic. Although the honey bee literature may be the most extensive on a single arthropod, this volume greatly enhances our comprehension by its comparative presentation. A further strength is that it brings together our rapidly expanding knowledge on the lesser known members of the family.

The issue of a single, as opposed to multiple origins, of eusociality in *Apis* is discussed from a morphological basis (Chapter 3 by Michael Prentice), nucleic DNA characters (Chapter 4 by Sidney Cameron) and mitochondrial DNA (Chapter 5 by W. Steve Sheppard and Bruce McPheron). Although there is no consensus reached, this review should help one formulate an opinion. Likewise, it also suggests the directions further studies might take to help reach a solution.

Several chapters examine taxonomic and evolutionary issues of the 4 related bee tribes of Apini, Meliponini, Bombini and the Euglossini. Other chapters examine just the *Apis* species. This genus consists of cavity nesting *Apis mellifera*, *A. cerana* and *A. koschevnikov*; the dwarf bees *A. florea* and *A. andreniformis* and a third group, the giant bees *A. dorsata*, which may be a species group of several subspecies or individual species. Each of these *Apis* lineages occurs over a wide range of habitats and climates. Each species consists of numerous morphologically differentiated populations ranging from ecotypes and allopatric species to reproductively isolated sympatric species. Numerous populations occur on geographically isolated islands in the large archipelagos of Indonesia, Malaysia and the Philippines.

The book is well done in a number of aspects. While there are few photographs, an adequate number of tables, diagrams and line drawings illustrate major issues. The individual contributors excellently reference other chapters in the book. There is little repeat review of the same basic studies from one chapter to the next which sometimes happens in a book with individual chapter authors. The two indexes of subject and author are accurate and very thorough. Except for Chapter 10, on *Apis* mating systems by G. Koeniger, the book is similar in style and generally free of typographical and punctuation mistakes.

There are two problems with the text. Chapter 10 is written in a very clipped style and, regrettably, has enough errors to distract the reader's attention. The conclusion of Chapter 9, by Fred Dyer on dance language, is not consistent with the balance of the book. It is not related to the other material in the book or the chapter itself.

This book is not just for apiculturists. It is a fascinating examination of one taxa using the considerable arsenal of techniques, now increasingly available to systematics and evolutionary biology. It is a must for students of genetics—editor Smith makes the comment that the mitochondrial DNA of *Apis* is the second best studied of any organism, exceeded only by *Drosophila*. It is also a must for comparative ethologists and sociobiologists since the honey bee has become a "generic" model organism in the study of insect societies.

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## ON PITFALL TRAPPING INVERTEBRATES<sup>1</sup>

Eric van den Berghe<sup>2</sup>

**ABSTRACT:** This paper represents a concise guide to pitfall trapping, including recommendations on preservatives. Techniques are based on some 10,000 traps set worldwide over the past decade.

The following methods are reliable, efficient, inexpensive and based on extensive field tests in terrains from arctic tundra to rainforest and desert conditions. Many of the present observations are covered in the literature compiled by Dunn (1989) on the subject. Although my principal quarry are carabids in the Genera *Calosoma*, *Carabus*, and *Cychrus/Scaphinotus*, there are typically substantial bycatches of Scorpionidae, Phalangidae, other arachnids, Raphidorphorinae, Tenebrionidae, formicine ants etc., making the methods of more widespread interest. In a typical season, I set anywhere from 1000 to 2000 traps, many of which are experimental to help determine what is most efficient for a particular set of conditions or area. Much of the information below is gleaned from trial and error although various colleagues have been instrumental in sharing ideas which are, to the best of my knowledge, unpublished. The bottom line is that there is no universal "best" design, but the following may help the beginner and even improve the efficiency of more advanced collectors.

### MATERIALS AND METHODS

Although various tins, bottles, etc. will work, plastic cups much like those of Morill (1976), but smaller (200ml-250ml) are more practical. The major advantage of small cups is that they are easier and faster to install where digging is difficult, and take up less storage space, so that when travelling to third-world countries or even hiking into remote areas in North America, 200 in the suitcase or backpack require little space and add minimal weight. A further advantage (or disadvantage, depending on the quarry) is that small cups allow most lizards, shrews and other small vertebrates to escape, but will hold the largest beetles regularly encountered in the USA, e.g. prionine cerambycids. Even the small cups do catch salamanders and some shrews if there is ample liquid in the bottom of the cup, but the number is greatly reduced in comparison with larger cups. In a recent experimental series, ten 500ml and ten 250ml

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cups interspersed in the same area yielded comparable numbers of carabids, but only 4 shrews in the small cups compared to 31 in the larger ones (binomial  $P < 0.001$ ). Silphids attracted to shrews in the larger cups actually served as a deterrent to carabids, as those cups with an abundance of silphids contained little else.

### About Cups

Plastic cups on store shelves come in two general shapes: shallow (depth roughly the same as the diameter) and "deep" (depth 1.5 times the diameter). The deep ones, as they can hold more rain, are harder to escape from, and can tolerate a few leaves in the bottom before organisms can climb out. These come in several grades: clear stiff ones tend to crack/break as they are forced into holes. Most colored stiff ones are fairly expensive, 20-40/\$1.00 but keep their shape well, and only become brittle after a year or two. Finally, the cheapest 100/\$1.00 are very thin-walled and can readily be forced into holes with protruding roots and take well to the contours of the hole one provides. The latter hold up to only one use. I alternate between economy and heavier duty cups but have no brand affinity. Buy whatever is most economical at the time. Paper cups are not recommended.

### Cup Modifications

A common problem is that following a heavy rain, the cups are filled to the rim with water and specimens may spill out, plus the cup becomes ineffective for further trapping. In areas where this difficulty is anticipated, the solution consists of small holes in the wall on opposite sides about 3cm from the bottom. These need not be much larger than pinholes, and are better if made by melting with a hot wire than by punctures, as the latter are more prone to tearing. It is most efficient to prepare the cups in advance at the campfire or at home. Keep hole sizes below 1 mm because larger holes afford footholds for potential escape and shrews can shred the cup starting at the hole. Such holes allow excess liquid to drain and the trap remains functional.

### Pitfall Placement

A common difficulty lies in relocating traps several months after their initial placement—a good field notebook here is essential, and diagrams are useful. Notes should be precise enough to allow others with access to the notes to find the traps for themselves! Some collectors

routinely leave traps in areas where they will not personally return, but give directions to colleagues who will be in the area for servicing. If notes are good enough for others to find the traps, then it should be easy to find them yourself. My own success at relocations this season averaged about 99%, but has been as low as 80% where I set traps in open woodland in the late-winter only to return and find a one meter high undergrowth on the next summertime check, or where traps were buried under snow, yet could still be found in spite of surroundings bearing no resemblance to the first visit.

Patterns (i.e. straight line, loop), with a fixed number of paces between cups can go a long way toward letting you know exactly where to look for a missing cup. Beware, however, and do not underestimate the ability of vertebrates to figure out patterns, especially where cups are only a few paces apart. Hence individual patterns of more than ten cups are not recommended.

Barrier pitfalls are more productive than simple holes in the ground (Gibbons and Semlitsch 1981), however they sometimes attract unwanted attention and suffer molestation, plus they are quite labor-intensive to install. Nonetheless, the extra effort in installation may be warranted where the traps will function over long periods of time, and where it is known that the exact site will yield the desiderata. A compromise is to place traps in or next to natural paths or obstacles, thereby getting the benefits of a barrier without the labor. Good places are alongside large rocks, next to fallen logs, around tree stumps, along cut banks, in ravines, etc. Man-made obstacles should not be ignored: stone walls along property boundaries and building foundations can be exceedingly productive, especially near permanent light sources such as campground outhouses. Where no obstacles are available, as in scrub/semi desert situations, try placing traps near the bases of small bushes, which provide shade or shelter. If it takes an equal amount of labor to put out five simple cups or one short barrier, then cups are better as they will be sampling more microhabitats and allow one to more quickly zero in on the exact places where items of interest are found, then set barriers later to collect series.

### Trap Installation

Obtain a small garden trowel, preferably one with a long, pointed, and stiff blade to cut through small roots and pry rocks without bending. Cookie cutter/plug cutting devices to remove cylindrical plugs of the dimensions to fit the trap sound good in the lab, but are nightmarish to use in the field. These require perfectly homogeneous soil without large

roots or stones, so the trowel is just as efficient under those conditions, and infinitely easier in difficult soils. Just insert and twist to produce a hole suitable for a small cup.

In arid conditions or in loose sand, the sides of the hole often cave in as one digs. This can be remedied with some water in the hole.

To force thin walled cups into holes, take the whole stack and push down then lift, leaving the bottom cup in the hole. The other cups add rigidity to prevent the cup being installed from becoming mangled. Alternatively, use fingers pushing against the bottom of the cup from the inside. In sphagnum, or very soft ground, and loose sand, it is often not necessary to dig, just push the cups into the substrate.

Once the trap is set, be sure that the lip of the cup is flush with the ground, otherwise smaller species will be missed, and even larger ones are partially deterred.

### How long to set?

An obvious disadvantage of pitfall collecting is that one is forced to either return or spend a long time in one place—unless conditions are exactly right and the desiderata can be baited. While one may not always have a choice of return times, the greatest proportion of the take generally comes in the first few weeks to a month. Longer intervals between servicing are only undertaken when the optimal time of year is unknown or unpredictable as in deserts where success is linked with rain. It is best to return at intervals of not longer than one month in areas with moderate precipitation.

### Preservatives

Although ethylene glycol is the overwhelming favorite choice in North America and is probably best for truly long intervals, rock salt or table salt may be an attractive alternative. This is a much more environmentally acceptable and cheaper preservative than antifreeze (also more readily available in the third world, plus it can tolerate the same amount of dilution as ethylene glycol. Simply add an equal volume of salt crystals (1-2 cm in the bottom of the cup), then add water to barely cover the salt (more in arid areas, less where much rain is anticipated). The longest I have run traps and obtained good specimens from salt brine is 8 months. For such long sets, however, a roof is essential, and ethylene glycol is a must in arid areas. Salt brine acts as a good preservative but it is not useful if it dries out completely, and the truly long sets with salt require rather special weather conditions, where there is neither

so much rain that the traps flood regularly, nor so little that they dry out completely. Salt is best for two- to five-week sets. Specimens thus preserved should be soaked in vinegar for a couple of days to let the salt diffuse out of specimens, otherwise it may precipitate out as the specimens dry. If this should happen, a quick (5 second), rinse in fresh water does no harm and dissolves the precipitate completely. Salamanders, annelids, and other soft-bodied organisms, will become completely dehydrated in salt brine, but will regain their original shape within hours if placed in water before fixing with formaldehyde.

Formaldehyde is also an effective preservative in pitfalls, but there are limitations to its use. However, formaldehyde-based traps usually are relatively free of molestation by vertebrates (see section on animal disturbance). Salt or vinegar spills in the car are nothing serious—formaldehyde is! Specimens taken with formaldehyde in traps (or preserved in ETOH) come out stiff, brittle, and unsuitable for genitalic preparation. These can be relaxed/salvaged, however, by soaking in dilute digestive enzymes such as pepsin for a few days (Persohn, pers. comm.). Since enzymes from pharmaceutical companies are not always readily available or inexpensive, an alternative may be a solution of commercial meat tenderizer which contains digestive enzymes to achieve the same breakdown of muscle fibres.

Vegetable oil may prove to be an alternative to antifreeze in very arid conditions. This will not work well where there is much rain, as the oil floats. A mix of salt and oil, may work, but long-term results are not yet available. This method seems promising as it does not pose the environmental hazard of ethylene glycol. Specimens can be recovered from oil in the same manner as from antifreeze, with a kitchen strainer, and a detergent bath to get them clean. Cost is comparable to antifreeze, but it is more available.

### Bait

Depending on the quarry, baits can be very effective for very short-term sets, even just overnight. The possibilities here are virtually endless. The Europeans are particularly fond of red wine vinegar as an attractor and short-term conservator. Ripe banana also attracts a wide spectrum of invertebrates including many that are typically considered to be strictly carnivorous. Meats, (e.g. squid) can also be effective, but any smelly bait is asking for trouble from vertebrate carnivores. Messy/sticky bait e.g. molasses, is best kept in small separate receptacles inside the trap so that specimens and traps are not soiled (see Fig. 1a).



## Roofing

It is always a good idea to add a roof, in part to keep out unwanted debris and excess water, but also to obscure cups from curious larger vertebrates. In a mature forest, simply peel bark from fallen trees and use the bark as in Fig. 1b. Where stones are available they can also make an effective roof (Fig. 1c) and where nothing is locally available, corrugated fiberglass roofing material cut into appropriately sized squares or rectangles, also makes for lightweight, compact portable roofs (Staven pers. comm.). Where there is much wind, however, it is advisable to weight these roofs with soil or sand to keep them in place. An alternative heavier roof can be fashioned from standard composite roofing material which is available free in unlimited quantities wherever somebody is having their roof redone. Leaves make poor roofing. Although roofs may appear to restrict access, many invertebrates crawl under in search of shelter!

### What if traps are disturbed regularly?

Vertebrate disturbances are particularly annoying in the Eastern U.S., and the remedy depends on the nature of the culprit. Typically, this can be diagnosed from the nature of the disturbance.

*Case 1:* Cups still in the hole, but pushed up just enough so that the rim is no longer flush with the soil tend to be caused by moles or voles whose passage has been obstructed—if you push the trap down, and it is back up the next day — then move the trap a short distance to resolve the problem.

*Case 2:* Cups completely out of the hole, contents spilled but clean and not chewed. This typical of squirrels burying/digging up nuts. Usually only one or two out of a series of twenty cups will be affected, but virtually never the entire line. One is helpless against squirrel disturbance.

*Case 3:* Cups (often the whole line) out and chewed or mangled. Opossum and raccoon are inquisitive and intelligent. Traps near waterways are particularly vulnerable to discovery, and even roofs do not help much as raccoons routinely turn stones in search of invertebrates. Deer and raccoon damage is not easily distinguished, except that the former tends to occur more in open forest situations and the latter near streams. If the raccoon decides that it likes the trap contents there is little to be done except to be sure the preservative is odorless (i.e. salt), and traps are far enough apart that the raccoon does not discover a pattern and systematically take out the whole line. If the whole line is taken out, there is little point in trying the exact site again that season. Instead, put out

Fig 1a bait container.

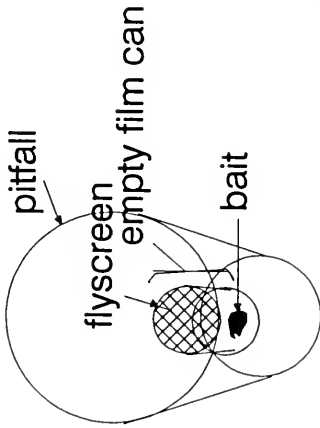


Fig 1b Bark roof over trap

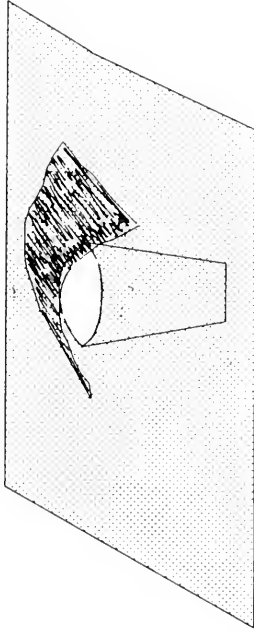


Fig 1c stone roof over trap

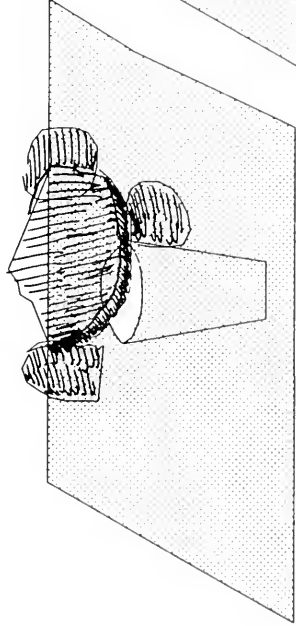
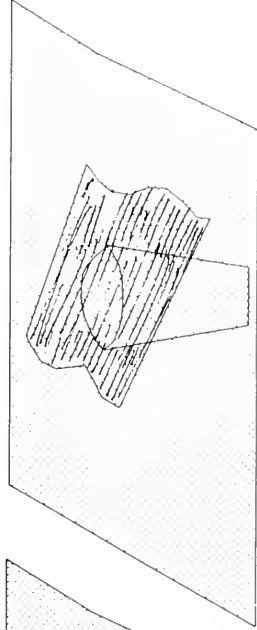


Fig 1d Corrugated roof over trap



small groups, widely spaced, and make sure they are not within sight of a deer trail (deer are very fond of salt!). As a last resort, use tabasco sauce or other distasteful substances along with the preservative, but this is too expensive to do routinely, and only works until the distasteful substance is diluted.

In conclusion, while the above is intended to give general guidelines, these methods will require customizing to fit the organisms sought and local weather conditions.

#### ACKNOWLEDGMENTS

I thank Bob Acciavatti, Walter Heinz, Manfred Persohn, Klaus Staven, Bernard Lassalle and others who have unselfishly shared their considerable experience and pitfalling methods in helping to refine my own. This represents CEEES contribution #2297.

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#### BOOKS RECEIVED AND BRIEFLY NOTED

HANDBOOK FOR BUTTERFLY WATCHERS. Michael Pyle. 1992. Houghton Mifflin Co. Soft cover. \$11.95.

This 'new' book for amateur butterfly watching enthusiasts appears to be an exact reprint, but in soft cover, of *The Audubon Society Handbook for Butterfly Watching* by the same author, originally published as a hard cover book by Scribners in 1984.

Jane M. Ruffin,  
Lepidopterist,  
Rosemont, PA

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## SOCIETY MEETING OF APRIL 22, 1992

### EVOLUTION OF CRICKET SONGS

Dr. Daniel Otte,  
Academy of Natural Sciences

The "simple" chirping song of the cricket outside one's window at night, although often admired, is not usually fully appreciated by the listener for actual complexity, its evolution over hundreds of millions of years, nor for the important role it plays in speciation. All of these topics were discussed by Dr. Daniel Otte, curator in the Department of Entomology at the Academy, in a lively, and at times, humorous, talk that incorporated computer-generated audio, actual song recordings of crickets from Dr. Otte's many travels worldwide and various cricket "props".

Due to an excellent fossil record, the evolution of crickets can be traced at least to the late Permian, over 250 million years ago. Unlike their sister group, the katydids, which show tremendous morphological variation, crickets have remained relatively homogeneous. This applies in part to their mechanism of sound production as well. Whereas in crickets and katydids, a single mechanism is utilized (file and scraper on each wing, with the "ears" on the front legs), in grasshoppers at least 12 different sound producing mechanisms have been identified. That sound production in crickets is ancient can be demonstrated by the overall similarity of the wing in fossil and recent species, even as far back as the earliest known forms. This conservatism does not extend, though, to the "song" itself, which shows an amazing diversity among the 3500 extant, described species (probably only one tenth of the actual diversity!).

As in most other sound producing insects, it is the males which sing to attract females, and the females which choose the males. Because sound in crickets is produced by opening and closing the wings, a true continuous sound cannot be produced, but a single tooth strike, multiplied in a series, forms a pulse, and these pulses can appear like a true continuum to the human ear. The pulse forms the basic building block of the song, and Dr. Otte has traced the evolutionary pathways of cricket songs through modifications of the pulses. For example, a train of pulses produces a trill, short gaps between series of pulses form chirps and mixing of these functions produce more complex songs. Most instructive was Dr. Otte's computer generation of audio pulses, which clearly illustrated how cricket song complexity can be constructed over evolutionary time through dropping, coupling or tightening pulses, with different pathways often yielding similar songs.

In nature, though, the story is even more complex, as illustrated by audio tapes recorded in the field. Males must find a "sound window" among other conspecific males, and their environment may be full of other singing species of Orthoptera, other insects and even frogs. Songs of a species may vary throughout the day, and decedant species may diverge in evolutionary time depending on the makeup of other cricket species in their area. And the habitat may include more than cricket singing, such as katydids, cicadas, and even frogs, although this chorus of species poses far more difficulty for the human researcher than for any specific female cricket!

The talk by Dr. Otte was preceded by the presentation of the Calvert Awards for student excellence. Among notes of entomological interest, Howard Boyd reported a massive aggregation of nesting plasterer bees (Colletidae: *Colletes thoracicus* (Smith)) in burrows on a sandy slope in Lebanon State Forest in the New Jersey pine barrens. Mr. Boyd counted 550+ active bee burrows in an area of 6 x 18 meters. Over 40 members and their guests were present.

Jon K. Gelhaus,  
Corresponding Secretary

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31. The Stoneflies (Plecoptera) of the Rocky Mountains. Richard W. Baumann, Arden R. Gauflin and Rebecca F. Surdick. 1977. 208 pp. \$10.50.
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33. Revision of the Milliped Genus *Sigmoria* (Polydesmida: Xystodesmidae). Rowland M. Shelley. 1981. 139 pp. \$11.00.
34. Proceedings of the 8th International Symposium on Chironomidae. Jacksonville, Florida July 25-28 1982. 1983. 385 pp. \$25.00.
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**BOOKS RECEIVED AND BRIEFLY NOTED**

**THE COMMON NAMES OF NORTH AMERICAN BUTTERFLIES.**  
J.Y. Miller, ed. 1992. Smithsonian Institution Press. 177 pp. Ppbk.

Dr. Paul Opler, who wrote the foreword for this small volume, states "This is the first serious effort at an "official" standardized common names list for butterflies". This book lists the scientific names of all butterflies recorded in the United States and Canada along with their affiliated common names listed in succession of usage and preference.

**SYSTEMATICS OF THE *CHRYSOXENA* GROUP OF GENERA (LEPIDOPTERA: TORTRICIDAE: EULIINI).** 1992. J.W. Brown & J.A. Powell. University of California Press. 87 pp., 143 figs. on 28 pl. \$15.00 Ppbk.

The title of this small volume adequately describes its contents.

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# ENTOMOLOGICAL NEWS

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(Continued on inside of back cover)

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## **TELEBASIS AUREA (ODONATA: ZYGOPTERA: COENAGRIONIDAE), A NEW SPECIES OF DAMSELFLY FROM COSTA RICA<sup>1</sup>**

Michael L. May<sup>2</sup>

**ABSTRACT:** A new species of Zygoptera, *Telebasis aurea*, from southeastern Costa Rica, is described and figured. Brief notes on its ecology and probable relationships are provided.

**RESUMEN:** Una nueva especie del suborden Zygoptera es descrita e ilustrada para América Central: *Telebasis aurea* para el sureste de Costa Rica. Se brindan, además, breves notas acerca de sus ecología y probables relaciones específicas.

The Zygoptera of the neotropics, although better studied than most tropical taxa, are still poorly known. Merely to catalog the diversity of that region is a monumental task facing biologists over the next decades. What follows is intended as a small contribution to that effort.

The genus *Telebasis* is endemic to the New World and is principally Neotropical, with about 28 species (Tsuda, 1991). *Telebasis* has not been treated comprehensively, but Calvert (1901-1908, 1909) and Kennedy (1936) clearly illustrated diagnostic features for males of many species. Comparison with descriptions and/or authoritatively identified specimens of all the regional species confirm that the species described here is new.

### **TERMINOLOGY AND METHODS**

Terminology for the caudal appendages follows Snodgrass (1954), for the penis Miller and Miller (1981), and for the wing veins Tillyard and Fraser (1938-1940).

All measurements are in mm and were made with a ruler (to 0.5 mm) or a filar micrometer (to 0.1 or 0.01 mm). Total length and abdomen length include the cerci. Cerci and paraprocts were measured in lateral view from about mid-height of each (not from a common point) to its tip. Ovipositor lengths exclude the styli. Illustrations were modified from sketches made using a Wild<sup>R</sup> stereo microscope equipped with a camera

<sup>1</sup> Received April 27, 1992. Accepted June 10, 1992.

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lucida and/or tracings of electron micrographs made with an Hitachi<sup>R</sup> S-510 scanning electron microscope. All specimens are preserved dry in transparent envelopes.

Collections referred to are abbreviated as follows: ANSP—Academy of Natural Sciences, Philadelphia; FSCA—Florida State Collection of Arthropods (Gainesville); IORI—International Odonata Research Institute (Gainesville); MLM—personal collection of M. L. May (New Brunswick).

### *Telebasis aurea*, spec. nov.

(Figs. 1A-E)

**Material examined:** Holotype: ♂ (#1), Costa Rica, Prov. Puntarenas, Peninsula de Osa, pond 5 mi. S. of Rincon, 10 August 1970, in tandem with allotype, coll. by M. L. May, IORI. Allotype: ♀ (#2), same data as holotype. Paratypes: 1 ♂, 1 ♀ (pair in tandem, #'s 3, 4), 1 ♂ (not paired, #5), same data as holotype, MLM; 1 ♂, 1 ♀ (pair in tandem, #6, 7), same data as holotype, FSCA.

**Etymology:** *aurea*, Latin for golden, referring to the color of the male.

**Diagnosis:** A large and robust species with the rear of the head mostly black, the dark middorsal pterothoracic stripe fairly wide, and the abdomen nearly lacking dark markings. The golden orange color of the male is distinctive, as are the shapes of the caudal appendages and penis (Figs. 1A-D). The female is distinguished by the presence and shape of the prothoracic processes and the pits on the middle lobe of the prothorax (Fig. 1E).

**Holotype:** Right metathoracic leg and left metathoracic tarsus missing, small crack on left side of anterior mesepisternum.

Head with labrum and entire anterodorsal surface golden orange. Dorsum shiny black posterior to line extending from midpoint of each eye to just anterior to lateral ocelli, thence anteriorly to median ocellus. Small, orange bar along occipital ridge, rear of head black except ventral eye margins. Mouthparts yellowish, apexes of mandible and maxillae black.

Prothorax dull orange dorsally, greenish yellow on pleura, with dark area on either side of midline of middle lobe and along sulcus between middle and hind lobe. Pterothorax with black middorsal stripe (including middorsal carina and antealar sinus but not antealar ridge or mesostigmal plates) widening from 1/3 width of mesepisterna at anterior end to about 3/5 width posteriorly, finally expanded to mesopleural suture just before antealar ridge; remainder of sclerite golden orange. Dark lateral markings including elongate spot on shallow fossa near upper end of mesopleural suture; stripe about 1/2 width of mesepimeron, extending from anterior bulge to extreme posterior end of sclerite, where much narrower along interpleural suture; hairline along metapleural suture. Remainder of thorax yellowish with slight greenish cast, except tan on mesinfraepisternum and extreme anterior mesepimeron; venter unmarked. Legs mostly pale, black on extensor surfaces and extreme apexes of femora and on flexor surfaces of all tibiae and external angle of protibiae, tarsi dark brown. Wing membranes distinctly flavescent, veins dark brown, pterostigmata tan; vein R<sub>3</sub> branching from R<sub>2</sub> just before 7th (forewing) or 6th (hindwing) postnodal crossvein.

Abdomen almost entirely golden orange, paler with greenish cast laterally on segment 1 and anterior end of 2, with brownish cast on 9 and 10; black dorsal spot on basal 1/2 of 1,

also with sperm vesicle, margins of hamules, subapical denticles on segments 7-9, and diffuse dorsal stripes on basal 1/2 of 9 and full length of 10 black. Third abdominal segment 5.9 times as long as its height at midlength, 2.3 times as long as segment 2. Cerci 0.50 mm., brown with black medial tooth; paraprocts 0.51 mm. brown, very broad basally, much narrower apically and curved upward and inward (Figs. 1A, B). Penis not extruded but presumably as in Figs. 1C, D.

**Measurements:** Total length—37.0, abdomen—29.0, hindwing—21.0.

**Allotype:** Both antennae with flagella broken off, pterothorax cracked along anterior margin of mesepisternum and anterior mesepimeron, abdomen somewhat compressed laterally.

Head pattern as in holotype, pale colors dull brownish yellow, with slight bluish-green tint on labrum; distinct dark mediobasal spot and basal marginal streaks on labrum, diffuse spots on postclypeus. Eyes brown.

Prothorax brownish yellow with dark, laterally concave dorsal stripe covering median 1/2 of middle and hind lobes and sulcus between anterior and middle lobes; small dark spot just beneath notopleural suture. Pair of divergent, straight, tapering but terminally rounded, flat processes, closely appressed to prothoracic dorsum, each extending from anterior edge of hind lobe to near medial edge of a distinct excavation at about midlength of middle lobe. Posterior lobe with margin sinuate and semi-erect. Pterothorax brownish yellow, dark markings as in holotype except all stripes slightly wider, C-shaped black mark on each mesinfraepisternum. Mesostigmal plates with black stripe crossing each at midwidth. Mesepisterna with distinct, black pit just behind middle of each mesostigmal plate. Legs as in holotype but with dark areas more extensive, slight pruinescence at bases. Wings hyaline; vein  $R_3$  branching from  $R_2$  at 5th-6th (forewing) or 5th (hindwing) postnodal crossvein.

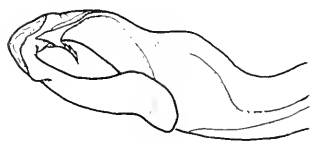
Abdomen marked much as in male, pale color ochre. Sternum mostly black, dorsal and pair of lateral dark streaks on segment 7, basal 2/3 of 8 and all but distal margin of 10 dark, cerci and ventral half of ovipositor dark. Third abdominal segment 4.1 times as long as its height at midlength (height excludes visible portion of sternum but still slightly exaggerated due to abdominal compression), 2.2 times as long as segment 2. Ovipositor 1.46 mm.

**Measurements:** Total length—37.5, abdomen—29.0, hindwing—21.0.

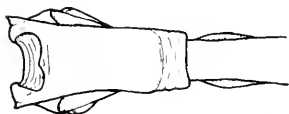
**Variation among paratypes:** Males: Coloration like holotype except all 3 with slightly wider dark thoracic stripes, extent of dark on terminal abdominal segments variable, one with dorsum of 7 largely dark; wings hyaline (slightly immature specimen?) to strongly flavescent;  $R_3$  branching from  $R_2$  at 5th-7th (f.w.) or 5th-6th (h.w.) postnodal; third abdominal segment 5.2-5.8 times as long as high. Females: coloration as in allotype, both with more pruinescence on and around bases of legs; third abdominal segment 4.6 times as long as high. Eyes in life black above, dull lime green below in males, brown above, tan below in females (Paulson, in litt.).

## DISCUSSION

All specimens were taken from a semipermanent pond in seasonal moist forest on the Osa Peninsula in southeastern Costa Rica. The pond was completely surrounded by trees but was large enough to receive sunlight during much of the day. Abundant submerged and emergent



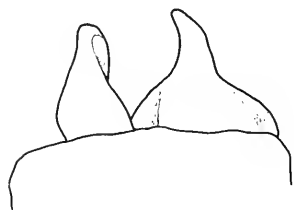
E



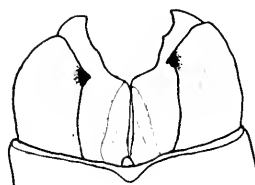
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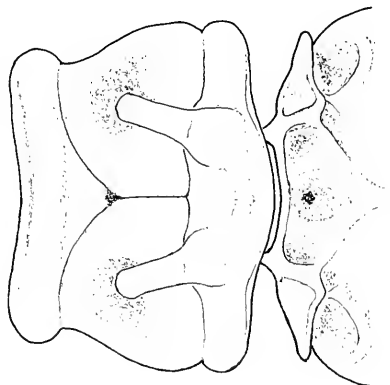
C



A



B



F



vegetation grew around its perimeter, and the *Telebasis* flew mainly among the latter, often in tandem pairs. I observed mature individuals only after 10:00 h; numerous teneral specimens could be flushed from the vegetation, especially from about 06:00 to 08:30. Associated Odonata included *Lestes scalaris* Gundlach, *Acanthagrion inexpectum* Leonard, *A. trilobatum* Leonard, *Erythemis haematogastra* (Burmeister), *Micrathyria atra* (Martin), *M. dictynna* Ris, *M. pseudeximia* Westfall, *Nephepeltia phryne* (Perty), *Orthemis ferruginea* (F.), and *Perithemis mooma* Kirby. D. L. Paulson has also taken what is apparently *T. aurea* (in litt.; specimens were not examined) at San Vito de Java, C. R., at an elevation of about 1500 m.

*Telebasis aurea* is one of the largest Central American *Telebasis*, and the only one with the males of the distinctive color that suggested its name. Among the regional species *T. garleppi* Ris may be longer, but it is a more slender insect (third abdominal segment 6.7-7.3 times as long as high in 3 males, 5.5 times as long as high in 1 female), it lacks the dark mespimeral stripe, and the black color of the epicranium extends forward to the bases of the antennae; the abdominal color of males is the typical red or red-orange of most *Telebasis*, the cerci are strongly convex dorsally and about as high as long, and the penis bears well-developed pre-apical lateral lobes; the female prothorax is similar to that of *aurea* but the forward-projecting processes each curve inward and slightly upward to an acute tip that lies medial to the lateral excavations of the middle lobe. *Telebasis theodori* (Navas), from southern South America, is similar in color, especially in having flavescent wings, but differs in other characters, including the shape of the male caudal appendages, the pale color of the rear of the head, and the much less extensive dark markings of the pterothorax (Jurzitza, 1980; Garrison, 1991, showed that Jurzitza's *T. aureipennis* is a synonym of *T. theodori*).

Relationships within the genus are not well understood, but the forms of the male caudal appendages and penis suggest a possible alliance with *T. coccinata* Calvert, *T. salva* (Hagen), and perhaps *T. livida* Kennedy. The female shares with several species the character of strap-like projections extending over the middle lobe of the prothorax, but their shape, together with the depth and position of the excavations beneath and/or lateral to them (Fig. 1E) is distinctive).

Figure 1 (opposite): *Telebasis aurea* spec. nov. A—male caudal appendages, lateral view; B—male caudal appendages, dorsal view; C—right cercus of male, dorsomedial view; D—head and distal shaft of penis, ventral view; E—head and distal shaft of penis, lateral view; F—prothorax and mesostigmal laminae of female, dorsal view. Scale bar = 0.5 mm for A, B, C, F; 0.3 mm for D, E.



The following key will separate all the species of *Telebasis* known to occur in Mexico and Central America. Further information on the known range of each species, except *aurea*, appears in Paulson (1982) and Tsuda (1991).

## Keys to *Telebasis* of Mexico and Central America

### Males

- 1 Cerci much longer than paraprocts, in profile their dorsal margin strongly convex, ventral margin straight or smoothly concave in apical 2/3 ..... *corallina*
- 1' Cerci subequal to or shorter than paraprocts, not shaped as above ..... 2
- 2(1') Posterior surface of head largely black ..... 3
- 2' Posterior surface of head largely pale ..... 8
- 3(2) Paraprocts about 1/2 the length of abdominal segment 10 at midheight, blunt apically; mesepisterna almost wholly black; small species, hindwing no longer than 13 mm ..... *filiola*
- 3' Paraprocts much more than 1/2 the length of abdominal segment 10, tapering and more or less acute apically; mesepisterna usually not almost wholly black (except some *digiticollis*); larger species, hindwing usually longer than 15 mm ..... 4
- 4(3') Abdominal segments 4-7 mostly black dorsally; cerci, in dorsal view, wider than long ..... *collopiastes*
- 4' Abdominal segments 4-7 mostly red or golden orange dorsally; cerci, in dorsal view, longer than wide ..... 5
- 5(4') Pale color of abdominal dorsum mostly golden orange; black on epicranium extending anteriorly barely beyond ocelli; cerci and paraprocts nearly equal in length; hindwing 20 mm or longer ..... *aurea*
- 5' Pale color of abdominal dorsum mostly red or orange-red; black on epicranium extending anteriorly at least to bases of antennae; paraprocts distinctly longer than cerci, or, if not, hindwing shorter than 20 mm ..... 6
- 6(5') Cerci, in profile, about as long as high; middle lobe of pronotum mostly pale; hindwings generally longer than 20 mm ..... *garleppi*
- 6' Cerci, in profile, distinctly longer than high; middle lobe of pronotum mostly black; hindwings generally shorter than 20 mm ..... 7
- 7(6') Cerci about 3/4 length of paraprocts, or less, and, in dorsomedial view, appearing rounded at apex (similar to Fig. 1 C); mesepimeron with narrow black stripe often extending most of length of sclerite ..... *digiticollis*
- 7' Cerci nearly as long as paraprocts and, in dorsomedial view, appearing squarely truncate at apex; mesepimeron usually with black stripe absent or reduced ..... *griffinii*
- 8(2') Paraprocts truncate at apexes, only slightly longer than cerci; pale color of thorax mostly pale green, mesepisterna with black middorsal stripe uniform in width, mesepimera without dark markings ..... *isthmica*
- 8' Paraprocts tapering and more or less acute at apexes, at least 1/3 longer than cerci; pale color of thorax mostly orange or red, mesepisterna with black middorsal stripe abruptly widened near posterior end, mesepimera with dark stripe or spot ... 9
- 9(8') Cerci, in ventrolateral view, with black subapical tooth bifid; Baja California only ..... *incolumis*
- 9' Cerci, in ventrolateral view, with subapical black tooth not bifid; widespread ..... *salva*

**Females**

1 Posterior surface of head largely black ..... 2  
 1' Posterior surface of head largely pale ..... 7  
 2(1') Dorsum of abdominal segments 1-3 and 8-10 pale, 4-7 black; pronotum without elongate processes ..... *collopiastes*  
 2' Dorsum of abdominal segments 1-9 more or less concolorous, or 8-10 only with diffuse dark areas; pronotal sculpturing variable ..... 3  
 3(2') Dorsum of abdomen largely pale; pronotal processes strap-like, appressed to surface of pronotum ..... 4  
 3' Dorsum of abdomen largely black or bronze; pronotal processes erect or absent ..... 5  
 4(3') Pronotal processes slightly divergent, rounded apically (Fig. 1F); abdominal segment 3 about 4.5 times as long as its height at midlength ..... *aurea*  
 4' Pronotal processes slightly convergent in distal 1/2, subacute apically; abdominal segment 3 about 5.5 times as long as its height at midlength ..... *garleppi*  
 5(3') Mesostigmal plates each with large, posterodorsally-projecting lobe; small species, hindwing no longer than 13 mm ..... *filiola*  
 5' Mesostigmal plates without large projecting lobe; larger species, hindwing usually longer than 15 mm ..... 6  
 6(5') Pair of erect, divergent processes projecting anterodorsally from hind lobe of pronotum ..... *digiticollis*  
 6' Pronotum without erect processes ..... *griffinii*  
 7(1') Pronotum without erect or strap-like processes projecting from hind lobe; mesepisterna with middorsal stripes obscure, or brown with only lateral margins black ..... *isthmica*  
 7' Pronotum with erect or strap-like processes arising from hind lobe; mesepisterna with distinct, black middorsal stripe, only middorsal carina pale ..... 8  
 8(7') Mesepisterna with black middorsal stripe uniform in width; mesostigmal plates each with distinct lateral protuberance, separated from main part of plate ..... *corallina*  
 8' Mesepisterna with black middorsal stripe abruptly widened near posterior end; mesostigmal plates without separated lateral protuberances ..... 9  
 9(8') Pronotal processes distinctly divergent, arising at or near midlength of hind lobe, extending almost vertically and not overhanging middle lobe; Baja California only ..... *incolumis*  
 9' Pronotal processes nearly parallel, arising from anterior 1/3 of hind lobe, extending somewhat anteriorly and usually partly overhanging middle lobe; widespread ..... *salva*

**ACKNOWLEDGMENTS**

My sincere thanks to S. W. Dunkle and M. J. Westfall for giving me free access to the IORI and FSCA collections and to Don Azuma for permission to examine specimens from the Calvert collection at the ANSP. R. Garrison generously provided information on species not available to me and critically read the manuscript. Finally, I thank D. R. Paulson, who collected this species before I did, for the privilege of describing it. New Jersey Agricultural Experiment Station Publication D-08425-19-91.

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## A NEW SPECIES OF *HANSENIELLA* (SYMPHYLA: SCUTIGERELLIDAE) FROM THE INTERIOR HIGHLANDS OF ARKANSAS<sup>1</sup>

Robert T. Allen<sup>2</sup>

**ABSTRACT:** *Hanseniella ouachiticha*, new species, is described from Rich Mountain in western Arkansas. The new species is most closely related to *H. vandykei* from California. A key to the three known North American species is given.

Edwards (1990) has pointed out that Symphyla are "extremely common inhabitants of soil in all parts of the world." but that "the scientific literature on the group is not voluminous." Both statements are certainly true of this class of arthropods in North America. Edwards (1990) in discussing the morphology and ecology of the Symphyla also rendered a valuable service to those wishing to work with this group by providing keys to the two North American families and the North American genera recognized in each family. The genus *Hanseniella* Bagnall belongs to the family Scutigerellidae. This paper describes a new species and presents a key to the three North American species of *Hanseniella*.

The symphylid genus *Hanseniella* occurs on all the continents except Antarctica. The genus is most diverse in tropical areas. Only two species, *H. californica* Hilton (1931) and *H. vandykei* Michelbacher (1939), are known from North America, both species recorded only from California. This paper describes a new species from the Ouachita Mountains of western Arkansas.

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**Key to the North American Species of *Hanseniella***

- 1. Tarsal claws unequal (Fig. 21), one claw much longer than the other ..... 2  
 Tarsal claws equal ..... *californica* Hilton
- 2. Proximal segment of first pair of legs with one long prominent seta; 21-26 antennal segments; central rod of head continued anteriorly ..... *vandykei* Michelbacher
- Proximal segment of first pair of legs with three prominent setae (Fig. 24); 16-25 antennal segments, usually 19, 20, 21; central rod of head not continued anteriorly (Fig. 1) ..... *ouachiticha* new species

***Hanseniella ouachiticha*, new species**

**Holotype:** Arkansas, Polk County, Rich Mountain, Eagleton Overlook, 17 February 1988, extracted with Berlese funnel, Robert T. Allen, collector. Slide-mounted in CMC medium, deposited in the American Museum of Natural History, New York (AMNH).

**Paratypes.** 79 slide-mounted (CMC medium) specimens, same data as the holotype; 10 specimens, University of Arkansas Arthropod Collection (UAAC); 5 specimens United States National Museum (USNM); 5 specimens AMNH; 59 specimens, Robert T. Allen Collection (RTAC).

**Etymology.** This species is named after the Ouachita Mountains, a major subsegment of the Interior Highlands.

**Length.** 2.5-3.0 mm (apex of head to apex of last abdominal segment).

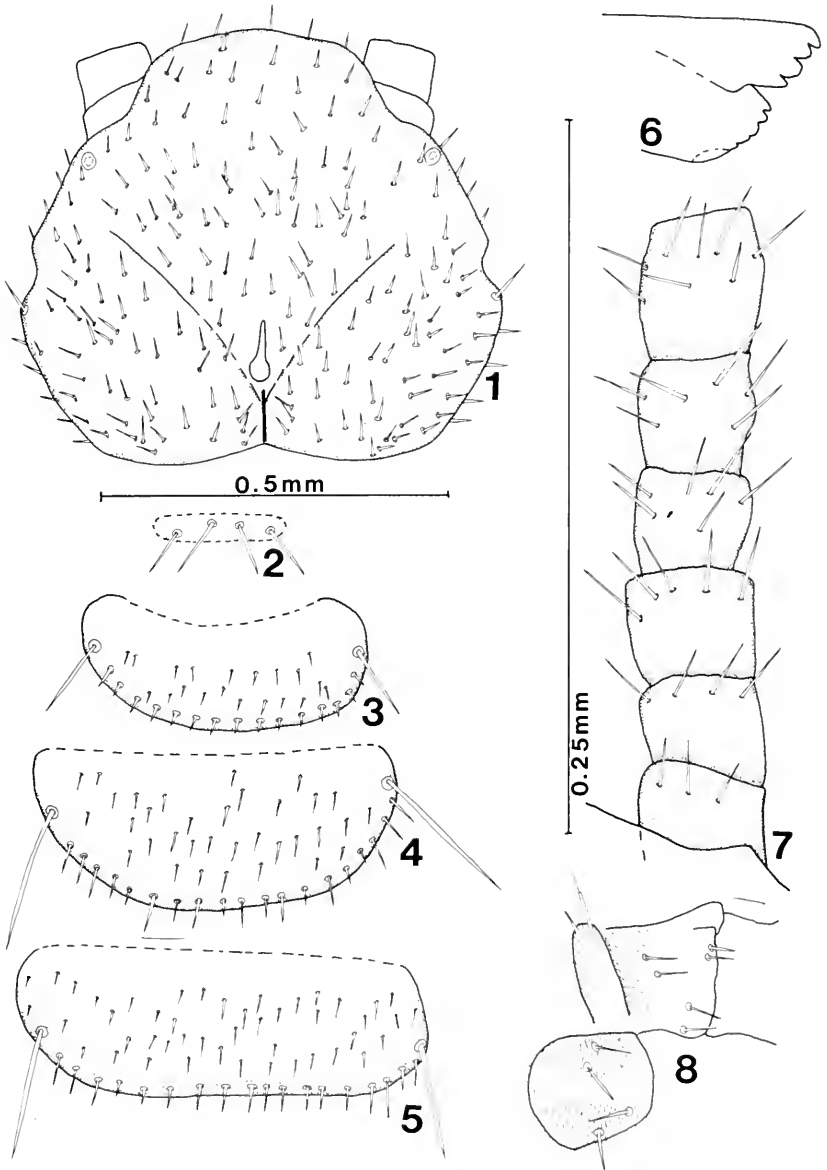
**Head** (Fig. 1). General: slightly wider than long, setae present over the entire surface, all about the same length and size, except for the setae along the posterior margins of the scuta. Central rod: weakly developed posteriorly, not evident in all specimens; lateral branches sometimes evident, extending toward the postantennal organs. Mandibles (Fig. 6): visible in most specimens; the mandible is a large endite apparently composed of two parts, the outer lobe bearing four distinct teeth, the inner lobe with a number of indentations not as deep or distinct as those in the outer lobe. Postantennal organ; small, not evident in all specimens.

**Antennae.** (Figs. 7,14) Number of segments variable ranging from 16-25, but most commonly 19, 20, 21; segments 1-3 usually with one whorl of setae; two whorls on segments 4-10, sometimes on 3 as well; other segments with three whorls, starting with segment 11; terminal segment with the usual three-stalked "sensory" structure; other segments without evident sensory organs.

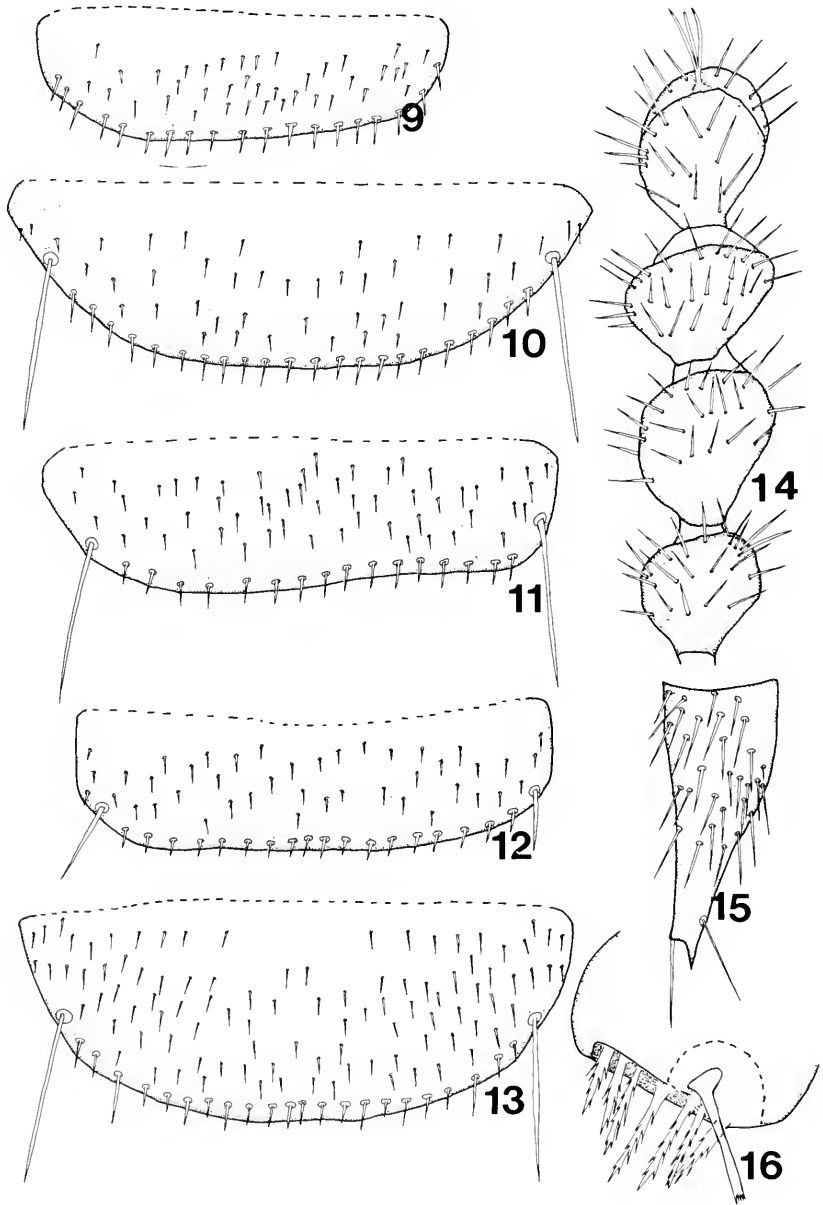
**Scuta.** (Figs. 2-5 9-13, 17-20) Posterior margins of scuta straight or only weakly concave.

The following "table" enumerates the number of setae found along the posterior margin of Scuta I-XIV. The Short Setae are those between the Long Lateral Setae or all the posterior on Scuta V, VII, and XI.

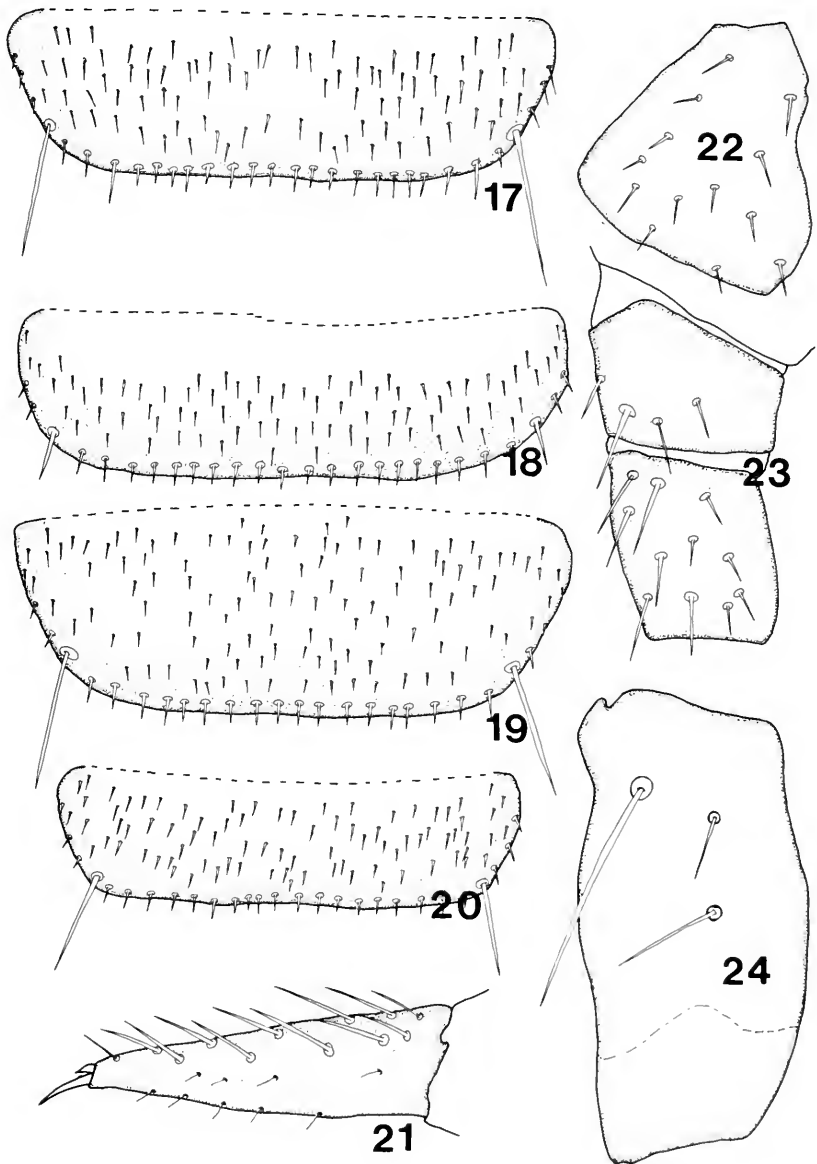
Scuta No.	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
Lateral Long Setae	4	2	2	2	0	2	2	0	2	2	0	2	2	2
Short Setae	0	13-16	16-20	14-22	18-23	19-25	18-23	17-24	17-23	18-22	16-14	15-20	11-19	10-19



Figures 1-8. *Hanseniella ouachitcha*: 1, head; 2-5, scuta 1 to 4 respectively; 6, mandible; 7, antennal segments 1-6; 8, stylus, coxal sac and coxa of leg 10.



Figures 9-16. *Hanseniella ouachiticha*. 9-13, scuta 5 to 9 respectively; 14, distal four antennal segments; 15, spinneret; 16, trichobothrium vesicle.



Figures 17-25. *Hanseniella ouachiticha*. 17-20, scuta 10 to 13 respectively; 24, tarsus and claws of leg 10; 22, coxa of leg 10; 23, femur and tibia of leg 10; 24, proximal segment of leg 1 showing 3 prominent setae.



Legs. Leg segments clothed with a dense covering of small pilose hairs. First pair: half the length of the second pair of legs; proximal segment with three distinct prominent setae on the anterior surface, distal segment with two rows of three prominent setae each on the anterior surface. Leg pairs 2-9; tarsi with two rows of 3-5 prominent setae (Fig. 21); tibiae, femora, and trochanters with a variable number of prominent setae. Leg pair 10 (Fig. 23): tarsi with two rows of 4 prominent setae, sometimes also with 2-3 additional setae near these rows; tibia and femora with a variable number of prominent setae. Claws: (Fig. 21) unequal, one claw half or less than half the length of the other on all legs.

Styli. (Fig. 8) Well developed, present at the base of leg pairs 3-11.

Coxal Sacs (Eversible vesicles) (Fig. 8). Distinct, present at the base of leg pairs 2-11; the sac appears to be composed of two "sclerotized" areas, each with 2-3 prominent setae.

Trichobothria (Fig. 16). Setae almost as long as the spinneret; ventral margin of trichobothrium vesicle with 7-8 prominent setae in the proximal 1/2-3/4; distal 1/4 with only one long prominent setae towards the apex. Inner apical margin with a seta 1/2 as long as body of the spinneret; outer apical margin produced into an acute spine-like process.

## DISCUSSION

*Hanseniella ouachiticha* appears to be most closely related to *H. vandykei*. The new species differs from *H. vandykei* by the characters given in the key, i. e. a fewer number of antennal segments, proximal segment of first pair of legs with three prominent setae rather than one, and the very short central rod of the head. In addition the proximal leg segment of the first pair of legs is elongate in *H. ouachiticha* and short, almost square, in *H. vandykei*.

The type locality for the new species is on Rich Mountain, the highest feature (about 2,750 feet) in the Ouachita Mountains. All the specimens were found in a single Berlese sample taken from rotting logs and at the base of rotting stumps. This mountain is also the type locality for two species of endemic earth worms, a freshwater amphipod, and the Rich Mountain salamander.

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## A NEW SPECIES OF THE BEE GENUS *ANTHIDIUM* (HYMENOPTERA: MEGACHILIDAE) FROM WESTERN NORTH AMERICA<sup>1</sup>

Roy R. Snelling<sup>2</sup>

**ABSTRACT:** *Anthidium cochimi* is described from the Lower California peninsula (Baja California Sur) and the southwestern United States (Arizona). Structural features that will aid in its recognition are illustrated. Males of *A. cochimi* are recognizable by a unique combination of characteristics of metasomal sternum 6 and terga 6 and 7; females are separable from similar species by characteristics of mandibular dentition, labral structure, and the structure of metasomal tergum 6. Diagnostic features are illustrated.

The following new species of *Anthidium* is one that may easily be confused with *A. sonorese* Cockerell, particularly since the male shares with that species a characteristic hitherto believed to be unique to *A. sonorese* males: the presence of a short, forward directed spine on the middle of the apical margin of metasomal sternum 6.

The ranges of the two species appear to be partially sympatric. Cockerell (1923) described *A. sonorese* from a male collected in Sonora, Mexico, at Guaymas. At the same time a female from Isla San Jose in the Gulf of California was described as *A. sonorese productum*. A few years later Schwarz (1927) described a male from Sacaton, Pinal Co., Arizona, as *A. rohweri*. Both *A. sonorese productum* and *A. rohweri* were synonymized with *A. sonorese* by Grigarick and Stange (1968). I have compared the types of all three of these taxa and agree with the synonymy proposed by Grigarick and Stange.

The range of *A. sonorese* extends from southern Nevada and adjacent southern California, through Arizona, south into the State of Sonora, Mexico, at least to the Guaymas area; it has been collected also on the Lower California peninsula. There are few records from the peninsula and the extent of its southward distribution is unclear. At present the southernmost peninsular record is from sand dunes 8 km N of Guerrero Negro, at the border between Baja California and Baja California Sur.

### *Anthidium cochimi*, new species

Figures 1-5

**DIAGNOSIS. Male:** metasomal sternum 6 (Fig. 2) with small anteriorly directed medioapical spine and lateral ridges low and evenly convex; basal apodeme of sternum 8 (Fig. 3) broadly

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truncate-triangular, apical process short and broad; lateral process of metasomal tergum 6 (Fig. 1) slender and spine-like, slightly curved; lateral lobes of tergum 7 (Fig. 1) roughly triangular, broad, inner margins nearly straight; median process short and fully visible in profile (not on same plane as lateral lobes). **Female:** mandible (Fig. 5) with 7 teeth; median groove of labrum broad, extending about 2/3 labral length and its flanking tubercles distinct but not spine-like; median truncation of clypeus (Fig. 5) narrow and nearly straight, apical margin laterad of median truncation with two low, rounded lobes; preapical carina of metasomal tergum 6 (Fig. 4) minutely crenulate and on each side terminating in short, acute tooth, posterior margin of tergum 6 visible only in median 1/4 in dorsal view.

**DESCRIPTION.** **Holotype male,** measurements (mm): head width (HW) 4.4; head length (HL) (anterior margin of clypeus to posterior margin of vertex in frontal view) 3.5; wing length (WL) (from margin of tegula) 8.7; total length (TL) (HL + dorsal length of mesosoma + dorsal length of metasoma) 15.3. **Paratypes:** HW 3.2-4.4; HL 2.4-3.4; WL 2.4-3.8; TL 15.0-17.7.

Head about 1.2 times as wide as long; inner eye margins moderately convergent below, upper interorbital distance 1.1-1.2 times lower interorbital distance; vertex margin nearly straight in frontal view; antennal scape attaining level of anterior ocellus; interocellar distance (IOD) about 1.8 times transverse diameter of anterior ocellus (OD); ocellular distance (OOD) about 1.25 times OD; ocellovertexal distance (OVD) about 1.7 times OD. Clypeus about 1.2 times as long as wide and separated from inner eye margin by about 0.5 times OD; apical margin transverse. Labrum distinctly constricted near base; median groove deep and broad, extending about 0.66 length of segment; flanking tubercles of labral groove absent at base, preapical pair low and inconspicuous.

Mesosoma and legs normal for *Anthidium*, except metatibia outer face anteriorly carinate.

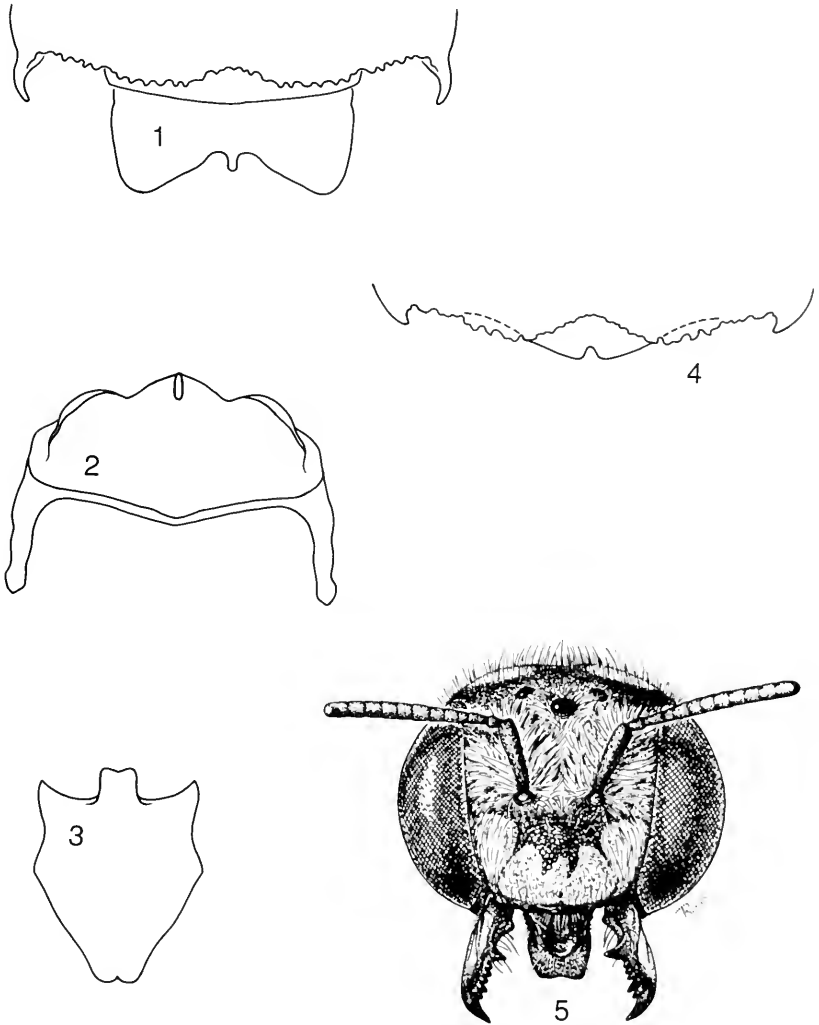
Metasomal tergum 6 with preapical carina broadly interrupted in middle, ending on each side in spine-like, slightly curved process; tergum 7 with broadly triangular lateral lobes, inner margins nearly straight for most of their length; median process short, suberect and curved distad, not on same plane as lateral lobes when viewed in profile; setal brush of sternum 4 brown, occupying middle 0.33 of apical margin; apical margin of sternum 6 with short median spine that is bent cephalad, lateral lobes distinct, low and evenly convex; sternum 8 with basal apodeme broad, margins convergent toward transverse base, apical margin broad and lateral angles acute, median process short and broad. **Genitalia:** gonostylus in profile with margins nearly parallel, apex obliquely truncate; inner lobe of gonobase short and triangular in ventral view; ventral margin of penis valve with 6-7 coarse teeth; apex of penis valve strongly narrowed and bent ventrad.

Punctuation of head and mesosoma normal for *Anthidium*, i.e., most areas contiguously to subcontiguously punctate, punctures moderate in size, disc of tegula contiguously and more finely punctate; basal area of propodeum distinctly subcontiguously punctate. Discs of metasomal terga 1-3 with elevated middle portion moderately and subcontiguously punctate, interspaces moderately shiny; basal depression more finely punctate, punctures dense; apical depression more finely and contiguously punctate; elevations of terga 4-6 more coarsely punctate except in middle; tergum 7 coarsely rugosopunctate.

Color blackish; antenna and legs dark reddish-brown but tarsi more reddish; clypeus, large lateral face mark, ending at level of antennal sockets, and underside of scape pale yellowish. The following brighter yellow: basal 0.66 of outer face of mandible; transverse spot on each side of vertex; spot on pronotal lobe; sublateral bands on anterior margin of mesoscutum and spot or band adjacent to tegula (may be absent); axillar spot (may be absent); posterior band on scutellum, narrowly interrupted in middle; anterior spot on tegula; external stripe on pro- and mesotibiae, that of mesotibia often more or less broadly interrupted; elongate basal spot on metatibia; small apical mark on metatibia (often absent); external face of all basitarsi; lateral and submedian marks of varying extent on metasomal terga 1-5 (sometimes lateral and sub-

median spots narrowly joined on 3-5); tergum 6 with large submedian spots. Tergum 7 immaculate.

Female, measurements (mm): HW 3.5-4.3; HL 2.7-3.5; WL 5.8-7.4; TL 9.5-13.2.



Figures 1-5, *Anthidium cochimi*. 1, male metasomal terga 6-7, dorsal view; 2, male metasomal sternum 6, ventral view; 3, male metasomal sternum 8, ventral view. 4, female: metasomal tergum 6, dorsal view; 5, female head, frontal view. Figures by Tina Ross.

Head width 1.2-1.3 times head length; inner eye margins moderately convergent below, upper interocular distance 1.2-1.3 times lower interocular distance; vertex margin low-convex in frontal view, weakly depressed in middle; antennal scape not attaining level of anterior ocellus; IOD about 2 times OD; OOD about 2.25 times OD; OVD about 2.5 times OD. Clypeus about 1.3 times as wide as long and separated from inner eye margin by slightly less than OD; median truncation of apical margin nearly straight, slightly narrower than distance between antennal sockets, apicolateral margin with two low, convex lobes. Labrum about as in male but with prominent basal and preapical tubercles flanking median groove. Mandible with 7 teeth.

Mesosoma and legs as usual in *Anthidium*, except metatibia outer face anteriorly carinate.

Transverse preapical carina of metasomal tergum 6 (Fig. 4) minutely crenulate and terminating on each side as short, acute tooth; apical margin visible in dorsal view only in median one-fifth before passing under carina.

Pilosity as usual in *Anthidium*; basitarsi with dense mats of finely plumose hairs; scopa variably entirely pale to largely very pale brownish except laterally.

Color about as in male but clypeus with black apical margin and with basal black area that extends distad along midline, sometimes beyond midlength; axillar spots prominent; protibial stripe incomplete; mesotibia with basal stripe only; submedian and lateral marks of metasomal tergum 5 sometimes joined.

**TYPE MATERIAL.** **Holotype male:** 17 mi SE Santa Rita, Baja California Sur, MEXICO, 18 Sept. 1983 (R.R. Snelling). **Paratypes** (all from Baja California Sur): 4 ♂♂, 4 ♀♀, same data as holotype; 3 ♂♂, 11 ♀♀, San Augustine, 8 Sept. 1989 (F.S. Truxal); 1 ♂, vic. Miraflores, 17 Sept. 1983 (R.R. Snelling); 1 ♀, 19 km NW Mulegé, 8 Sept. 1977 (R.R. Snelling); 1 ♀, vic. Estación Microondas "Ligui", 425 m el. (ca. 40 km S Loreto), 14 Sept. 1983 (R.R. Snelling), on *Antigone leptopus*; 4 ♂♂, 5 mi NW San Ignacio, 19 Sept. 1983 (R.R. Snelling), on *Tephrosia tenella*; 6 ♂♂, 1 ♀, Rancho Tablón, 13 km S Guillermo Prieto, 14-18 Apr. 1983 (M. Wasbauer), 3 ♂♂ on prostrate *Dalea* sp., 2 ♂♂, 1 ♀ ex malaise trap; 1 ♀, 12 mi S Guillermo Prieto, 7 Apr. 1982 (J. Slansky); 1 ♀, same data except (M.S. Wasbauer); 1 ♀, Boca de la Sierra, (near Miraflores), 900 ft. elev., 7 Mar. 1969 (R.R. Snelling); 2 ♀♀, 3.7 mi W La Burrera, 1400 ft. elev., 7-8 Oct. 1975 (R.R. Snelling), on *Celosia floribunda* (1 ♀) and *Verbesina palmeri* (1 ♀); 1 ♀, 5.5 mi W La Burrera, 1200 ft. elev., 8 Oct. 1975 (R.R. Snelling); 1 ♀, 9.6 mi N Loreto, 14 Sept. 1983 (R.R. Snelling), on *Bebbia juncea*. Holotype and most paratypes in LACM; additional paratypes deposited in American Museum of Natural History, California Academy of Sciences, California Department of Food and Agriculture, and National Museum of Natural History.

**ADDITIONAL MATERIAL** (Not paratypes). **United States, Arizona:** 3 ♂♂, Silver Bell Bajada, Pima Co., 7 May 1973 (J.L. Neff), on *Dalea parryi*; 1 ♂, same except 7 June 1973, on *Prosopis*; 1 ♂, same except 15 June 1973, on *Prosopis*; 4 ♀♀, 2.5 mi. SW Congress, Yavapai Co., 3150 ft. elev., 13 May 1975 (R.R. Snelling), on *Sphaeralcea*.

**ETYMOLOGY.** This species is named for the Cochimi linguistic group of Native Americans who formerly inhabited central Lower California.

## DISCUSSION

The important characteristics of this species have already been cited above in the **DIAGNOSIS**. These alone should be sufficient to separate *A. cochimi* from any other known Nearctic species.

The spine at the apex of metasomal sternum 6 of the male is so similar to that of *A. sonorensis* that it is tempting to suggest that the two are closely related. On the other hand, there are so many differences in other characters, e.g., metasomal sculpture, the preapical carina of tergum 6, the shape of sternum 8, and many details of the genitalia, that this appears unlikely. The females differ markedly in the structure of the labrum, the number of mandibular teeth, in details of metasomal tergum 6, and in metasomal sculpture.

Because of the spotted, rather than striped, metasoma and the crenulate preapical margin of metasomal tergum 6, females of *A. cochimi* may be confused with those of *A. porterae* Cockerell, 1900, to which they will run in the key by Schwarz (1927). Females of *A. porterae*, however, have prominent curved, spine-like labral tubercles and the mandibles possess only six teeth.

Both sexes of *A. cochimi* possess a distinct carina anteriorly on the outer face of the metatibia, extending nearly the entire length of the segment. A similar carina is present and sharply defined in *A. maculifrons* F. Smith, *A. maculosum* Cresson, and *A. porterae*. A similar, but less well defined, carina is present along approximately the middle one-half of the metatibia in *A. sonorensis*. This carina is lacking in the remaining known North American species of *Anthidium*.

Aside from variations in size and in the extent of maculations, there is little variation in the material I have seen. Males commonly have the maculations of the third to fifth metasomal terga narrowly joined along their posterior margins. In only one female are the lateral and submedian spots joined, on the fifth segment only.

#### ACKNOWLEDGMENTS

For the loan of relevant type material I am indebted to Wojciech Pulawski, California Academy of Sciences, and to Ronald McGinley, National Museum of Natural History. Marius Wasbauer loaned material from the collection of the California Department of Food and Agriculture. An earlier draft of this paper was reviewed by Terry Griswold and materially improved as a result. My thanks and appreciation to each of these colleagues.

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## A NEW SPECIES OF *HARPACTUS* (HYMENOPTERA: SPHECIDAE) FROM SPAIN<sup>1,2</sup>

S. F. Gayubo<sup>3</sup>

**ABSTRACT:** *Harpactus alvaroi*, a new species from Spain, is described and compared with similar species of the genus.

*Harpactus* Shuckard, 1837 is still little known; many species are undescribed and many forms of doubtful status cannot be clearly defined. In earlier literature most of the species were placed in the genus *Gorytes* Latreille, in subgenera *Harpactus* Shuckard, *Harpactes* Dahlbom, or *Arpactus* Jurine and more recently *Dienoplus* W.Fox. This last subgenus was raised to full generic status in Bohart & Menke (1976). Currently the valid name is *Harpactus* Shuckard (Pulawski, 1985).

Species of *Harpactus* Shuckard occur in the Holarctic, Afrotropical and Oriental zoogeographic Regions, but the Palearctic Region is particularly rich, and several undescribed species are known to exist there. One of them, from Spain, is described below.

I use the terminology of Bohart & Menke (1976).

### *Harpactus alvaroi*, Gayubo, new species

Figs. 1-4

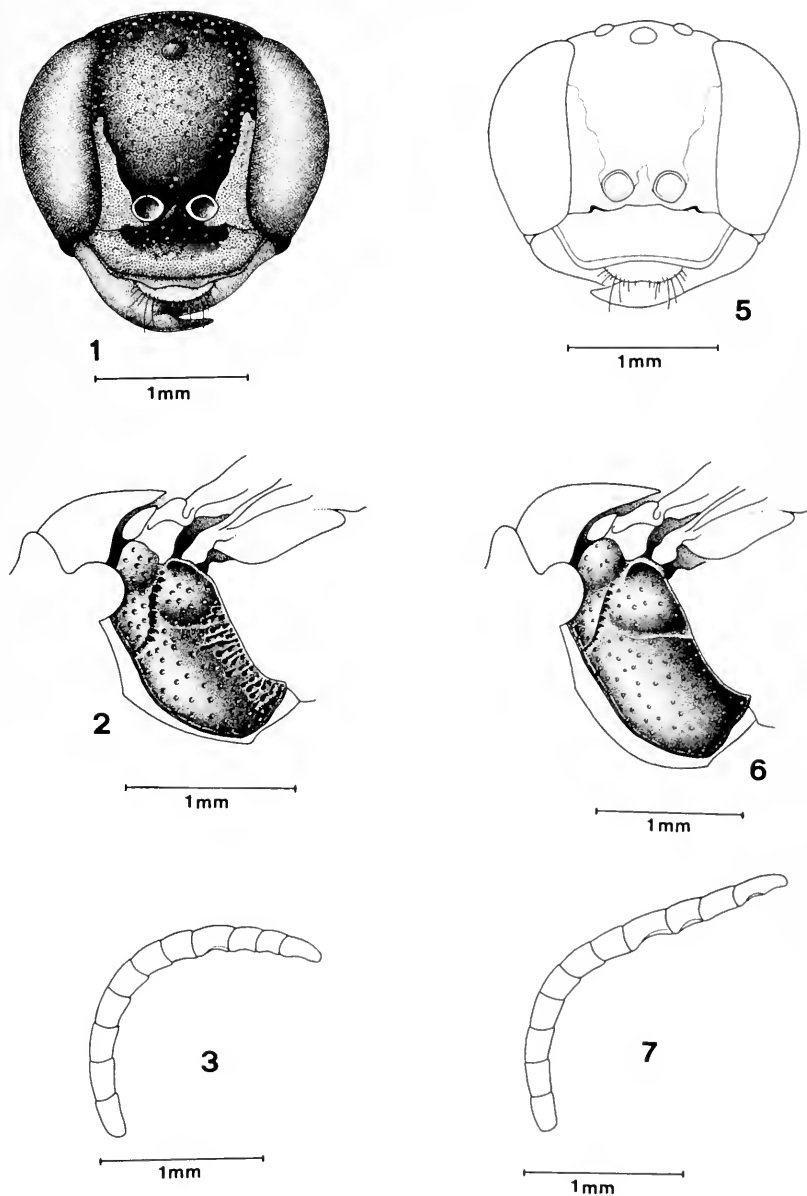
**Diagnosis.** *Harpactus alvaroi* sp.n. differs from similar species of the genus by the following features: clypeal free margin with an obtuse emargination (Fig. 1); frons with well-defined punctures, some of which are more than one diameter apart (Fig. 1); mesopleuron with deep punctures, some of which are more than two diameters apart, their posterior margin being particularly carinate (Fig. 2).

**Description.** Head subrounded, inner orbits slightly convergent towards the vertex; labrum semicircular, with inconspicuous mesal emargination; frons with well-defined punctures, which are less than one diameter apart on the upper central part and about one diameter apart elsewhere (Fig. 1). Pronotal collar narrow. Many scutal punctures more than one diameter apart, others (forming irregular groups) less than one diameter apart. Scutellum: anterior margin crenulate, most punctures along anterior and posterior margins. Metanotal punctures compressed along anterior and posterior margins. Mesopleural punctures deep, more than one diameter apart in the center, less than one diameter at the top; punctures confluent posteriorly, forming posterior carinate margin (Fig. 2). Metapleuron shiny, with some punctures at the top. Propodeum coarsely sculptured, except the zone anterior to spiracular groove which is smooth and shiny; enclosure

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Figs. 1-3—*Harpactus alvaroi* sp.n.: (1) Head in front view (female); (2) Mesopleuron; (3) Antenna (male).

Figs. 5-7—*Harpactus tumidus* (Panzer): (5) Head in front view (female); (6) Mesopleuron; (7) Antenna (male)



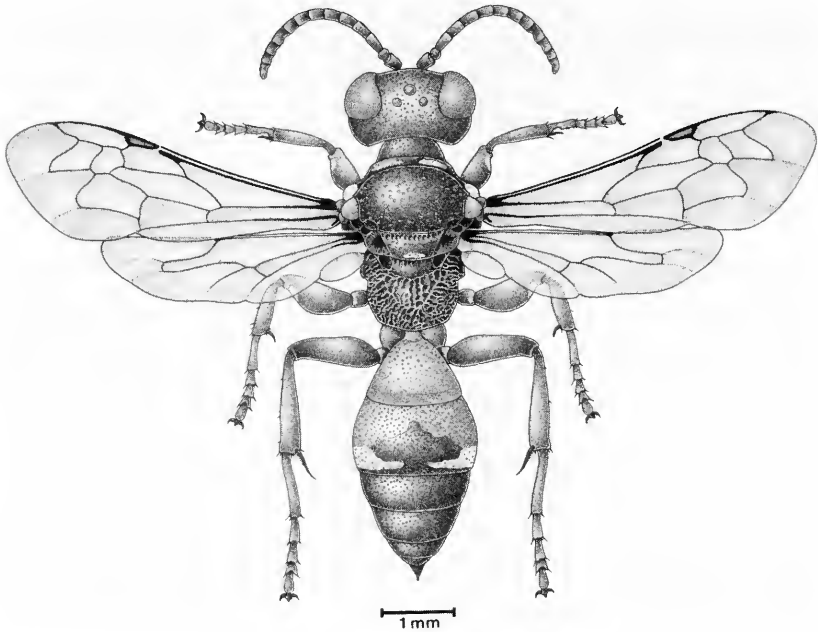


Fig. 4—*Harpactus alvaroi* sp.n., male nototype.

irregularly, longitudinally carinate; surface outside enclosure with oblique carinae; posterior face with transverse carinae arising from median carina. Tergal punctures finer than those on thorax; punctures of tergum II more than one diameter apart mesally, less than one diameter apart laterally; punctures of other terga more than one diameter apart except near apical margin of terga III-V where they are compressed against each other.

**Vestiture.** Setae silvery, appressed on clypeus (except apicomesally) and along inner orbits; erect, scattered on interocellar area. Other body setae inconspicuous, not concealing integument, which is easily visible.

**Length:** 6-7 mm. (Fig. 4).

**Coloring—**Body: black, except the following which are ivory-white: labrum, clypeus (except black basomedially), and bands along ventral 2/3 of inner orbits; pronotal lobes; pronotal collar (band complete or mesally interrupted); posterior spot on scutellum; coxae I-II more or less spotted; one small apical spot on posterior face of femora I-II; large patches (nearly meeting each other mesally) on gastral tergum II. The following are reddish: mandibles mesally; two small spots behind vertex, adjacent to orbit, one behind each eye; antennal flagellum ventrally; anterior face of tibiae I-II; tarsi I-II; longitudinal patches on inner surface at apex of femora I-II and large longitudinal patch on femur III; gastral terga and sterna I-II.

**Female:** Clypeal free margin more prominent (Fig. 1) than in the male. Pygidial plate subtriangular, laterally carinate, with larger punctures on an area of micropunctuation. One ivory-white spot on tergum V (largely reduced in some specimens).

**Male:** Flagellomeres VIII-XI with notches (Fig. 3). In one male examined there was one ivory-white patch on each posterior corner of tergum I. Anterior margin of tergum and ster-

num II black (only tergum I and sternum I red in one specimen).

**Name derivation:** This species is dedicated to my son Alvaro.

**Habitat:** The specimens were collected in sandy areas.

**Material examined:** Holotype: ♂, SPAIN: Salamanca Province: Béjar, 8-VIII-1978, S. F. Gayubo leg.

**Paratypes**—Alicante Province: Tibi, 21-VII-1988, 1♀ (S. F. Gayubo leg). Avila Province: Candeleda, 21-IX-1989, 1♂ (J. J. Pedrero leg). Cáceres Province: Gargantilla, 21-VII-1978, 1♀ (S. F. Gayubo leg); Madrigal de la Vera, 21-IX-1989, 1♂, 4♀ (J. J. Pedrero leg); Piornal, 18-VIII-1988, 1♀ (F. Sanza leg). Salamanca Province: Sotoserrano, 31-VIII-1989, 1♀ (J. J. Pedrero leg). Soria Province: Alcubilla del Marqués, 16-VIII-1989, 2♀ (J. García leg); Almazán, 26-VII-1989, 1♀ (J. García leg); Zamora Province: Villardiegua de la Ribera, 3-IX-1989, 1♀ (C. Heras leg). Zaragoza Province: Pina de Ebro, 12-VIII-1990, 2♂; 28-VIII-1990, 2♀; 3-IX-1990, 1♀ (J. Blasco leg). All material is deposited in the Gayubo Collection, Universidad de Salamanca except a female in the California Academy of Sciences.

## DISCUSSION

There are some similar Palearctic species like *H. affinis* (Spinola), *H. elegans* Lepeletier, *H. exiguus* (Handlirsch), *H. lunatus* (Dahlbom), *H. mundus* (de Beaumont) and *H. pyrrhobasis* (Morice), which can be distinguished from *H. alvaroi* n.sp. by their clypeal free margin being more or less concave, posterior margin of mesopleuron without carinae and different color pattern.

*H. consanguineus* Handlirsch and *H. quadrisignatus* Palma have an obtuse emargination on clypeal free margin similar to that of *H. alvaroi* n.sp.; but in *H. consanguineus* Handlirsch the mesopleuron on posterior margin shows superficial carinae only on the upper part, and ill-defined punctuation on the rest of the mesopleuron; moreover, the gastral color pattern is different with a white band on the posterior margin of tergum III and a spot on tergum V; this color characteristic of having white markings on the gaster is important in grouping related species (Bohart, 1980). In *H. quadrisignatus* Palma the sculpture of all the body is very different from that of the new species.

Finally, it must be noted that the specimens of *H. alvaroi* n.sp. could easily be confused with those specimens of *H. tumidus* (Panzer) from the Iberian Peninsula, which have coarser sculpture (the punctuation on the whole body and well-defined propodeal carinae) than those from central Europe. Both species differ particularly in the clypeal free margin, and sculpture of mesopleuron (compare Figs. 1 and 5; 2 and 6), and the presence of a small apical spot on the posterior face of femora I-II in the new species and not in *H. tumidus* (Panzer). In addition, notches of male flagellomeres VIII-XI are shallower in *H. alvaroi* n.sp. than in *H. tumidus* (Panzer) (compare Figs. 3 and 7)

## ACKNOWLEDGMENTS

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## NEW RECORDS OF MAYFLIES (EPHEMEROPTERA) FROM NOVA SCOTIA AND NEW BRUNSWICK, CANADA<sup>1</sup>

Eric R. Whiting<sup>2</sup>

**ABSTRACT:** Collections of mayflies (Ephemeroptera) from Nova Scotia and New Brunswick, Canada in 1988 and 1989 yielded 38 species, all but four of which were identified from adult males. Twelve of these species are reported from the area for the first time; nine additional species were previously reported only in technical reports by the Canadian Department of Fisheries and Oceans. The majority of these mayfly species are widely distributed in eastern North America. Only three appear to be restricted to the northeast, and six are transcontinental in distribution.

The mayfly fauna of the provinces of Nova Scotia and New Brunswick, Canada is poorly known. The majority of species recorded from this area are from taxa which can be identified as larvae, particularly the family Ephemerellidae and the genus *Stenonema* (Allen and Edmunds 1961, 1962a, 1962b, 1963a, 1963b, 1965, Lewis 1974, Bednarik and McCafferty 1979, Peterson *et al.* 1985). The most thorough study of mayflies in these provinces was restricted to four drainage basins in southern Nova Scotia and two in southwestern New Brunswick (Peterson and Martin-Robichaud 1986, Peterson 1989).

I collected mayfly adults and larvae from Nova Scotia and southern New Brunswick in 1988 and 1989 (Fig. 1). Collections were made from July 15 to August 31, 1988, and from May 12 to July 24, 1989.

Adult mayflies were obtained by netting specimens from swarms, by examining streamside vegetation and spider webs, and by rearing field-collected larvae in the laboratory. Larvae were reared individually in cylindrical mesh cages (25 cm long by 5 cm diameter) made of nylon window screening. Cages were placed partially submersed in 25 l aquaria containing dechlorinated tap water. Aquaria were aerated continuously, and exposed to a photoperiod of 16 hours light and 8 hours darkness. Each cage had a removable top for extracting the reared adult.

Adult mayflies were identified using the keys and descriptions in Traver (1935), Burks (1953), Allen and Edmunds (1961, 1962b, 1963a, 1963b, 1965; Ephemerellidae), McCafferty (1975; Ephemeridae), Bednarik and McCafferty (1979; *Stenonema*) and Kondratieff and Voshell (1981; *Siphonurus barbaroides* McDunnough). Generic and species con-

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cepts within the Baetidae follow McCafferty and Waltz (1990).

It was not always possible to distinguish adults of *Ephemerella rotunda* Morgan and *E. subvaria* McDunnough. Of the thirty adult *Ephemerella* collected, some clearly fit the descriptions of either of these two species. However, the majority of specimens were intermediate in form. Larval exuviae associated with adult males all appeared to be *E. subvaria*. This suggests that the adults collected represent previously undescribed variations in *E. subvaria*, and that adults of this species and *E. rotunda* cannot be separated using existing keys and diagnoses. However, it is also possible that the intermediate specimens are hybrids between *E. subvaria* and *E. rotunda*. The resolution of this problem requires more specimens (adults with associated larval exuviae) from a broader geographic area.

A few species were identified from larvae alone. Larvae of *Anthopotamus* and *Baetisca* were identified using Bae and McCafferty (1991) and Pescador and Berner (1981), respectively. Larvae of *Heptagenia* were identified by comparison with specimens in the author's collection. As

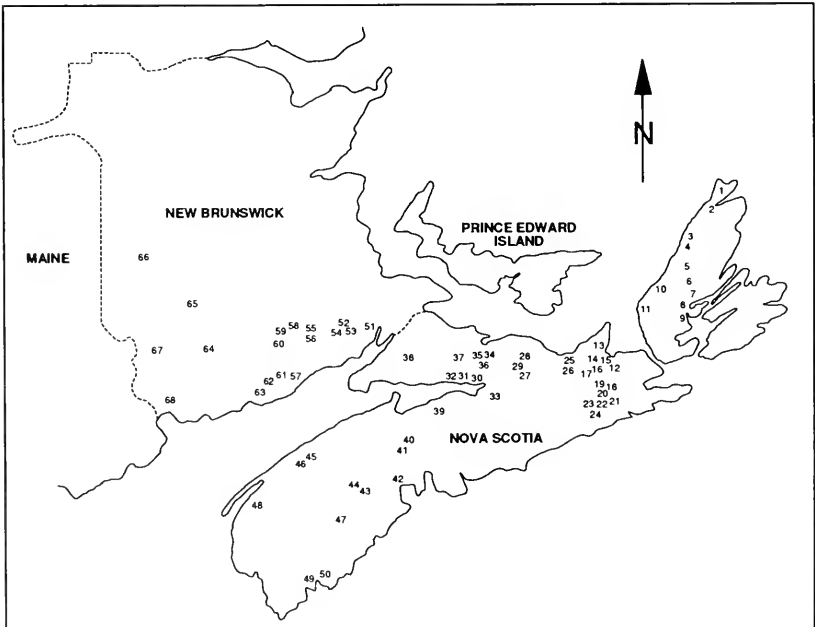


Figure 1. Sites in Nova Scotia and New Brunswick from which mayfly adults were collected or reared. Site locations are described in the Appendix.

only one species of *Arthroplea* is known from North America, the larvae collected are assumed to be *A. bipunctata* McDunnough.

A total of 330 adult males were identified to species (Table 1). These adult males represented thirty-four species in seven families. Four additional species, representing two additional families, were identified from larvae alone.

Twelve species are recorded from the Maritime Provinces for the first time. Nine additional species have been previously reported only in technical reports by the Canadian Department of Fisheries and Oceans (Peterson and Martin-Robichaud 1986, Peterson 1989). Two of these species (*Paraleptophlebia adoptiva* (McDunnough) and *P. volitans* (McDunnough) were previously identified only from larvae. Four species previously known from only one of the Maritime Provinces are now recorded from both Nova Scotia and New Brunswick. *Procloeon rufostrigatum* (McDunnough) and *Eurylophella temporalis* (McDunnough) are recorded from Nova Scotia for the first time. *Leptophlebia cupida* (Say) and *Siphonurus alternatus* (Say) are reported from New Brunswick for the first time.

Four species collected in this study are very widely distributed in North America (Table 1). Two additional species appear to have disjunct distributions, with separate populations in the east and west. *Procloeon venosum* has been reported from the southwestern United States (McCafferty and Waltz 1990), northern Quebec (Harper 1989) and now Nova Scotia. *Cinygmula subaequalis* is widely distributed in eastern North America and has also been reported from Alaska (McCafferty 1985).

Eighteen or nineteen species collected in this study occur throughout eastern Canada and the eastern United States (regions defined as in Edmunds *et al.* 1976), at least as far south as North Carolina. The ranges of eleven of these species extend westward into central regions of Canada and/or the U.S. Nine additional species also occur in eastern and central regions of Canada and the U.S., but are absent from the southeastern U.S. Seven of the preceding twenty species reported to occur in central North America have ranges that extend northwest into the MacKenzie River drainage in the Northwest Territories (Cobb and Flannagan 1980); two of these have also been reported from the Yukon (McCafferty 1985). Only three of the species collected in this study appear to be restricted to the northeast (northeastern U.S. and eastern Canada). The mayfly fauna of Nova Scotia and New Brunswick thus appears to be dominated by species which are generally and widely distributed in eastern and central North America. Only one species of mayfly, *Siphonurus demarayi* Kondratieff and Voshell, is known only from the study area. No adults of *S. demarayi* were collected during this study.

The collection sites presented in Table 1 do not represent the entire range within the study area for most species. Because adult mayflies have short lifespans and many species are difficult to rear from larvae, adults were not obtained from all sites at which a species occurred.

This study brings the total number of mayfly species reported from Nova Scotia and New Brunswick to about 80. There are probably additional species present, especially among the Baetidae. *Siphonisca aerodromia* Needham is also likely to occur in the area, as it has been reported from Maine, New York and Labrador (Burian and Gibbs 1988).

Table 1. Mayflies collected in Nova Scotia and southern New Brunswick. Collection sites are shown in Figure 1.

	Sites <sup>†</sup>	N.A. Distribution
<b>Siphonuridae</b>		
<i>Siphonurus alternatus</i> (Say)	44	northeastern & central
** <i>Siphonurus barbaroides</i> McDunnough	6,17,23,27,55,59	northeastern
<b>Metretopodidae</b>		
** <i>Siphloplecton basale</i> (Walker)	64,66	eastern & central
<b>Baetidae</b>		
* <i>Acerpenna pygmaea</i> (Hagen)	16	eastern & central
* <i>Baetis flavistriga</i> McDunnough	14,15	eastern & central
<i>Baetis tricaudatus</i> Dodds	8,12	widespread
** <i>Callibaetis ferrugineus</i> (Walsh)	28	northeastern & central
** <i>Procloeon venosum</i> (Traver)	12,14,31	eastern & southwestern
** <i>Procloeon rubropictum</i> (McDunnough)	18	northeastern
<i>Procloeon rufostrigatum</i> (McDunnough)	22	northeastern & central
<b>Heptageniidae</b>		
* <sup>N</sup> <i>Arthroplea bipunctata</i> McDunnough	21,56,64	northeastern & central
* <i>Cinygmula subaequalis</i> (Banks)	2,27,36,51,55,58	eastern & Alaska
** <i>Epeorus pleuralis</i> (Banks)	6,10,12,19,27,29, 31,32,34,37,38,39,54,55,58	eastern
** <sup>N</sup> <i>Heptagenia pulla</i> (Clemens)	37	northeastern & central
* <i>Leucrocota hebe</i> (McDunnough)	4,31,47	northeastern & central
** <i>Nixe inconspicua</i> (McDunnough)	13	northeastern & central
** <i>Rhiithrogena impersonata</i> (McDunnough)	1,6,19,27,55	northeastern & central
** <i>Rhiithrogena jejuna</i> Eaton	23,27,35,38,64	northeastern & central
* <i>Stenacron interpunctatum</i> (Walker)	13,20,24,49	eastern & central
<i>Stenonema femoratum</i> (Say)	20,63	eastern & central
<i>Stenonema modestum</i> (Banks)	21,40,42,48,50	eastern
<i>Stenonema vicarium</i> (Walker)	23,33,57,60,65,68	eastern & central
<b>Leptophlebiidae</b>		
<i>Leptophlebia cupida</i> (Say)	28,52,56,57	widespread
* <i>Paraleptophlebia adoptiva</i> (McDunnough)	19,25,29,52,54,57, 59,61	eastern & central
* <i>Paraleptophlebia mollis</i> (Eaton)	14,15,16,22,30,33, 45,51	eastern
* <i>Paraleptophlebia strigula</i> (McDunnough)	13	northeastern
* <i>Paraleptophlebia volitans</i> (McDunnough)	22	eastern

**EphemereIIDae**

<i>Attenella margarita</i> (Needham)	14	widespread
<i>Drunella cornuta</i> (Morgan)	3,7,26	eastern
<i>Ephemerella dorothea</i> Needham	46	eastern & central
<i>Ephemerella rotunda</i> Morgan/ <i>subvaria</i> McDunnough	5,9,11,12,23,25, 35,38,53,59,61,66	eastern/ northeastern
<i>Eurylophella bicolor</i> (Clemens)	20,59	eastern & central
<i>Eurylophella temporalis</i> (McDunnough)	21,43	eastern & central
<i>Serratella deficiens</i> (Morgan)	4,14	eastern

**Baetiscidae**

<sup>N</sup> <i>Baetisca laurentia</i> McDunnough	41,67	eastern & central
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**Potamanthidae**

** <sup>N</sup> <i>Anthopotamus distinctus</i> (Traver)	62	eastern
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**Ephemeridae**

** <i>Ephemera simulans</i> Walker	20	widespread
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<sup>t</sup> — sites 1-50 are in Nova Scotia; sites 51-68 are in New Brunswick

\*\* — new record for the area Nova Scotia and New Brunswick

\* — previously reported from Nova Scotia and New Brunswick only in reports by Peterson and Martin-Robicaud (1986) and Peterson (1989).

<sup>N</sup> — identified from larvae only

**Appendix.** Collection sites in Nova Scotia and southern New Brunswick. Sites are numbered from northeast to southwest.

**NOVA SCOTIA****Victoria County**

- 1 Salmon River, 2 km E of Capstick
- 2 North Apsy River, 8 km SW of Cape North

**Inverness County**

- 3 Farm Brook at Cabot Trail, 6 km S of Cheticamp
- 4 stream at Cap Lemoine, at Cabot Trail
- 5 Margaree River Southwest at Hwy. 395, 5 km N of Scottsville
- 6 Mathieson Glen Brook at Hwy. 395, 3 km N of Scottsville
- 7 Mackay Brook at Hwy. 395, at south end of Lake Ainslie
- 8 River Denys at Hwy. 105, at Blues Mills
- 9 River Denys at River Denys
- 10 Broad Cove River at Hwy. 19, 8 km NE of Mabou
- 11 Southwest Mabou River at Hwy. 19, 8 km SW of Mabou

**Antigonish County**

- 12 South River, 2 km W of St. Andrews
- 13 Wright's River at Hwy. 245, 12 km NW of Antigonish
- 14 Wright's River at Antigonish
- 15 West River at Antigonish
- 16 West River at West River Road, 5 km W of Antigonish
- 17 James River, at West River Road, 13 km SW of Antigonish
- 18 Copper Lake
- 19 McNab Brook at West Lochabor Lake Road
- 20 Lochabor Lake at West Lochabor

**Guysborough County**

- 21 Goshen Lake



- 22 North River, St. Mary's, 2 km S of Lochabor Lake
- 23 East River, St. Mary's at Hwy. 347, 1 km. S of New Town
- 24 West Branch, St. Mary's, 2 km W of Glenelg

**Pictou County**

- 25 Barney's River at Avondale
- 26 Fall Brook, 2 km S of McPherson's Mills

**Colchester County**

- 27 Salmon River at Kempton
- 28 Earltown Lake, 2 km SE of Earltown
- 29 Waughs River at Hwy. 311, 1 km S of Earltown
- 30 Debert River at Hwy. 104, 1 km E of Glenholme
- 31 Great Village River at Hwy. 2, at Great Village
- 32 Bass River, 5 km N of Bass River
- 33 Stewiacke River at Middle Stewiacke

**Cumberland County**

- 34 Wallace River, East Branch, at Hwy. 246, 3 km E of Wentworth
- 35 Wallace River at Hwy. 104, at Wentworth Provincial Park
- 36 Smith's Brook at Hwy. 104, 7 km S of Wentworth
- 37 Portapique River, 9 km NW of Sutherland Lake
- 38 Maccan River at Mapleton

**Hants County**

- 39 Little Nine Mile River at Hwy. 14, at Roulston Corner

**Lunenburg County**

- 40 stream, flowing into South Canoe Lake, 9 km SW of Vaughn
- 41 Gold River at New Ross
- 42 Middle River, 10 km NNW of Chester
- 43 New Germany Lake at New Germany

**Annapolis County**

- 44 pond, 1 km N of Springfield
- 45 Leonard Brook at Hwy. 1, 1 km NE of Paradise
- 46 Round Hill River at Hwy. 201, at Round Hill

**Queen's County**

- 47 Medway River at Hwy. 208, at South Brookfield

**Digby County**

- 48 stream flowing into Partridge Island Lake, at Hwy. 340

**Shelbourne County**

- 49 Ogden's Creek at Hwy. 103, 4 km E of Jordan Falls
- 50 Jordan River at Hwy. 103, at Jordan Falls

**NEW BRUNSWICK****Westmoreland County**

- 52 Pollett River at Hwy. 905, at Pollett River

**Albert County**

- 51 Turtle Creek at Rosevale, 18 km SW of Hillsborough
- 53 Little River at Hwy. 895, at Parkindale
- 54 Pollett River at Hwy. 895, 2 km N of Elgin

**King's County**

- 55 Kennebecasis River, South Branch, at Hwy. 114
- 56 pond at Hwy. 114, 2 km E of Hwy. 2 junction
- 57 Anderson Brook, 3 km S of Walton's Lake
- 58 Windgap Brook, 5 km NW of Newtown
- 59 Millstream River, 7 km N of Berwick

- 60 Trout Creek at Hwy. 111, at Sussex Corner  
 61 Hammond River at Hwy. 111, 1 km E of Hillsdale  
 62 Hammond River at Hwy. 120, 6 km SE of Upham  
**St. John's**  
 63 Loch Lomond at Loch Lomond  
**Sunbury County**  
 64 Oromocto River at Hwy. 101, 10 km SSE of Fredricton Junction  
**York County**  
 65 Nashwaak River at Hwy. 620  
 67 Magaguadavic River at Brockway  
**Carleton County**  
 66 Clearwater Stream at Hwy. 107, 5 km SW of Juniper  
**Charlotte County**  
 68 Digdeguash River at Hwy. 770, at Rolling Dam

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## ESTABLISHMENT OF *RHINOCYLLUS CONICUS* (COLEOPTERA: CURCULIONIDAE) ON MUSK THISTLE IN TENNESSEE<sup>1</sup>

Paris L. Lambdin, Jerome F. Grant<sup>2</sup>

**ABSTRACT:** The head weevil, *Rhinocyllus conicus*, was reintroduced into Tennessee in 1989 and released at 11 sites along the interstate highway system in eastern and middle Tennessee for control of musk thistle, *Carduus thoermeri*. One new release site was added in 1990. In 1991 and 1992, weevils were released at more than 60 sites in 13 additional counties each year. Head weevils are now well-established at the five oldest release sites. By 1991, 48 to 97% of the musk thistle at these sites were infested with these plant-feeding weevils. These high numbers may be the result of surviving progeny from three limited releases made in 1975.

Musk thistle, *Carduus thoermeri* Weinmann, was introduced into the United States from Europe more than 100 years ago (Rees 1982). Thistles compete with desirable grasses on thousands of hectares of pastures, and hinder the maintenance of roadways (Lambdin and Grant 1989). Musk thistle, which grows in many areas that are inaccessible and uneconomical for herbicide use, is a problem in many states and affects agricultural production (Grant *et. al.* 1990). Current mechanical and chemical management of musk thistle results in a substantial annual expenditure of time, labor, and money. In contrast, thistle-feeding weevil species have been released and established in several states including Maryland and Virginia, where they are estimated to save taxpayers ca. one million dollars annually (L. Kok and J. Tate, personal communication). Few native arthropod species have been found to cause serious damage to the reproductive capabilities of musk thistle in Tennessee (Powell *et al.* 1992), which supports the need to release the head weevil, *Rhinocyllus conicus*, Froelich (Coleoptera: Curculionidae), against infestations of musk thistle.

In 1975, 500 *R. conicus* adults were released at each of three sites in eastern Tennessee and one site in middle Tennessee (unpublished data). However, less than two dozen adults were recovered the following spring and no additional follow-up studies were made. The University of Tennessee Agricultural Experiment Station and the Tennessee Department of Transportation (TDOT) initiated a research program in 1989 directed at the management of musk thistle using plant-feeding insects. The ini-

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tial objective of this research was the introduction, release and establishment of an introduced plant-feeding weevil, *R. conicus*, in eastern and middle Tennessee.

## MATERIALS AND METHODS

**Release Areas:** In 1989 and 1990, adult head weevils were obtained from Dr. Loke Kok (VPI & SU) and released ( $n = 300\text{-}400/\text{site}$ ) at thistle-infested sites in 11 counties in eastern and middle Tennessee (Fig. 1). These initial release sites were located along the interstate highway system (e.g., I-24, I-40, I-75, and I-81).

In 1991 and 1992, adult head weevils were collected from field insectaries established in 1989 in eastern Tennessee and released ( $n = 75\text{-}100/\text{site}$ ) at ca. 60 sites in 13 additional counties each year (Fig. 1). Release sites in 1991 and 1992 were located along selected highways and on private property (e.g., farms and nurseries). All release sites during each year were selected in cooperation with Tennessee Department of Transportation and the University of Tennessee Agricultural Extension Service.

Prior to releases in the field each year, weevils were collected, placed into cardboard containers (9.5 cm x 9.0 cm) with a moistened paper towel and foliage of musk thistle, and placed into an ice chest until their release

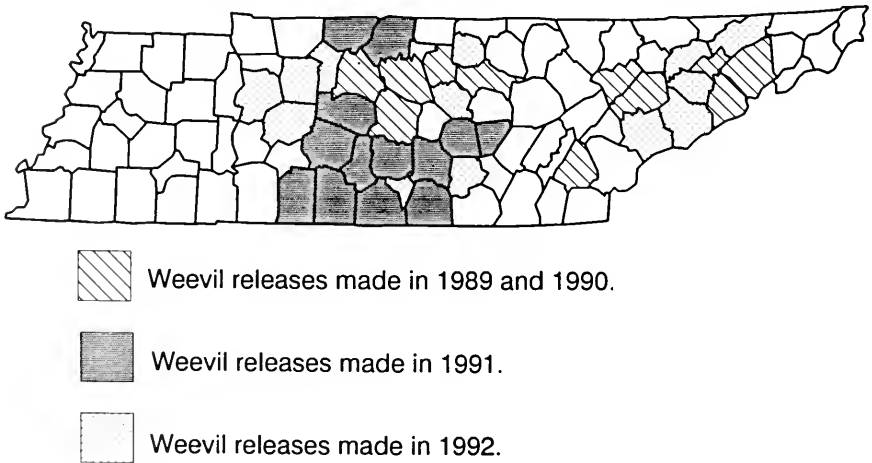


Figure 1. Locations of releases of *Rhinocyllus conicus* into counties in eastern and middle Tennessee, 1989-1992.

in the field. Weevils were released by opening the lid of the container and gently shaking the adult weevils onto developing buds of musk thistle at each site.

**Monitoring Procedures:** Each of the 1989 release sites was monitored twice monthly, and will continue to be monitored throughout the duration of this 6-year program. Plants were examined for the presence of head weevil adults and/or eggs (Fig. 2a and 2b, respectively). Infestation of musk thistle by the head weevil was easily determined by examining the undersurface of a bud or flower for eggs. The eggs are covered with masticated plant material and appear "wart-like" (Roberts and Kok 1979). The 1990, 1991 and 1992 release sites will be monitored in 2 to 5 years to evaluate weevil establishment at those sites.

## RESULTS AND DISCUSSION

From 1989 to 1992, adult *R. conicus* were released at 132 selected sites along roadways and in pastures in 37 counties in eastern and middle Tennessee (Fig. 1). Weevil releases were concentrated in these two areas of the state because of abundant populations of musk thistle; this weed is rare in western Tennessee. As musk thistle spreads to other areas of the state, especially in western Tennessee, the weevils should move into these localized areas.

Progeny of head weevils released in 1989 and 1990 are well-established at the 1989 release sites. Although thistle density remained high by late spring in 1991 [6.4 (0.5-22) plants/m<sup>2</sup>], 48 to 97% of the plants at the five most densely populated research sites were infested with eggs of these plant-feeding weevils (Fig. 3). Highest numbers of adults and eggs/plant were found at release sites in eastern Tennessee (sites 4, 5, and 7), possibly due to surviving weevil progeny from the 1975 releases. At several sites, 10 to 30 eggs per bud were observed (unpublished data). Upon dissection of these infested buds in mid-June, well developed larvae were found. Also, larvae were found within the stem about 2.5 to 5.0 cm below the bud. An infestation level of 10 to 15 larvae per bud can prevent seed production (Roberts and Kok 1979).

Populations of the head weevil are currently maintained at several field reservoir sites in eastern Tennessee. Individuals will be collected from these reservoir sites annually and transferred to other areas of the state until weevils are released and established in all thistle-infested counties in Tennessee. Infestations of weevils are expected to increase annually. About 5 years after release and establishment, population densities of *R. conicus* should increase substantially and reduce seed production and plant density (Kok and Pienkowski 1985, Surlles and Kok 1976).



Figure 2. *Rhinocyllus conicus*: a) adult and b) eggs on underside of musk thistle bracts indicated by arrows.

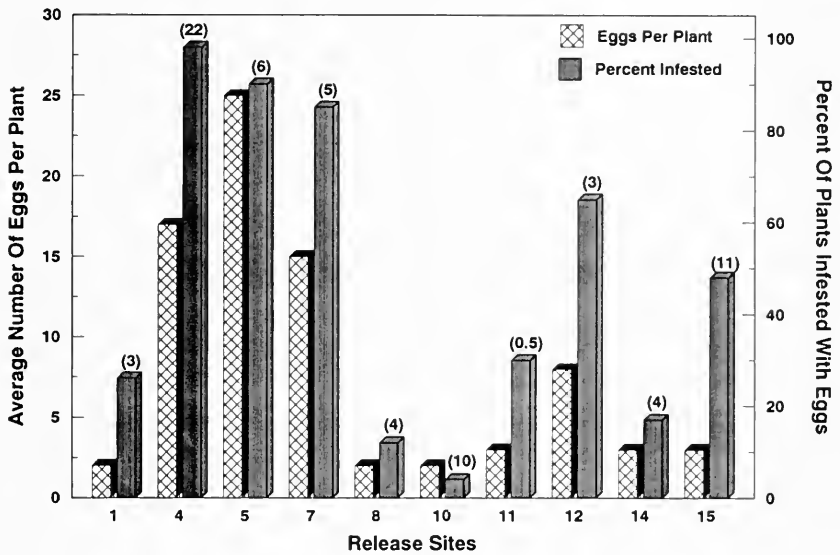


Figure 3. Densities of eggs of *Rhinocyllus conicus* and musk thistle at selected sites in eastern and middle Tennessee, 1991. Numbers in parentheses above bars represent density of musk thistle, (plants/m<sup>2</sup>).

As fewer seeds are available for dispersal and fewer plants are present and visible, highway maintenance personnel and farmers can utilize their time and budget for other concerns.

The goal of this project is to reduce musk thistle infestations across the state to non-pest levels by incorporating the use of the biological control agent *R. conicus*. This management program should lead to a reduction in musk thistle populations and reduce the cost of thistle control. In addition, biological control offers an alternative means of pest suppression that is environmentally safe, compatible with other control tactics and provides a self-perpetuating, sustainable control system.

#### ACKNOWLEDGMENTS

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## NEW AND ADDITIONAL RECORDS OF SMALL MINNOW MAYFLIES (EPHEMEROPTERA: BAETIDAE) FROM TEXAS<sup>1,2</sup>

W. P. McCafferty<sup>3</sup>, Jack R. Davis<sup>4</sup>

**ABSTRACT:** Eleven genera and 31 species of mayflies of the family Baetidae are reported from 32 counties in the state of Texas. Twenty-six species among the genera *Acentrella*, *Acerpenna*, *Apobaetis*, *Baetis*, *Centropilum*, *Falliceon*, *Paracloeodes*, and *Procloeon* represent new state records. Other Texas genera include *Baetodes*, *Callibaetis*, and *Camelobaetidius*. Annotations to the species list presented indicate that the baetid fauna of Texas is made up of widespread continental (three species), elements of the southwestern United States and/or Mexico (10 species), elements of the central and/or eastern United States and Canada (10 species), and elements that are endemic or unresolved (eight species).

New data on the Baetidae of Texas, as presented below, are based on extensive collections made in 1977 by the first author and others associated with the Laboratory of Aquatic Entomology at Purdue University, miscellaneous Texas samples present in the Purdue Entomological Research Collection (PERC), and material taken by the second author and others associated with stream surveys conducted by the Texas Water Commission or privately since 1976. The latter are held in the private collection of the second author (JRD). Samples were variously acquired by benthic, aquatic-drift, aerial-net, and black-light sampling techniques. Some of the larval material was reared to adults for stage correlation.

Prior to this report, Texas records of only five species of the family baetidae have been published, quite remarkable considering the size of Texas and the emphasis placed on benthic macroinvertebrates in relation to water quality assessment during the past 25 years. We present new state records for 26 species of Baetidae, in addition to presenting additional records for the five previous reported species. Twenty-three of the species are nominal; others represent distinctive populations, sometimes from several locales, but for one reason or another (as explained in the annotations), they are not given formal names at this time. Three new species not reported herein, in addition to a new subspecies and a pre-

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viously unknown adult stage of a nominal species, are being described elsewhere by the first author and A. V. Provonsha. Even with the considerable additions presented below, only 32 of the 254 Texas counties are represented in our samples. We expect many more additions forthcoming, especially if larvae can be reared to adults for proper association. This will be particularly important for the application of appropriate specific names in genera such as *Centroptilum* and *Procloeon*.

Species representing new state records are asterisked in the following annotations, and depositions of cited material examined are indicated as PERC or JRD.

### ANNOTATIONS

#### *\*Acentrella ampla* Traver

**New Records.** JRD: Brewster Co., Rio Grande at Santa Elena Canyon, III-24-1976, J. R. Davis (larvae).

**Remarks.** This species was previously known only from the mid-western and southeastern United States (Moriyama and McCafferty 1979b).

#### *\*Acentrella carolina* (Banks)

**New Records.** JRD: Bastrop Co., Colorado R. at FM 969, near Utley, XII-11-1984, J. R. Davis (larvae); Presidio Co., Rio Grande, 13 mi downstream from Presidio, III-26-1976, J. R. Davis (larvae).

**Remarks.** The correct placement of these larvae remains somewhat tentative pending further study of cognates. It is possible that the Texas material will prove to be pale variants of *A. turbida* (McDunnough), which has not been described as larvae but which is currently being studied by the first author and R. D. Waltz.

#### *\*Acentrella insignificans* (McDunnough)

**New Records.** JRD: El Paso Co., Rio Grande at Hwy. 273, XII-27-1991, J. R. Davis (larvae).

**Remarks.** This is a broad ranging western species, and Texas represents the eastern limit of its known range. It is known from New Mexico, and its presence in the Rio Grande was to be expected.

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**\**Acerpenna pygmaea* (Hagen)**

**New Records.** PERC: Blanco Co., Blanco R. 6 mi W Blanco, V-6-1977, W. P. McCafferty, A. V. Provonsha, D. Morihara (adults). JRD: Austin Co., Mill Cr. at County Road, SW Bellville, VII-19-1988, S. Twidwell (larvae); Waller Co., Ponds Cr. at County Road off FM 1098, N Prairie View, VII-19-1988, S. Twidwell (larvae).

**Remarks.** Texas represents the westernmost record for this species; it had been reported from throughout the east as far west as Missouri (Morihara and McCafferty 1979b).

**\**Acerpenna* sp. 1**

**New Records.** PERC: Denton Co., Clear Cr., Hwy 2164, light trap, VI-30-1977, P. M. Grant (adults).

**Remarks.** This species agrees well the description of *A. harti* (from Illinois), but is much lighter and slightly larger. Only one male was available to us, and we have deferred naming a new species until more data are available.

**\**Apobaetis indepressus* Day**

**New Records.** JRD: Jackson Co., Arenosa Cr. at County Road off U. S. 59, 3.5 mi N Inez, IX-16-1988, S. Twidwell (larvae).

**Remarks.** This North American genus is thus far known from two described species: *A. indepressus* in the West and *A. etowah* (Traver) from Georgia. *Apobaetis indepressus* has been reported from Kansas and California, and the first author has seen specimens from Colorado. Although the Texas larvae agree with the previous description of *A. indepressus* by Day (1955), the larval stage of *A. etowah* is still unknown, and therefore the placement of the Texas larvae to species remains somewhat tentative. Since elements from the Southeast appear to influence the Texas baetid fauna to about the same extent as elements from the Southwest, it could well prove to be *A. etowah*.

**\**Baetis caelestis* Allen and Murvosh**

**New Records.** PERC: Culberson Co., stream in McKittrick Canyon, ca 2 mi W Info. Center, Guadalupe Mountains National Park, near Pine Springs, VII-18-1985, A. R. Brigham, J. L. Brower (larvae).

**Remarks.** This species was previously known from California, New Mexico, and the Baja Peninsula. With respect to the diagnosis of this species, the Texas material, unlike some other southwestern populations, has no robust setae on the edges of some gills. All gills, however, are clearly serrate.

**\**Baetis ephippiatus* Traver**

**New Records.** JRD: Dallas Co., Trinity R. at Continental Ave. in Dallas, VIII-25-1987, J. R. Davis (larvae); Gregg Co., Sabine R. above Longview WTP intake, X-21-1987, J. R. Davis (larvae); El Paso Co., Rio Grande at Hwy. 273, VII-14-1984, J. R. Davis (reared adult and larval exuviae).

**Remarks.** This is one of three species of the *propinquus* group of *Baetis* species that are reported here from Texas for the first time. It has previously been regarded as a southeastern species although it is also known from Indiana (Moriyara and McCafferty 1979b).

**\**Baetis flavistriga* McDunnough**

**New Records.** PERC: Austin Co., Brazos R. at Austin State Historical Park at light, V-9-1977, W. P. McCafferty, A. V. Provonsha, D. Moriyara (adults).

**Remarks.** Texas adults of this species fit the color variation originally described for *B. pallidulus* McDunnough. Bergman and Hilsenhoff (1978) synonymized the latter with *B. phoebus* McDunnough, and Moriyara and McCafferty (1979b) subsequently synonymized *B. phoebus* with *B. flavistriga*. This is one of the most common and widespread species in eastern North America; its most western record is from the Black Hills of South Dakota. Texas represents a significant southwestern extension of its known range, although it may prove to be rare in Texas because we have not as yet found larvae. The first author has previously discussed the distribution of this species (McCafferty 1990) and more recently has seen material from Colorado.

### *Baetis intercalaris* McDunnough

**New Records.** PERC: Bandera Co., Medina R., 4 mi N Medina at Texas Hwy. 16, V-6-1977, W. P. McCafferty, A. V. Provonsha, D. Morihara (larvae); Jasper Co., small stream at bridge on Farm Road 156, 10 mi SE Colmesneil, V-4-1977, W. P. McCafferty, A. V. Provonsha, D. Morihara (larvae); Walker Co., Cobb Cr., Hwy. 207, 10 mi E Huntsville, IV-20-1990, Baumann & Nelson (larvae). JRD: Freestone Co., Trinity R. at U. S. 79 near Oakwood, X-7-1987, J. R. Davis (larvae); Hays Co., Blanco R. at Hays County Road 295, VI-4-1985, J. R. Davis, (larvae); Henderson Co., Trinity R. near Trinidad, X-7-1987, VI-23-1988, J. R. Davis (larvae); Houston Co., Trinity R. at State Hwy. 7 near Crockett, VI-24-1988, X-13-1988, J. R. Davis (larvae).

**Remarks.** Texas represents a significant southwestern extension of the known range of this common and widespread eastern North American species. It is known as far west as Manitoba to the north. Texas larvae presently identifiable as *B. intercalaris* may eventually prove to be the closely related *B. ochris* Burks, for which the larval stage has not yet been described (R. D. Waltz, personal communication).

### \**Baetis longipalpus* Morihara and McCafferty

**New Records.** PERC: Austin Co., Brazos R. at Austin State Historical Park, overnight drift, V-10-1977, W. P. McCafferty, A. V. Provonsha, D. Morihara (larvae). JRD: Henderson Co., Trinity R. near Trinidad, VIII-27-1987, X-7-1987, VI-23-1988, J. R. Davis (larvae).

**Remarks.** This species was previously known from Indiana and Wisconsin (Morihara and McCafferty 1979a). Evidently, it may be common throughout the central United States.

### \**Baetis notos* Allen and Murvosh

**New Records.** PERC: Kendall Co., Block Cr. 5 mi NE Comfort, V-7-1977, W. P. McCafferty, A. V. Provonsha, D. Morihara (larvae).

**Remarks.** This species was previously known from Arizona and New Mexico [see *B. sp. C* of Morihara and McCafferty (1979b)].

### \**Baetis propinquus* (Walsh)

**New Records.** PERC: Austin Co., San Bernard R. at I-10, near Sealy, V-9-1977, W. P. McCafferty, A. V. Provonsha, D. Morihara (larvae and adults).

**Remarks.** This species is known from throughout eastern North America to Mississippi and Indiana. Its discovery in Texas extends its known range westward to a considerable extent.

**\**Baetis punctiventris* (McDunnough)**

New Records. PERC: Bandera Co., Medina R. 4 mi N Medina at Texas Hwy. 16, V-6-1977, W. P. McCafferty, A. V. Provonsha, D. Morihara (larvae); Kerr Co., Turtle Cr. at Texas Hwy. 16, V-6-1977, W. P. McCafferty, A. V. Provonsha, D. Morihara (larvae).

**Remarks.** This species is found throughout much of North America but had not been taken in the Southwest [see recent synonymies of this species in McCafferty and Waltz (1990)]. Larval cerci in this species show both the typical *punctiventris* pattern and the *myrsum* pattern (see Burks 1953).

**\**Baetis* sp. 1**

New Records. PERC: Kendall Co., Guadalupe R. 1 mi S Sisterdale at Ranch Road 1376, V-7-1977, W. P. McCafferty, A. V. Provonsha, D. Morihara (larvae).

**Remarks.** These larvae lack hindwingpads, and their rather pale and diffuse color pattern does not match any larvae that have been described variously under the names *Acentrella*, *Baetis*, or *Pseudocloeon*. Specific identification of these and some other *Baetis* larvae lacking hindwingpads in North America must be considered tentative until further research is conducted on species characteristics and larva-adult associations.

***Baetodes edmundsi* Koss**

Additional Records. PERC: Blanco Co. (Pedernales R.); Kendall Co. (Guadalupe R.); Kerr Co. (Guadalupe R.).

**Remarks.** This evidently is a common species in the southwestern United States. It was first reported from Texas (Uvalde Co.) by Edmunds (1950) as *Baetodes* sp. and has been taken several times since then. Some material attributed to this species, however, could possibly be *Baetodes inermis* (see remarks below).

**\**Baetodes inermis* Cohen and Allen**

New Records. PERC: Bandera Co., Medina R. 4 mi. N Medina at Tex. Hwy. 16, V-16-1977, W. P. McCafferty, A. V. Provonsha, D. Morihara (larvae); Blanco Co., Blanco R. 6 mi W Blanco, V-6-1977, W. P. McCafferty, A. V. Provonsha, (larvae); Kendall Co., Block Cr. 5 mi NE Comfort, V-7-1977, W. P. McCafferty, A. V. Provonsha, D. Morihara (larvae).

**Remarks.** This species was previously known only from Mexico (Cohen and Allen 1978). The Texas material matches previous descriptions of this species precisely except the pronotal tubercle can be difficult to detect because it appears more like a midposterior hump. The mesonotal tubercle is also poorly developed. If the Cohen and Allen (1978) key to larvae is relied on solely and followed exactly (i.e., at the geographic couplet 3 one chooses Texas vs Mexico), it would be possible to incorrectly key (force) this species to *B. edmundsi* since, according to those authors, only *B. edmundsi* and possibly *B. arizonensis* are to be expected in Texas. Actually, two additional, new species of *Baetodes* have been collected from the central hill country of Texas and are being described in a separate paper by McCafferty and Provonsha (in manuscript). We doubt that *B. arizonensis* will be found in Texas because it is thus far known only from mountainous regions in Arizona.

**\**Callibaetis californicus* Banks**

**New Records.** PERC: Blanco Co., Pedernales R. 1 mi N Johnson City at U. S. Hwy. 281, V-6-1977, W. P. McCafferty, A. V. Provonsha, D. Morihara (larvae); Rancho de Palmas, Nueces R., III-5-1936 (larvae).

**Remarks.** The discovery of this distinctive species in Texas suggests that it occurs across the Southwest, being previously recorded only from southern California.

**\**Callibaetis floridanus* Banks**

**New Records.** PERC: Austin Co., Brazos R. at Austin State Historical Park, in overnight drift sample, V-10-1977, W. P. McCafferty, A. V. Provonsha, D. Morihara (larvae); Hidalgo Co., Edinburg, 1935, Mulaik (larvae); Reagan Wells, XI-6-1936, J. G. Needham (larvae). JRD: Guadalupe Co., Geronimo Cr. off FM 20 near Seguin, IV-10-1990, D. Buzan, E. Hornig (larvae); Jasper Co., swamp adjacent to Sandy Cr. near Jasper, V-29-1985, M. G. Dick (larvae).

**Remarks.** The discovery of this species throughout much of Texas may indicate a broad distribution across the southeastern and south central states. It was previously known from Florida, although the senior author has also seen it from Arkansas, Kentucky, and southern Indiana. Berner and Pescador (1988) have discussed the biology, ecology, and variation in this relatively ubiquitous species in some detail. It develops in small streams and swampy habitats in Texas; and it has been reported from the everglades in Florida.



*Callibaetis montanus* Eaton

**Additional Records.** PERC: Hidalgo Co. (Weslaco); Victoria Co. (Guadalupe R.).

**Remarks.** This primarily Mexican and Central American species occurs in central and southern Texas. Traver (1935) first reported this species from Texas (Weslaco and Austin). She indicated one specimen from Weslaco at Cornell University; one of the specimens in PERC is from Weslaco but is accompanied by little other information. The considerable materials we have studied from Texas appear to represent a distinct geographic variant of this species and are being described elsewhere as a new subspecies by McCafferty and Provonsha (in manuscript).

*Callibaetis pictus* Eaton

**Additional records.** PERC: Blanco Co. (Pedernales R., spring at Pedernales Falls); Culberson Co. (McKittrick Canyon Cr.); El Paso Co. (Keystone Outlet Conduit); Kerr Co. (Robinson Cr., Turtle Cr.); Uvalde Co. (Rio Frio); Arroyo at U.S. 83. JRD: El Paso Co. (Rio Grande).

**Remarks.** This broad ranging western species occurs in several color variations in Texas, especially in the larval stage. Populations tend to be large and have not been found coexisting with other species of *Callibaetis*.

*\*Callibaetis pretiosus* Banks

**New Records.** JRD: Jasper Co., swamp adjacent Sandy Cr. near city limit of Jasper, IV-24-1985, M. G. Dick (larvae).

**Remarks.** East Texas may represent the westernmost limit of this strikingly patterned eastern species.

*Camelobaetidius mexicanus* (Traver and Edmunds)

**Additional Records.** PERC: Austin Co. (Brazos R.); Bandera Co. (Medina R.); Blanco Co. (Blanco R.); Kendall Co. (Block Cr., Guadalupe R.); Kerr Co. (Turtle Cr.); Presidio Co. (Rio Grande). JRD: Val Verde Co. (Devil's R., Rio Grande).

**Remarks.** This species is a common and widespread small minnow mayfly in Texas.

### \**Camelobaetidius* sp. 1

**New Records.** JRD: Brewster Co., Rio Grande at Santa Elena Canyon, IX-28-1977, J. R. Davis (larvae); Presidio Co., Rio Grande, 13 mi downstream from Presidio, VI-28-1977, J. R. Davis (larvae); Val Verde Co., Rio Grande at Foster Ranch near Langtry, V-2-1977 (larvae).

**Remarks.** This species is unlike any thus far known from North or Central America. Its spatulate claws possess 16-18 denticles and in this respect are most similar to those of some undescribed South American species and *C. cayumba* (Traver and Edmunds 1968), the latter of which is known only from Peru. We are not naming this species at this time because the material is somewhat immature and a larger series may be required to assess variability since McCafferty and Waltz (1990) noted that several specific synonyms may be required in this genus.

### \**Centroptilum* sp. 1

**New Records.** JRD: Dallas Co., Elm Fork Trinity R. near SH 356 in Dallas, X-6-1987, J. R. Davis (larvae); Guadalupe Co., Geronimo Cr. off FM 20 near Seguin, IV-10-1990, D. Buzan, E. Hornig (larvae).

**Remarks.** This species is most similar to *C. alamance* (Traver) and *C. triangulifer* (McDunnough) in overall structure and in lacking hindwings, but it is distinct from them in terms of abdominal color pattern.

### \**Centroptilum* sp. 2

**New Records.** PERC: Austin Co., San Bernard R. at I-10, near Sealy, V-9-1977, W. P. McCafferty, A. V. Provonsha, D. Morihara (larvae). JRD: Bosque Co., North Bosque R. at Hwy. 6, SW Iredell, IV-25-1978, D. Petrick (larvae); Bosque Co., North Bosque R. at Hwy 22 in Meridian, IV-25-1978, D. Petrick (larvae); Jackson Co., Arenosa Cr. at County Road off U. S. 59, 3.5 mi N Inez, IX-6-1988, S. Twidwell (larvae); McLennan Co., South Bosque R. at Hwy. 84 NE McGregor, IV-25-1978, D. Petrick (larvae).

**Remarks.** These *Centroptilum* larvae possess hindwingpads but cannot be matched to any described larvae. They are distinctive because of a dark brown transverse bar across the anterior portion of abdominal sternum 8 (absent in some immature specimens). The species does not appear to be a member of the genus *Procloeon*, to which most North American species originally described as *Centroptilum* have recently been moved (McCafferty and Waltz 1990).

### *Fallceon quilleri* (Dodds)

**Additional Records.** PERC: Bandera Co. (Sabinal R.); Blanco Co. (Pedernales R.); Brewster Co. (Big Bend National Park); Gonzales Co. (Gonzales); Kendall Co. (Guadalupe R., West Sister Cr.); Kerr Co. (Robinson Cr.); Williamson Co. (Brushy Cr.); Uvalde Co. (Rio Frio). JRD: Val Verde Co. (Rio Grande).

**Remarks.** This species is one of the most common small minnow mayflies in Texas and was first reported there by Morihara and McCafferty (1979b). We have seen numerous color variations of adults from the state, including some typical *leechi*, *endymion*, and *quilleri* variations, but at this time we are following the conservative classification that recognizes only one variable species (see McCafferty and Waltz 1990).

### *\*Paracloeodes minutus* (Daggy)

**New Records.** JRD: Austin Co., Mill Cr. at County Road, SE Bellville, VII-19-1988, S. Twidwell (larvae); Jackson Co., Arenosa Cr. at County Road off U. S. 59, 3.5 mi N Inez, IX-6-1988, S. Twidwell (larvae); Lipscomb Co., Wolf Cr. at FM 1454 E Lipscomb, VII-18-1990, S. Twidwell (larvae); Wheeler Co., Sweetwater Cr. at U. S. 83 N Wheeler, IX-9-1987, S. Twidwell (larvae).

**Remarks.** The larvae from Texas agree sufficiently with Daggy's (1945) original description of Minnesota larvae to consider them the same species. In particular, larvae possess the distinctive spot on abdominal tergum 2. The first author has seen this species from Illinois and Indiana. It has been reported from Kansas, and it probably occurs throughout central North America.

### *\*Procloeon* sp. 1

**New Records.** PERC: Blanco Co., Blanco R. 6 mi W Blanco, V-6-1977, W. P. McCafferty, A. V. Provonsha, D. Morihara (adults).

**Remarks.** This material consists entirely of numerous female adults that are striking because of their white and semi-hyaline bodies and the large black tracheal branching impressions covering much of the lateral and dorsal abdomen. The determination of female adults with hindwings as either *Centroptilum* or *Procloeon* remains somewhat tentative at this time.

**\**Procloeon* sp. 2**

**New Records.** JRD: Austin Co., Mill Cr. at County Road, SW Bellville, VII-19-1988, S. Twidwell (larvae).

**Remarks.** These larvae possess hindwingpads, and their gills are all single with no flaps. The species might be related to the eastern *P. album* (McDunnough).

**\**Procloeon* sp. 3**

**New Records.** JRD: Kinney Co., Pinto Cr. at U. S. 277 near Bracketville, VI-30-1990, S. Twidwell (larvae).

**Remarks.** These distinctive larvae possess hindwingpads in addition to small anterior gill flaps on gills 1 and 2 and a tiny anterior flap on gill 3.

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## NEW RECORDS FOR *AGAPANTHINUS CALLOPHILA* (HYMENOPTERA: ANTHOPHORIDAE), A BEE RARE IN COLLECTIONS<sup>1</sup>

Wallace E. LaBerge<sup>2</sup>,

**ABSTRACT:** The range of *Agapanthinus callophila* is extended several hundred miles and it is suggested that the bee is crepuscular.

The genus *Agapanthinus* was described by LaBerge (1957) to include one species, the female of which was described by T. D. A. Cockerell in 1923 as *Melissodes callophila* (the male was described in the same publication as *Melissodes idonea*). It was known at that time only by the two specimens described by Cockerell and collected from Isla San José, Baja California Sur in the Gulf of California. Two additional male specimens have been examined by this author. One male from south of Mulege, Baja California Sur was collected by J. R. Powers, May 20, 1975, and another male from Warm Sulphur Spring, Inyo County, California was collected by D. Q. Cavagnaro, May 6, 1961 (deposited in the collections of the University of California, Berkeley and the Los Angeles County Museum, respectively). These two specimens extend the known range of *A. callophila* almost 900 miles in a straight line to the north. It is unfortunate that in neither case do we have information concerning the flowers the bees were visiting when collected, nor do the type specimens bear this information.

In examining the two new specimens it was noted that the ocelli as well as the compound eyes of these males are considerably larger than normal for anthophorid bees. This was not emphasized in the original description of the genus, although the female compound eye is described as being twice as long as broad in profile. Other anthophorid bee females usually have compound eyes two and one-half times as long as broad in profile or more. Perhaps *A. callophila* is active collecting pollen in the early morning or late evening hours and can be found on flowers opening at one or both of these times, such as members of the Onagraceae. Thus far, this bee has been collected only in severe desert regions. It is hoped that our improved knowledge of the distribution and of the morphology of this very rare bee will aid collectors in locating and studying this interesting and beautiful native bee.

<sup>1</sup> Received June 1, 1992. Accepted August 26, 1992.

<sup>2</sup> Illinois Natural History Survey, Champaign, Illinois.

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**BOOK REVIEW**

**KILLER BEES: THE AFRICANIZED HONEY BEE IN THE AMERICAS.** Mark L. Winston. 1992. Harvard University Press. 162 pp. \$19.95.

The Africanized honey bee, labelled the "Killer Bee" due to several incidents where humans or animals died from multiple bee stings, has been the focus of much public and scientific attention since its accidental introduction into Brazil in 1956. There was not much known about the biology of this intrusive bee early after its initial spread. Not until Orley R. Taylor began a thorough study funded by the U. S. Department of Agriculture on

the biology and ecology of the Africanized honey bee in 1975 did scientists start to appreciate the significance of the defensive behavior and other unusual characteristics that make this bee more successful in the tropics compared to the European races. Mark Winston, one of Taylor's graduate students working on this project, has made a career of researching the Africanized honey bee and is thus a highly qualified source on this subject.

Winston's book is intellectually well done and is a delight to read. The book flows well and is logical in presentation. It should appeal to those with an interest in bees ranging from laypeople to experts in apiology. He shares many of his personal experiences starting with his first research assignment with Taylor in French Guiana. Much of the book centers around showing how the Africanized honey bee is well adapted for the tropics and compares its biology with the more gentle European honey bees which are better adapted for the temperate regions.

Winston documents how the media have overlooked many of the fascinating characteristics of the Africanized honey bee's biology and instead have focused on its trait of having numerous workers of the colony rush out to defend the nest in response to any kind of disturbance. He examines how several forms of the media have sensationalized and exaggerated the "killer bee" and its potential impact on humans. It is interesting how over the past 20 years the media have evolved through a number of phrases in headlines of articles and in movie titles to exploit human emotions associated with bees.

The most significant contribution of Winston's book is his coverage of the biology and ecology of the Africanized honey bee. He ties together research results on this topic into a very understandable story. Anyone who has an interest in this subject whether they have a good background in science or not will benefit from reading his book. It is helpful if one is already familiar with the European honey bee races because Winston does a nice job of relating them to the Africanized honey bee's life style.

Several other facets of interest about the Africanized honey bee brought out in Winston's book include: 1) stinging is mostly associated with defensive behavior, 2) Africanized honey bees produce a greater amount of alarm peromone odor than European races, 3) larger colonies are more defensive and consequently harder to prevent from swarming, 4) swarms (the purpose of which is movement of a portion of the colony or the whole colony to a new nest in response to reproducing a new colony or finding a more suitable habitat) are generally quite docile and seldom sting except for those in which the workers lack honey in their stomachs (dry swarm), and 5) absconding (due to a response to predators or a dearth of nectar or pollen) is a major problem in managing them for honey production.

The book includes other information on problems associated with managing the Africanized honey bees for honey production in the tropics and those anticipated for beekeepers as it moves further into the United States (It is now in Texas). This book will be valuable to those in the beekeeping industry to better understand the Africanized honey bee and its potential impact on beekeeping in all of the Americas.

Winston has not only done a suitable job of addressing the scientific and social issues associated with the Africanized honey bee, but has also nicely integrated science with practical management and public interest for honey bees in general.

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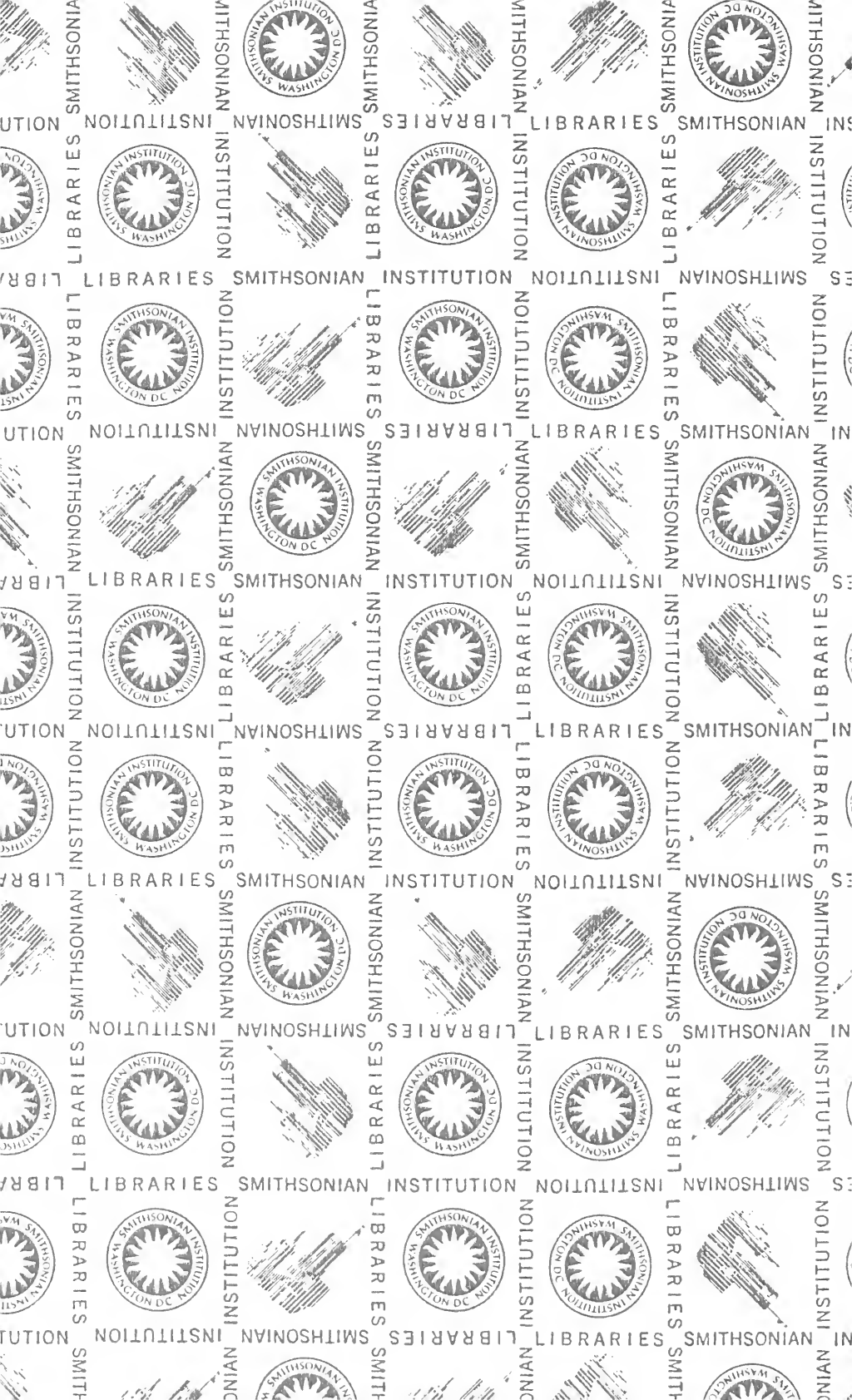


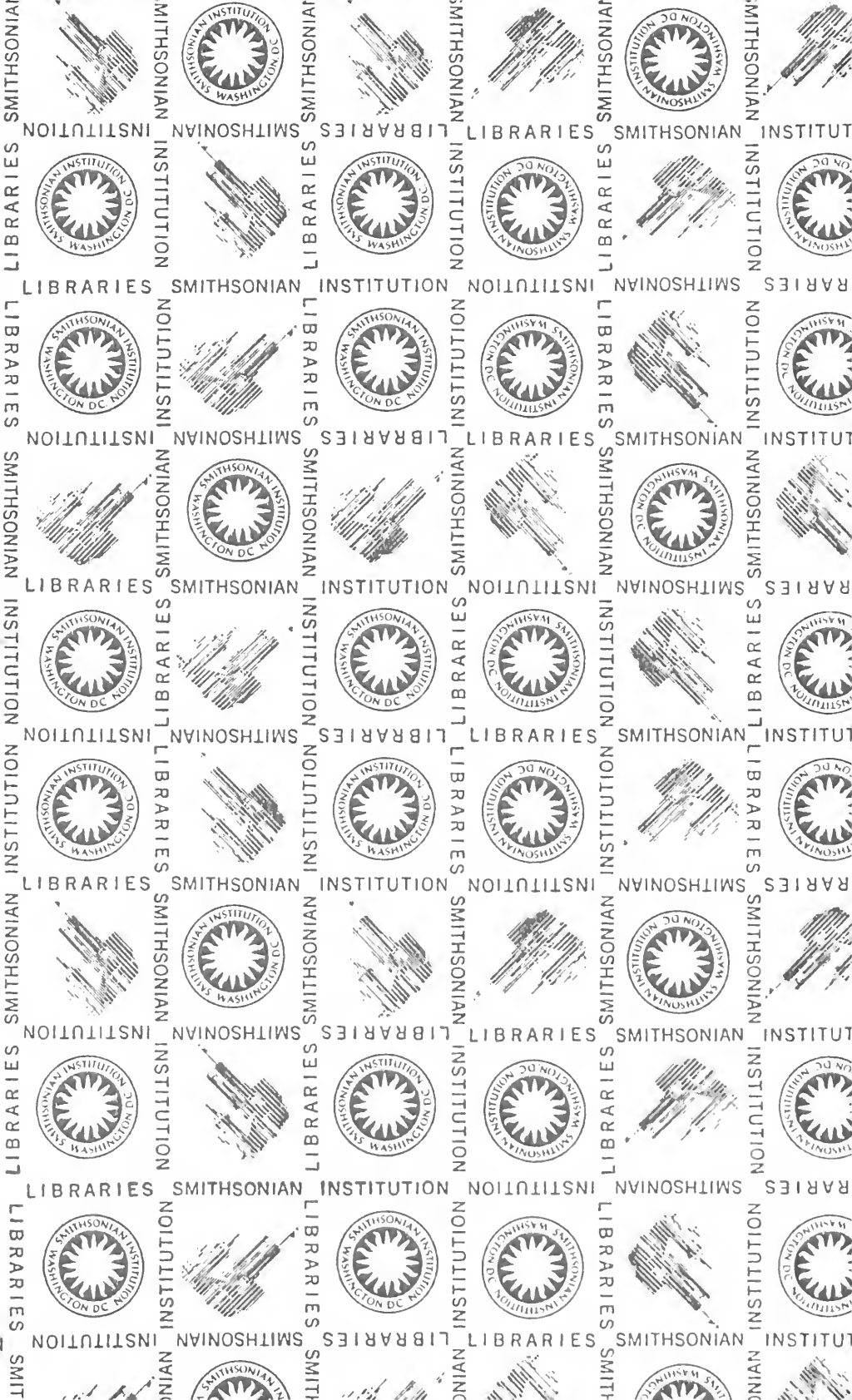












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