US ISSN 0013-872X
L. 112 JANUARY & FEBRUARY, 2001 NO. 1

ENTOMOLOGICAL NEWS

SCIENTIFIC NOTE:

THE AMERICAN ENTOMOLOGICAL SOCIETY

ENTOMOLOGICAL NEWS is published bi-monthly except July-August by The American Entomological Society at the Academy of Natural Sciences, 1900 Benjamin Franklin Parkway, Philadelphia, Pa., 19103-1195, U.S.A. AES office phone: 215-561-3978; e-mail: aes@ansp.org; website: http://www.ansp.org/aes.

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(Continued on inside of back cover)

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NEW SPECIES OF CHRYSOPINAE (NEUROPTERA: CHRYSOPIDAE) FROM COSTA RICA, WITH SELECTED TAXONOMIC NOTES AND A NEOTYPE DESIGNATION[1]

Norman D. Penny[2]

ABSTRACT: Three new species are described: *Chrysopodes (Neosuarius) crassipennis* from 3 km SE of Rio Naranjo, Guanacaste Province, Costa Rica; *Leucochrysa (Nodita) amistadensis* from Parque Nacional La Amistad, Puntarenas Province, Costa Rica; and *Leucochrysa (Nodita) ratcliffei* from Pandora, Limón Province, Costa Rica. The new name *Leucochrysa (Leucochrysa) adamsi* is proposed for the junior secondary homonym *Leucochrysa navasi* Banks, 1941 [nec. *Leucochrysa navasi* (Kimmins, 1940)]. A neotype is designated for a species of Costa Rican Chrysopinae – *Leucochrysa (Nodita) indiga*. Redescriptions are presented for *Leucochrysa (Nodita) indiga* and *Leucochrysa (Nodita) maculata*.

As part of a plan to inventory all plant and animal species of Costa Rica (Yoon, 1993), a project was undertaken to develop a monograph of the Neuroptera of this country. Intensive collection of Neuroptera in Costa Rica in recent years by many researchers and parataxonomists has yielded large numbers of chrysopine chrysopids. Among the collected specimens are three species which were previously unknown and are described below. Nomenclatural problems have been noted for several other species. *Leucochrysa (Nodita) navasi* Banks, 1941 is a junior homonym. The types of six chrysopid species described by Navás (1928) have been destroyed. In preparation for a monograph of the Chrysopidae of Costa Rica, a neotype is designated here for one of these species and two of them are redescribed.

Materials and Methods: The apical part of the abdomen of selected specimens was broken off with fine forceps and macerated in 10% KOH, stained in Chlorazol Black E, and preserved in a glycerin-filled microvial pinned beneath the rest of the specimen. Wing tracings were made with a microprojector from temporary wing mounts on microscope slides. Following illustration, wings were glued to cards pinned beneath the appropriate specimen. Body and genitalic drawings were made with the aid of dissecting or compound microscopes with camera lucida attachments. Morphological terminology follows Brooks and Barnard (1990).

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NEW SPECIES DESCRIPTIONS

Chrysopodes (Neosuarius) crassipennis Penny, NEW SPECIES

(Figures 1-6)

HOLOTYPE: a male, "COSTA RICA: Guan., 3 km SE Rio Naranjo, 22-25 Jan 1993, F.D. Parker." Type deposited in Instituto de Biodiversidad (INBio), Santo Domingo de Heredia, Costa Rica. Type locality: 3 km SE of Rio Naranjo, Guanacaste Province, Costa Rica.
Additional material examined: (all paratypes): COSTA RICA: Guanacaste Province, 3 km SE Rio Naranjo, F.D. Parker, 39 males, 67 females; specimens collected in all months except October and November; 14 km S Cañas, F.D. Parker, 1 female collected in June. Paratypes deposited in collections of Utah State University (USU), California Academy of Sciences (CAS), INBio, Texas A. & M. University and U.S. National Museum of Natural History.

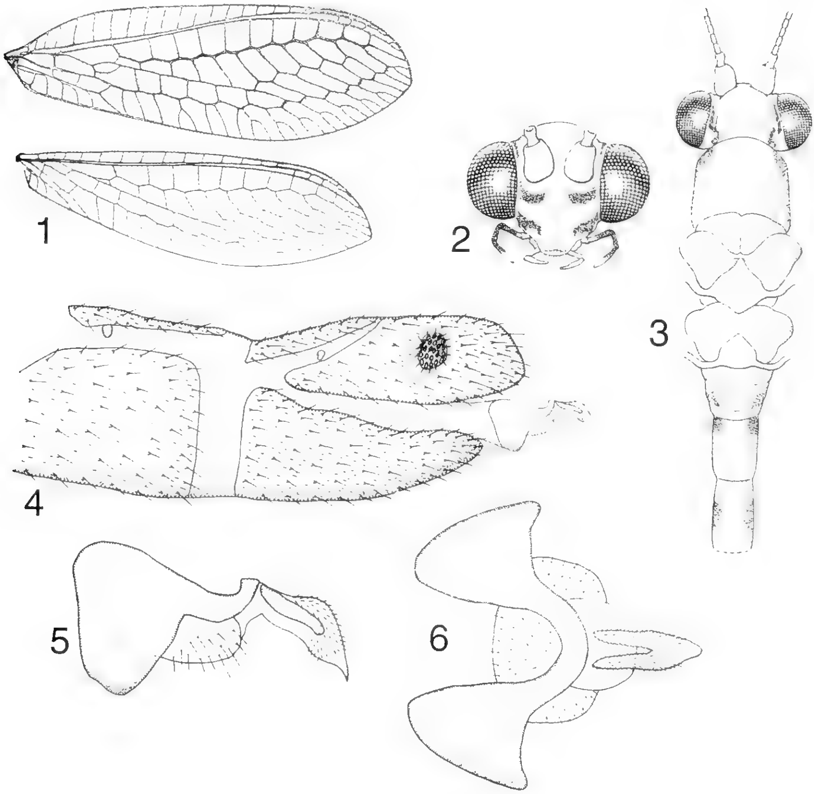
Diagnosis: The most distinctive feature of this species is the distinctly swollen (incrassate) radial sector vein of the male forewing. Incrassate wing veins are also found in *Chrysopodes (Neosuarius) crassinervis,* but this species lacks the red head markings of *C. (N.) crassipennis.* Another species which often has swollen wing veins is *Chrysopodes parishi* (Banks), but members of this species have pale maxillary palpi, divergent gradate series, and males with a massive gonarcus. *Chrysopodes (N.) crassinervis* has dark palpi, parallel gradate series, and relatively thin gonarcus medial arch.

Chrysopodes (N.) crassipennis n.sp., Chrysopodes (N.) collaris (Schneider) and *Chrysopodes (N.) divisa* (Walker) adults share a double red band on the frons which is interrupted medially . However, *C. collaris* adults are much more robust, (i.e., pronotum wider than long) with green rather than dark forewing crossveins. The head, wing, and male genitalia are very similar in *C. crassipennis and C. divisa*, but *C. crassipennis* lacks the two ventral projections of the dorsal apodeme of the male ectoproct, that are present in *C. divisa,* and males of both *C. divisa* and *C. collaris* lack incrassate forewing veins.

Head: Clypeus, labrum, labial palpi, and medial part of frons and vertex pale green. Maxillary palpi dark laterally; pale medially and at apex of terminal segment. Genae red. Additional red markings include two short parallel bands from gena and below antennal bases (Fig. 2), as well as along margins of compund eyes on vertex. Subantennal bands fuse medially in some individuals. Antennal scape, pedicel and flagellum entirely pale green. Mandibles asymmetrical with basal tooth on left mandible.
Thorax: Pronotum creamy yellow medially and pale green laterally, with red markings on vertex extended onto antero-lateral margins of pronotum (Fig. 3). Meso- and metanota pale green, without markings. Legs entirely pale green. Tarsal claw apically sharply bent at 90° and base quadrate. **Wings:** forewing length – 10.8 to 11.2 mm. Forewing (Fig. 1) with longitudinal veins pale green. Radial and gradate crossveins dark, with gradates darkly margined on membrane. Five to six inner and outer gradate crossveins in parallel series. Costal and m-cu crossveins pale in some individuals, dark in others. Radial sector of males strongly incrassate, while costal, radial and medial crossveins less so. Intramedian cell ovate. Wing membrane clear, without dark markings, except along margins of gradate veins. Hindwing veins entirely pale green without dark markings on membrane; apex pointed; five inner and outer gradate veins.

Abdomen: Pale green with rusty red coloration around spiracles and extending onto lateral margins of tergites. Male ectoprocts evenly rounded apically, extended slightly beyond apex of sternite 9; ventro-medial projection and dorsal apodeme of ectoproct absent (Fig. 4). Gonarcus strongly arched, with narrow medial portion and broad lateral arms (Fig. 6). Arcessus with microsetae, tapered to single, simple, medial point. Gonosaccus with gonosetal fields on either side of mid-line (Fig. 5), but not meeting medially.

Name derivation: The name refers to the swollen radial sector veins of the male forewing.



Figures 1-6. *Chrysopodes (Neosuarius) crassipennis.* Fig. 1. Fore and hindwings; Fig. 2. Head in frontal view; Fig. 3, head, thorax, and anterior abdomen in dorsal view; Fig. 4, apex of male abdomen in lateral view; Fig. 5, male genitalia in lateral view; Fig. 6, male genitalia in dorsal view.

Leucochrysa (Nodita) amistadensis Penny, NEW SPECIES

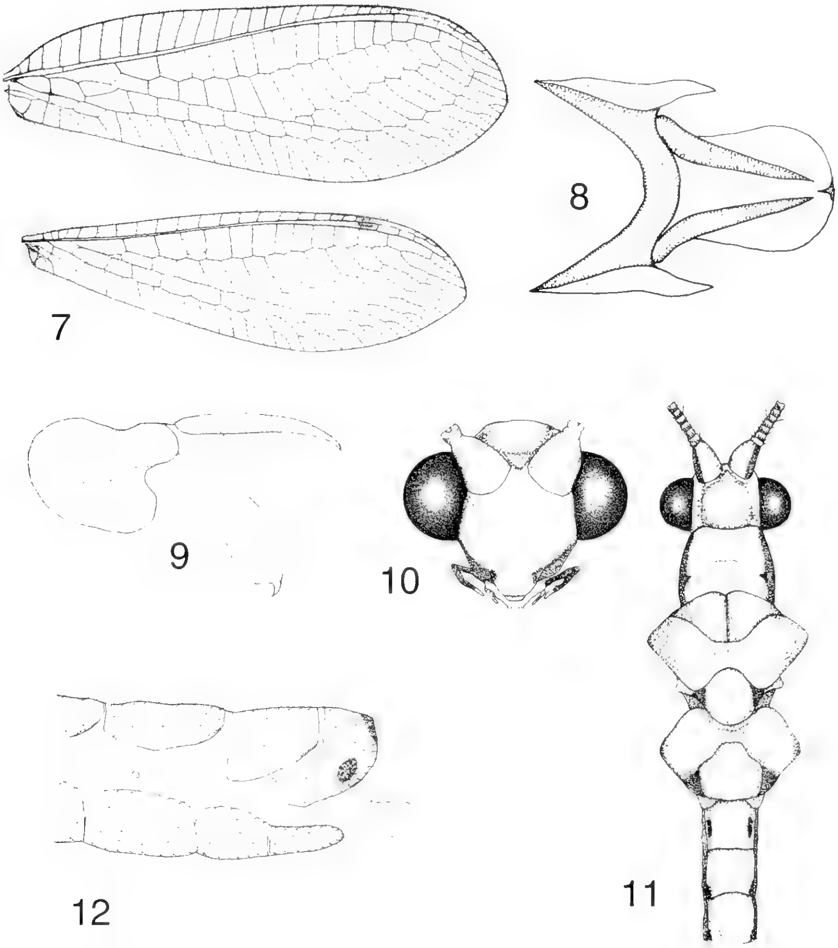
(Figures 7-12)

HOLOTYPE, a male, deposited in INBio, labelled: "COSTA RICA: Puntarenas, La Amistad Nat. Park, 08°57'N, 82°50'W, 28 Feb. 1991, 1500 m, Norman D. Penny." Type locality: Parque Nacional La Amistad, Puntarenas Province, Costa Rica.
Additional Material Examined: one male (paratype): COSTA RICA, Puntarenas Province, Parque Nacional La Amistad (08°58'N, 82°50'W), 21 February 1991, 1600 m, N.D. Penny (CAS).

Diagnosis: This species belongs to a group having the following suite of characteristics: gena red, but frons pale green, without transverse band linking the genal marks; maxillary palpi dark laterally; antennae pale, with reddish-brown lateral scape stripe; pronotum with lateral red stripe; hindwing pale apically; male gonarcus with broad lateral arms and a pair of elongate parasagittal gonocornu. Adults of *Leucochrysa (Nodita) amistadensis* differ from those of the closely related *L. (N.) caucella* Banks in lacking spots on the mesoscutum. Adults of both species have the meso- and metascutella dark laterally.

Head: Frons, labrum, clypeus, labial palps and vertex pale green. Genae and maxillary palpi dark reddish-brown (Fig. 10). Antennae pale green, with a dark reddish-brown, lateral stripe on scape and pedicel.
Thorax: Pronotum pale green with narrow, dark reddish-brown stripe wider at mid-length (Fig. 11). Meso- and metanota pale green with small dark spots laterally on meso- and metascutella. Pleural areas white. **Forewing:** (Fig. 7) length = 14.3 mm to 17.0 mm (holotype 14.3 mm). Longitudinal and crossveins pale green, except apex of costal crossveins, origin of radial sector, basal radial crossveins, gradate crossveins, pterostigma and apical twiggings dark. Nine inner gradates not extended far basally, eight outer gradates, with one or two extra gradates of an intermediate series in some individuals. **Hindwing** pale green, except for dark pterostigma. Wing apex rounded, not darkened.
Abdomen: pale green, with segmental dark markings; tergite 2 with dark reddish-brown lateral stripe; tergites 3 to 9 with dark reddish-brown mark at postero-lateral corner; apex of ectoproct with dark reddish-brown mark (Fig. 12). Male gonarcus with thin, rounded lateral arms (Fig. 9); gonocornu as long as gonarcus, only slightly arched apically and convergent apicomedially (Fig. 8); mediuncus a single medial point with ventral, elongate narrow gonosaccus.

Name Derivation: The name refers to the national park in southern Costa Rica where the type series was collected.



Figures 7-12. *Leucochrysa (Nodita) amistadensis.* Fig. 7, Fore and hindwings; Fig. 8, male genitalia in dorsal view; Fig. 9, male genitalia in lateral view; Fig. 10, head in frontal view; Fig. 11, head, thorax and anterior abdomen in dorsal view; Fig. 12, apex of male abdomen in lateral view.

Leucochrysa (Nodita) ratcliffei Penny, NEW SPECIES

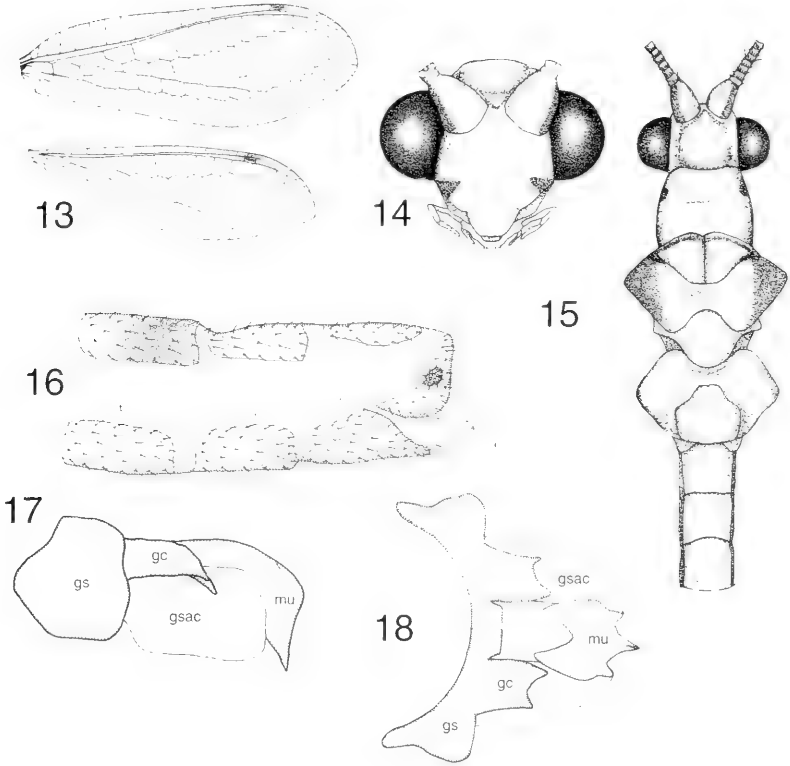
(Figures 13-18)

HOLOTYPE, a male deposited in INBio, labelled: "COSTA RICA: Limón, Pandora, 24 Sept. 1990, Norman D. Penny." Type locality: Pandora, Limón Province, Costa Rica.
Additional Material Examined: 1 male, 2 females (CAS) (all paratypes): same data as holotype.

Diagnosis: Adults of this species, *Leucochrysa (Nodita) lenora* (Banks) and *Leucochrysa (Nodita) maculata* (Navás) share a chevron-shaped dark mark behind the antennal bases, red dorsal stripe on antennal scape, pale antennae, pale palpi and dark markings on the frons. However, *L. (N.) ratcliffei* adults are not darkened along the first few flagellar segments and markings of the frons below the antennae are reduced to two reddish-brown spots near the eyes and not medially continuous, as in the other two species. Additionally, *L (N.) maculata* adults have darkened basal segments of the antennal flagellum. Males of *L. (N.) forcipata* Penny and *L. (N.) ratcliffei* are similar in having a stout, two-pronged gonocornu on either side of the gonarcus of the genitalia. However, the cleft between the prongs is much deeper in *L. (N.) forcipata* males and the mediuncus is much more elongate. Non-genitalic differences include no stripe on the scape and no dark genal mark and spots on the mesoscutum in *L. (N.) forcipata.*

Head: Frons, gena, labrum, clypeus, and palpi pale yellow; reddish-brown spot on either side of frons above gena and below antennal base (Fig. 14). Vertex green, rugose; bearing chevron-shaped reddish-brown mark behind antennal bases in some individuals. Antennal scape pale yellow ventrally (reddish at base in some individuals) and pale yellow dorsally with reddish-brown longitudinal stripe at dorso-lateral margin or over entire dorsal surface at apex of scape; pedicel and flagellomeres pale green, without markings; flagellum longer than forewing length.
Thorax: Pronotum pale green with small reddish-brown spot at anterolateral margin (Fig. 15). Mesoscutum green medially and reddish-brown laterally; reddish-brown markings contiguous as arc at anterior margin of scutum in some individuals. Meso- and metascutella and metascutum green, without markings. **Forewing:** (Fig. 13) length – 11.6 to 13.0 mm. Longitudinal veins pale green; costal and radial crossveins dark at vein intersections; gradates and medial crossveins (to last inner gradate in some individuals), apical medial crossvein, some apical forks, and pterostigma dark. Five to six inner gradates, five to six outer gradates not parallel. **Hindwing:** pale green without dark markings, except anterior part of pterostigma dark brown; wing apex pointed, pale. Legs pale green. Tarsal claw with sharply broadened base with seta at apex of basal flange.
Abdomen: Pale green, with tergites 3 and 7 covered by reddish-brown spots. Male ectoproct extended slightly beyond sternite 9 (Fig. 16); sternite 9 with microtholi. Dorsal apodeme very weakly developed. Gonarcus broad, weakly arched; with broad lateral arms. Gonocornu each apically two-pronged (Fig. 18) with shallow indentation between them. Mediuncus short, tripartite, with rugose area lateral to non-decurved, apical point (Fig. 17).

Name Derivation: This species is named for Dr. Brett C. Ratcliffe, a scarab specialist from the University of Nebraska. He not only has shown an interest in Neuroptera systematics over a 25 year period and gone out of his way to collect chrysopids while light trapping on field trips, but organized the field trip which allowed the author to collect the type series of this species.



Figures 13-18. *Leucochrysa (Nodita) ratcliffei.* Fig. 13, Fore and hindwings; Fig. 14, head in frontal view; Fig. 15, head, thorax, and anterior abdomen in dorsal view; Fig. 16, apex of male abdomen in lateral view; Fig. 17, male genitalia in lateral view; Fig. 18, male genitalia in dorsal view. gc = gonocornu, gs = gonarcus, gsac = gonosaccus, mu = mediuncus.

Leucochrysa (Leucochrysa) adamsi Penny, NOM. NOV.

I propose the new replacement name *(nomen novum) Leucochrysa (Leucochrysa) adamsi* for the preoccupied name *Leucochrysa (Leucochrysa) navasi* Banks, 1941 (itself a replacement name for *Leucochrysa antennata* Navás, 1921 [from Cuba], nec. *Leucochrysa antennata* Banks, 1905 [from Mexico]), which is a junior secondary homonym of *Leucochrysa (Nodita) navasi* (Kimmins, 1940) (*Nodita navasi* Kimmins being a replacement name for *Leucochrysa alternata* Navás, 1914 [from Costa Rica], nec. *Leucochrysa alternata* Navás, 1913 [from Mexico]). The new name is dedicated to Phillip A. Adams, the recently deceased expert on Neotropical chrysopids.

TAXONOMIC NOTES AND NEOTYPE DESIGNATION

Navás (1928) described six new species of Chrysopidae from Costa Rica: *Ancylochrysa nevermanni, Chrysopa binaria, Meleoma titschacki, Nodita indiga, Nodita maculata* and *Nodita nevermanni.* The types of all of these species were destroyed in the World War II bombing of the Hamburg Museum in July of 1943. Tauber (1969) designated a neotype for *Meleoma titschacki* and Adams (1982) for *Chrysopa binaria.*

Chrysopodes (Chrysopodes) nevermanni (Navás)

Navás (1928) described the genus *Ancylochrysa* for a new species (*nevermanni)* from Costa Rica. Adams and Penny (1987) synonymized *Ancylochrysa* with *Chrysopodes (Chrysopodes).* Navás' original description was very brief, but the species (and genus) were differentiated from other related species by the sinuous curves of the costal crossveins and the inner gradate series. Navás' drawing (1928, Fig. 15) of the forewing shows two additional distinctive characters: a quadrate intramedian cell and the first outer gradate vein lying at nearly a right angle to the pseudomedius vein (the latter trait being a defining characteristic of the tribe Chrysopini). Within the tribe Chrysopini in Central America only *Chrysopodes* has a broad costal area with sinuous crossveins. Only two species of *Chrysopodes* with a quadrate intramedian vein has been collected in Costa Rica. One species, from Guanacaste Province, has extensive reddish-brown markings on frons and vertex, and straight, parallel rows of gradate crossveins. The second species, has completely pale frons and vertex, as well as completely pale antennae, and the forewing gradate series are arched and not parallel. The second species fits the brief original description of *Chrysopodes nevermanni* much closer, and, not surprisingly, the only two additional known specimens of *Chrysopodes nevermanni* were both collected in Limón Province, about 90 km southeast of the type locality. Because Navás' (1928) original description does appear to describe the second species better, and because presently only females of this species are available, I have chosen to not designate a neotype for *Chrysopodes nevermanni* at this time.

Ceraeochrysa arioles (Banks)

The name *Chrysopa binaria* was first proposed by Navás (1923) for a species from Argentina, which today is considered a valid species in the genus *Ungla.* Navás used the name *Chrysopa binaria* again in 1928 in describing a species from Costa Rica. Banks (1944), recognizing the resulting homonymy, proposed the new name *Chrysopa arioles.* In 1945, Banks declared *Chrysopa arioles* the replacement name for *C. binaria* Navás (1928) for a second time.

The description of *Chrysopa binaria* Navás (1928) includes an illustration of the head and pronotum in dorsal view. Clearly visible are two dark stripes on the dorsal surface of the scape. Also illustrated are thin, dark lateral stripes on the pronotum. The type locality is "San José de Costa Rica." There are three known species of *Ceraeochrysa* from this region which can have this distinctive double scape stripe and dark lateral pronotal stripe: *Ceraeochrysa arioles, cincta,* and *claveri. Ceraeochrysa claveri* has a dark antenna flagellum while the other two species have pale antennae. Unfortunately, the coloration of the antennal flagellum is not mentioned in the original description nor shown in the drawing. Other characters mentioned in the original description are not adequate to differentiate the species.

Adams (1982) chose to follow Banks' (1944, 1945) interpretation of the species by selecting one of Banks' specimens as explicit neotype. It is from "Vergel, Chiapas/13-V-35/light, "Mexico, A. Dampf".

Leucochrysa (Nodita) indiga Navás

(Figures 19-24)

NEOTYPE, here designated, a male deposited in INBio, labelled: "COSTA RICA: Ala, 20 km S Upsala, 12 Feb 1991, F.D. Parker." Type locality: 20 kilometers south of Upsala, Alajuela Province, Costa Rica.
Additional Material Examined: same data as neotype, except 28 October 1990, (1 female, INBIO); same data as neotype, except 29 January 1991, (1 male, CAS); 25 December 1990, (1 male, USU); 5 February 1991, (1 female, USU).

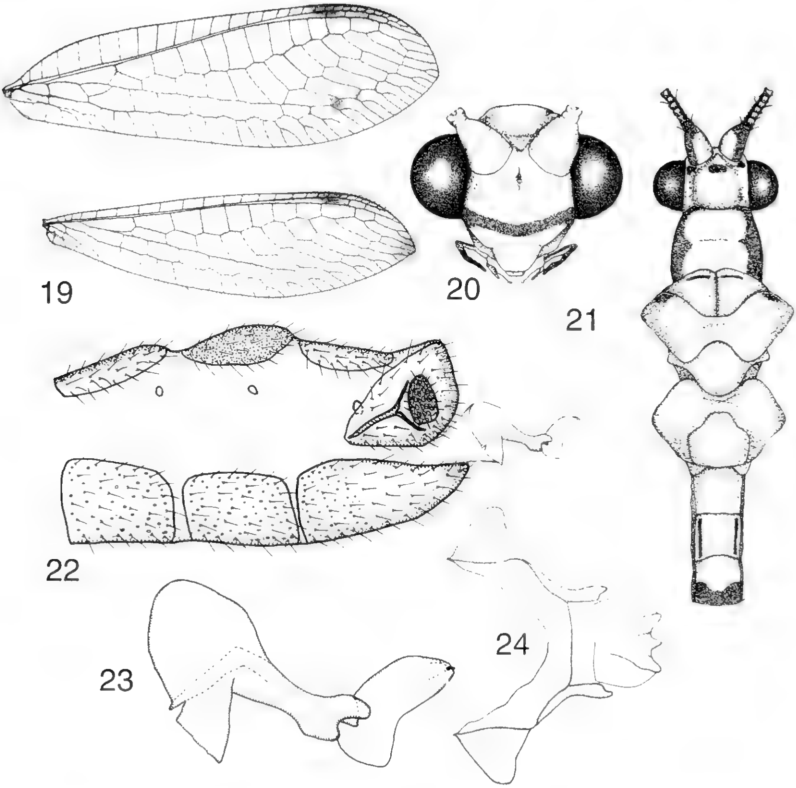
Diagnosis: The combination of characteristics of prontoum with lateral stripe expanded at mid-length, maxillary palpi dark, and hindwing with darkened apex places this species close to *Leucochrysa (Nodita) apicata, L. (N.) askanes,* and *L. (N.) postica.* Among these four species several other character states also are shared and the species are clearly closely related. However, *Leucochrysa (Nodita) indiga* can be easily separated from these related species by the male genitalia lacking the dorsal horn of the gonarcus and small, unipartite arcessus. Eidonomic characteristics which may be used with great caution are the lack of dark markings on abdominal tergite 3, and lack of dark margining of the forewing inner gradate veins.

Redescription:
Head: Frons white dorsally with reddish-brown transverse band ventrally from gena to gena (Fig. 20). Gena reddish-brown. Clypeus and labrum pale yellow. Maxillary palpi black, except apical 1/3 of apical segment pale. Labial palpi pale yellow. Vertex pale green, except small reddish-brown spot behind each antenna. Antennae pale yellow, except dorsal surface of scape reddish-brown; pedicel and first flagellar segment black; flagellum longer than forewing.
Thorax: Pronotum green with lateral, longitudinal reddish-brown stripe widened at mid-length (Fig. 21). Meso- and metanota pale green with thin reddish-brown transverse mark at anterior margin of mesonotum and also on mesoscutum at base of mesothoracic wings in some individuals. Pleural areas pale yellow, without markings but with numerous microtrichiae.
Wings: Forewing length 13.5 – 14.0 mm. Longitudinal veins pale green; crossveins dark, except in discal area pale. Basal half of pterostigma heavily darkened. Wing membrane infuscated at origin of radial sector, in apical 1/3 of radial sector and along outer gradate veins. Six inner

gradates and seven outer gradate veins. Costal and anal margins at wing base darkened. Hindwing veins pale green, except basal half of pterostigma, apical 1/3 of radial sector and apical forks along anal margin dark. Wing with apex pointed and darkened (Fig. 19). **Abdomen:** Pale green with quadrate dark marks on tergites 4 and 7 (Fig. 22). Ectoproct apically rounded, without lobes; dorsal apodeme apically branched, extended to callus cerci. Male gonarcus broad, only slightly arched, with broad, ovate lateral arms (Fig. 23); inner margin of lateral arms formed as a caudo-laterally directed ridge. Arcessus proportionately very small, formed as a single medial point from triangular base (Fig. 24). Dorsal horns and endoprocesses absent. Gonosaccus without gonosetae or gonocristae.

Notes: The original description of *Nodita indiga* Navás, 1928 provided few characters that are useful for identification. However, one distinctive characteristic shown on the illustration accompanying the description is a lateral pronotal stripe, which is wider in the posterior half (Fig. 21). There are several closely related Costa Rican species with this characteristic pronotal stripe: *Leucochrysa (N.) amistadensis* n. sp., *Leucochrysa (N.) askanes* (Banks, 1946), *Leucochrysa (N.) caucella* Banks (1910), *Leucochrysa (N.) postica* (Navás, 1913) and one unnamed species. Of these, *Leucochrysa (N.) amistadensis* and *N. caucella* lack the mesonotal dark markings and the dark first three flagellar segments and have more gradate crossveins than mentioned in Navás' original description. The other three species appear to form a compact group sharing the following characteristics, some of which were noted by Navás (1928): dark maxillary palpi, a dark transverse band on the frons from gena to gena (Fig. 20), dark first three antennal flagellomeres, antennal scape with a dark dorso-lateral stripe and reddish suffusion over most of the rest of the dorsal surface, a distinctive lateral pronotal stripe that is expanded caudally, a dark arc on the anterior and lateral part of the mesonotum, forewing costa dark at its base, a dark region of longitudinal and crossveins in the apical 1/3 of the radius; much dark margining of membranes along crossveins and apical forks, about six inner gradate crossveins (Fig. 19), dark tip to the hindwing, and dark spots on abdominal tergites 4 and 7 (Fig. 22).

These three species have different male genital armature (Figs. 23, 24), but few eidonomic characters. Navás' original illustration includes a small dark spot on the vertex. This spot can be seen in many specimens of *Leucochrysa (N.) askanes* and the unnamed species, but not in *Leucochrysa (N.) postica. Leucochrysa (N.) postica* also has heavy margining of the inner gradate series, which is much reduced in or absent from the other two species, and not mentioned by Navás. Hence, the name *Leucochrysa (N.) indiga* could apply equally well to either *Leucochrysa (N.) askanes* or the undescribed species. Rather than add a new name to the literature, I prefer to conserve the names *Leucochrysa (N.) indiga* and *Leucochrysa (N.) askanes* by selecting a specimen of the undescribed species as neotype of *Leucochrysa (N.) indiga.* The locality at which this neotype was collected is approximately 180 km northwest of the original type locality (ICZN Article 75.3.6).



Figures 19-24. *Leucochrysa (Nodita) indiga.* Fig. 19, Fore and hindwings; Fig. 20, head in frontal view; Fig. 21, head, thorax and anterior abdomen in dorsal view; Fig. 22, apex of male abdomen in lateral view; Fig. 23, male genitalia in lateral view; Fig. 24, male genitalia in dorsal view.

Leucochrysa (Nodita) maculata (Navás, 1928)

(Figures 25-30)

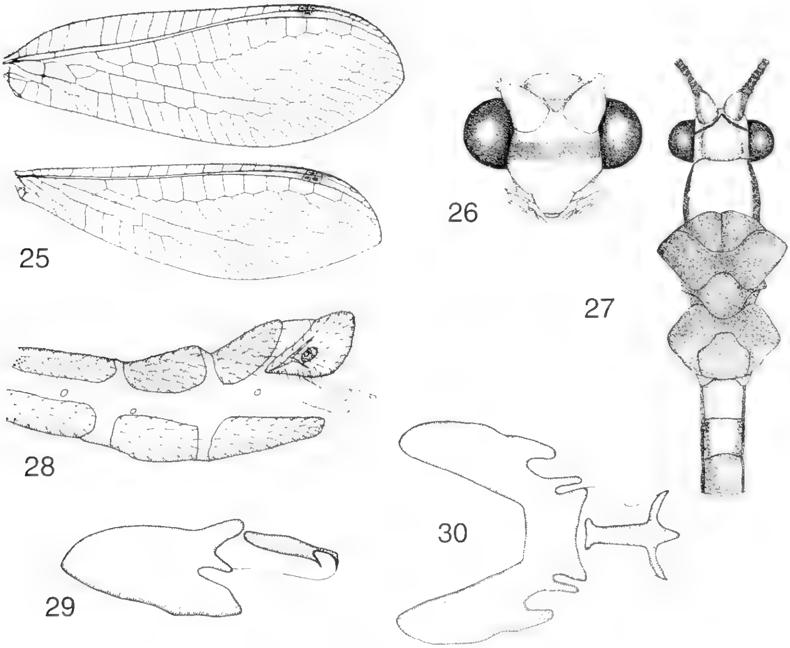
Navás' (1928) original description and illustration addressed some of the features of *Leucochrysa (N.) maculata* adults. Frons with a dark transverse band below the antennal bases; palpi pale; antennal scape with a dark line on the lateral surface, first five flagellar segments dark on the mesal surface, remainder of the flagellum pale; a v-shaped mark on the vertex; a thin, dark line laterally on the pronotum; and dark spots on abdominal segments 4, 6, 7, and 8. Although the original description and illustration are woefully inadequate to identify this species in many respects, a neotype is probably not needed. Few species of *Leucochrysa (Nodita)* have a complete dark band across the frons and the dark stripe extending the length of the pronotum will distinguish *Leucochrysa (Nodita) maculata* from the closely related *Leucochrysa (Nodita) lenora*. However, a redescription is presented here.

Redescription: Based on 1 male, 2 females deposited in CAS.
Head: Frons pale yellow with transverse reddish-brown band between compound eyes below antennal bases (Fig 26). Clypeus, labrum and palpi pale yellow. Vertex pale green with reddish-brown V-shaped mark posterior to antennal bases. Antennal scape pale green with lateral reddish-brown longitudinal stripe; scape and first 5-10 flagellomeres dark brown, shaded to pale green on apical segments; about 86 flagellomeres, each with four whirls of dark setae.
Thorax: Pronotum pale green with longitudinal lateral reddish-brown stripe (Fig. 27). Meso- and metanotum mottled brown and green to completely dark brown in mature individuals, but metascutellum dark brown in all individuals. Pleural area creamy yellow to white.
Legs: Pale green; tarsi golden yellow; tarsal claws dark brown; tarsal claws abruptly broadened basally.
Wings: Forewing length 14.0-16.0 mm. Forewing membrane without markings, except proximal part of pterostigma dark. All longitudinal veins green; gradate, radial and cubital crossveins dark, all others pale green. Six inner and six to eight outer gradate crossveins (Fig. 25). Hindwing pale green, without markings, including apex of wing. Six inner and six outer gradate crossveins.
Abdomen: Pale green with sparse long pale setae and large reddish-brown spots on tergites 4, 6, 7 and 8 (Fig. 28). Eighth sternum with microtholi. Male ectoproct extended slightly beyond sternite 9. Dorsal apodeme of ectoproct branched around anterior margin of callus cerci. Male gonarcus broad, only slightly arched, with broad lateral arms (Fig. 29). Arcessus apically tripartite with no declination of medial prong (Fig. 30). Gonosaccus without gonosetae or gonocristae.

Remarks: The combination of character states of pale palpi, transverse dark band on frons, pale antennal flagellum which is dark basally; dorsal dark scape stripe and chevron-shaped dark marking on vertex behind antennae all ally this species to *Leucochrysa (Nodita) lenora* (Banks, 1944). However, *Leucochrysa (N.) lenora* has extensive dark margining of wing crossveins and the lateral pronotal mark is restricted to a short red spot, while *L. maculata* has no margining of wing crossveins and the lateral pronotal mark is a more elongate brown stripe.

Leucochrysa (Nodita) palliceps (McLachlan, 1867)
= ***Leucochrysa (Nodita) nevermanni*** Navás, 1928, NEW SYNONYMY

The description and illustration of *Nodita nevermanni* leave little doubt that this is a synonym of *Leucochrysa (N.) palliceps* (McLachlan, 1867). The combination of entirely dark frons, completely pale pronotum, and extensive pigmentation of crossveins below the pterostigma will immediately identify individuals of this distinctive species. More problematical is its generic placement. The character states mentioned above are those often associated with *Gonzaga* Navás, 1913. A fourth characteristic of *Gonzaga* is a quadrate



Figures 25-30. *Leucochrysa (Nodita) maculata.* Fig. 25, Fore and hindwings; Fig. 26, head in frontal view; Fig. 27, head, thorax and anterior abdomen in dorsal view; Fig. 28, apex of male abdomen in lateral view; Fig. 29, male genitalia in lateral view; Fig. 30, male genitalia in dorsal view.

intramedian cell. Some specimens of *Leucochrysa (N.) palliceps* have an elongate triangular intramedian cell while in others this cell is quadrate. I have examined one specimen with left wings having a triangular and right wings having a quadrangular shape. However, in the vast majority of specimens the intramedian cell is triangular.

Brooks and Barnard (1990) used three additional male genitalic characteristics to help define *Gonzaga:* 1) males bear a ventral lobe of the ectoproct, 2) the arcessus is narrow, and 3) the arcessus is apically striated. This definition of *Gonzaga* describes the type species and several probable synonyms, but does not encompass all species now placed in the genus: for example, *Gonzaga nigriceps. Leucochrysa (Nodita) palliceps* seems to form a transition between *Nodita* Navás (1916) and *Gonzaga*, but the presence of a triangular intramedian cell in this species may indicate that *Gonzaga* does not form a monophyletic clade. Until a cladistic analysis can be done for the Leucochrysini it would seem more prudent to leave the species *palliceps* within the subgenus *Leucochrysa (Nodita).*

I thank Virginia Kirsch for the wing, head and thorax illustrations of *Chrysopodes crassipennis*, David H. Kavanaugh and Sergio de Freitas for reviewing an early draft of this manuscript, John D. Oswald for reviewing a later draft of the manuscript, and the California Academy of Sciences In-House Research Fund for illustrative assistance.

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A NEW SPECIES OF ANT (HYMENOPTERA: FORMICIDAE) FROM NORTH FLORIDA[1]

Mark. Deyrup[2], David Lubertazzi[3]

ABSTRACT: A new species of dacetine ant, *Pyramica apalachicolensis*, is described. Specimens were found in poorly drained, fire-maintained flatwoods with an open canopy of large pines and dense herbaceous ground cover in the Apalachicola National Forest of Florida. Diagnostic features of the species are the cuneiform head, the conspicuous mandibular diastema, and the long, fine, sparse, suberect, slightly recurved clypeal hairs. It is generally similar to several of the other 26 species of *Pyramica* native to southeastern North America.

The genus *Pyramica* includes 26 described native species in southeastern North America, which is apparently a center of distribution of Arctotertiary elements of the genus (Deyrup and Cover 1998). It is the most speciose genus of southeastern ants, but the small size (workers are about 2mm in length) and cryptic habits of the species guarantee their obscurity. There is no satisfactory way to survey for these ants: they can be found by minutely examining leaf litter, or by extraction with a Berlese funnel or a similar device, but processing large quantities of leaf litter in these ways is a laborious process. Scarce species and those that occur in some unknown special microhabitat are likely to be overlooked. The species described below may be a good example of a species that has escaped notice by occurring in an unlikely habitat. It was discovered during a study of ant assemblages in low pine flatwoods, a habitat that is prone to both fire and flooding, phenomena inimical to most litter-inhabiting ants. Two specimens were found in pitfall traps, and an intensive search of the area around these pitfall traps yielded a nest with 332 individuals.

For a formal diagnosis of the genus *Pyramica* and the reasons for placing the genus *Smithistruma* in synonymy with *Pyramica* see Bolton 1999. For a key to the genera of Nearctic ants, see Hölldobler and Wilson (1990); in this key most members of the genus *Pyramica* will key out to *Smithistruma*.

Pyramica apalachicolensis Deyrup and Lubertazzi, NEW SPECIES

Diagnosis. Distinguished from all other Nearctic *Pyramica* by the following combination of character states: head with preocular laminae convergent distally, so head in frontal view roughly cuneiform; mandibles with a conspicuous diastema between the triangular basal tooth and the subapical series of teeth; marginal and discal hairs of clypeus sparse, long, filiform, slightly recurved.

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ENT. NEWS 112(1): 15-21, January & February, 2001

Description. Holotype worker. Measurements in mm: total length: 2.11; head length: 0.65; maximum head width: 0.33; length of mesosoma: 0.53.

Features described below as in Fig. 1. Head in frontal view with preocular laminae convergent distally and clypeus narrow, so head in frontal view roughly cuneiform. Mandibular diastema conspicuous at full closure; mandibular apices strongly decurved in lateral view; mandible (as in Fig. 2) with a triangular basal tooth, two large subequal subapical teeth, followed by two teeth about one half the length of the first pair, followed by an indistinct series of vestigial teeth. Clypeus about as long as wide, finely reticulate, with sparse erect, somewhat recurved filiform hairs in marginal, submarginal, antesubmarginal series, each hair rising from a small tubercle. Antennal scapes with proclinate, curved, unmodified hairs. Frontal and occipital areas with suberect curved hairs that appear in lateral view similar in length and type to those on the clypeus; a pair of long, irregularly curved, filiform hairs on the edge of the antennal scrobe above the eyes, on the sides of the occipital lobes, and on the tops of the occipital lobes. Head and body without any spatulate or spoon-shaped hairs, though the larger, proclinate,

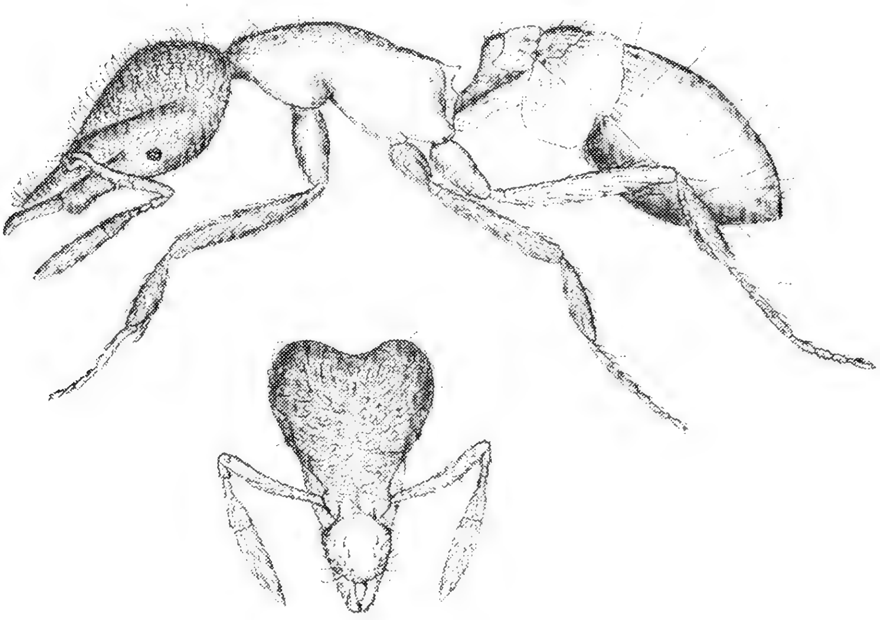

Figure 1. *Pyramica apalachicolensis*, new sp., worker

Figure 2. *Pyramica apalachicolensis*, new sp., right mandible of worker

curved hairs on the femora and tibiae are slightly flattened, so that they shine under illumination. Pronotum reticulate, with two pairs of long, irregularly curved, filiform hairs on a pair of weak carinae along the lateral margins of the pronotal disc; remainder of mesosoma reticulate dorsally, shining along sides. Propodeal teeth short, triangular; infradental laminae conspicuously emarginate above. Mid and hind tibiae and basitarsi with a long, irregularly curved, filiform hair at proximal third of length. Petiole and postpetiole finely reticulate; infrapetiolar lamina gradually emarginate medially; lower postpetiolar spongiform process large, extending length of basal face of first sternite of gaster; gaster shining, with sparse, long, irregularly curved, filiform, erect hairs.

Paratype female. Measurements in mm: Total length: 2.43; head length: 0.67; maximum head width: 0.40; length of mesosoma: 0.62; length of forewing: 2.12.
Paratypes. Paratype material is 213 workers and 27 alate females.
Collecting data for type material. All type material is from the same site: FLORIDA: Leon County, Apalachicola National Forest, off Forest Service Road 373, T1S, R2W, S19; pine flatwoods habitat, stand of *Pinus palustris* Mill. All specimens collected by D. Lubertazzi. Two specimens collected in pitfall traps, 21 July 1997; remaining specimens collected from nest in soil, 20 September 1997.
Deposition of type material. Holotype, 36 paratypes: Museum of Comparative Zoology, Harvard University, Cambridge, Mass.; 20 paratypes: National Museum of Natural History, Smithsonian Institution, Washington, D.C.; 20 paratypes: The Natural History Museum, London; 20 paratypes: Los Angeles County Museum of Natural History; 12 paratypes: Florida State Collection of Arthropods, Gainesville, Florida; 20 paratypes: arthropod collection, Archbold Biological Station, Lake Placid, Florida; remaining paratypes: temporarily housed in the collection at Archbold Biological Station.

Etymology. This species is named for the Apalachicola National Forest, which is the type locality and the only area from which the species has been recorded.

Assignment in the Genus *Pyramica*. The closest relatives of the species described above are undoubtedly members of a group of species formerly placed in the genus *Smithistruma*, especially the apparent Arctotertiary relicts of North America and temperate East Asia. In Bolton's 1999 revision of the Dacetonini the genus *Smithistruma* is combined with 17 other genera in the genus *Pyramica*. Bolton's work contains so much detailed examination of specimens (many representing undescribed species) and such thoughtful analysis of character states that we must gratefully accept its conclusions. Nevertheless, further work is likely to destabilize *Pyramica*, a genus so heterogeneous as to verge on an oxymoronic genus concept. The divergence between species such as *Pyramica eggersi* (Emery) and *Pyramica membranifera* (Emery) is so extreme, and in all likelihood so ancient, that the genus *Pyramica* will probably require some disassembly to maintain the utility and consistency of generic concepts within the ants. For the moment, however, it seems best to assign *apalachicolensis* to *Pyramica*, even though its relationship to the type species of *Smithistruma* and the relatively early establishment of the latter genus suggest that it could easily end up in some revised version of *Smithistruma*.

DISCUSSION

Similar species. In Brown's 1953 key to the North American species of *Smithistruma* north of Mexico, *P. apalachicolensis* specimens cannot be readily taken past couplet past couplet 10, which separates species with a wedge-shaped head and no conspicuous mandibular diastema from species that do not have a wedge-shaped head and do have a conspicuous mandibular diastema. *Pyramica apalachicolensis*, and another recently described species, *P. archboldi* (Deyrup and Cover) (1998), have both the wedge-shaped head and the conspicuous mandibular diastema. The clypeal pilosity of *P. archboldi* is not suberect and filiform, but proclinate and narrowly spatulate. If one were to de-emphasize the shape of the head, *P. apalachicolensis* would easily key to *P. filitalpa* (Brown) in Brown's treatment; while the two species are similar, the clypeal pilosity is different (Fig. 3), and the mandibular dentition is also different, according to the description of the mandibles of *P. filitalpa* (Brown 1953). If one were to ignore the mandibular diastema, *P. apalachicolensis* would key to *P. laevinasis* (M. R. Smith), but the latter species has much denser clypeal pilosity, with the hairs not suberect. (Fig. 4). As indicated by these disparities between *P. apalachicolensis* and other species, this new species does not fit into the provisional species groups in Brown's 1953 work, falling somewhere between the *clypeata* group and the *talpa* group.

Notes on habitat. The large nest series and two collections of stray specimens were in open, low pine flatwoods (for a discussion of Florida pine flatwoods, see Myers and Ewel 1990). The open, sparsely forested character of this habitat is maintained by frequent fires (about every 4-15 years). Before European settlement of Florida, fires were probably caused by summer thunderstorms, but the fragmentation of the landscape now requires fire management by national forest personnel to prevent the development of unnaturally dense hardwood forest and thickets over much of the flatwoods habitat. The fires remove much of the standing vegetation, except pines, and most of the ground litter. The water table is high, and in the summer rainy season the soil may become flooded or saturated for a few days or weeks. In such habitats we usually find dacetine ants, including *Strumigenys louisianae* Roger and several species of *Pyramica*, confined to patches that escape burning along the edges of streams or swamps, or more rarely in large grass tussocks or in the thick layers of bark at the bases of large pines.

The nest was in an area with scattered *Pinus palustris*, shrubs (*Ilex glabra* (L.) Gray, *Quercus minima* (Sarg.) Small, *Serenoa repens* (Bartr.) Small, *Lyonia fruticosa* (Mich.) G. S. Torr.), and herbaceous plants (*Aristida beyrichiana* Trin. & Rupr., *Pteridium aquilinum* (L.) Kuhn, *Balduina uniflora* Nutt., *Seymeria cassioides* (G. F. Gmel.) S. F. Blake, *Sabatia brevifolia* Raf., *Aster tortifolius* L.). The soil type was Leon sand.

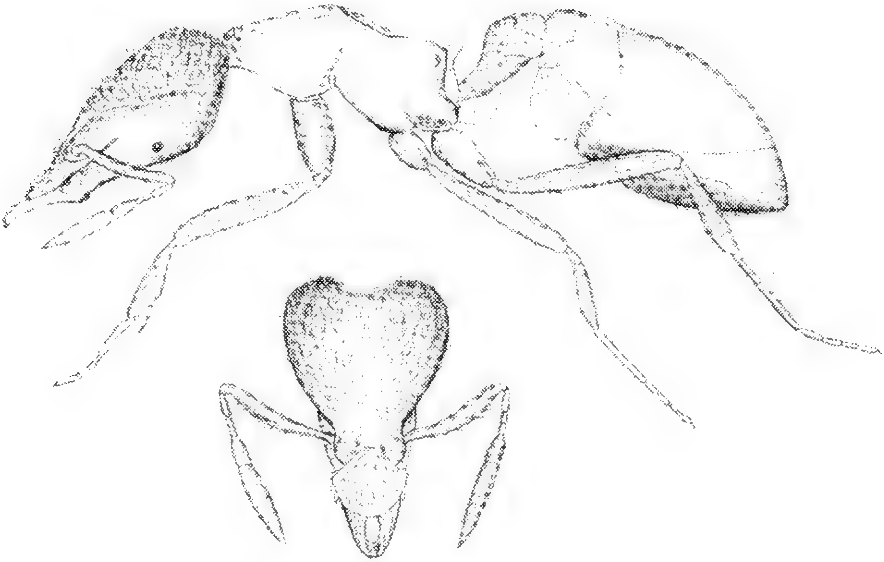

Figure 3. *Pyramica filitalpa* (Brown), worker

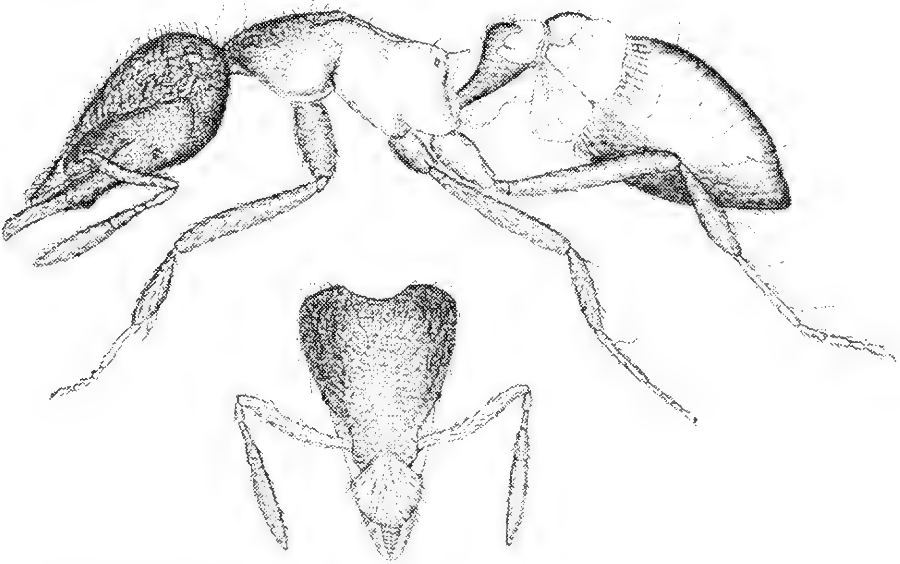

Figure 4. *Pyramica laevinasis* (M. R. Smith), worker

With over 300 individuals, the nest is the most populous *Pyramica* nest the authors have seen in Florida. It is tempting to relate this to some habitat feature, such as a scarcity of suitable nest sites or a lack of competition from other dacetines, but it is possible that this nest was abnormally large for the species; only additional field research could clarify this.

General comments on southeastern *Pyramica*. With the description of *P. apalachicolensis*, there are now 27 native species of *Pyramica* known from the southeastern United States. Almost all of these species can be identified by species-specific, highly consistent elaborations of the clypeus and the clypeal hairs, and often by elaborations of the mandibles as well. Nobody knows enough about the natural history of these *Pyramica* to explain the details of this remarkable diversity. In a more general way, the evolution of morphological peculiarities in *Pyramica* and related genera can be understood by perusing Brown and Wilson's classic paper on the subject (1959). The jaws of these ants can be cocked back and held open by a catch, which can be released to allow the jaws to snap shut with great speed. This allows these ants to capture small but speedy subterranean invertebrates, especially springtails (Collembola), whose escape mechanism involves a spring-loaded appendage that allows them to leap away faster than anything other than the spring-loaded jaws of a specialized ant. One might assume that the specific differences in the length of the jaws and the configuration of their teeth might reflect specialized prey preferences, but there is no observational evidence of this, and even the significance of major features, such as the presence or absence of the mandibular diastema, is unclear. There is the additional confounding factor that the teeth should mesh when they snap shut empty, so any change in dentition that evolves in relation to prey capture must be matched by a certain amount of repositioning that has nothing to do with predation.

The types and patterns of modified hairs on the clypeus are even more inscrutable. Brown and Wilson tentatively suggest (1959) that these hairs might be tactile lures or tactile "camouflage." There is the additional possibility that the modified hairs might dispense attractive chemicals. In the forty years since the lure hypothesis was proposed nobody has looked at the biology of dacetines in enough detail for corroboration; these are, after all, extremely small ants that have no economic importance and live in total obscurity in a fantastically complex environment. Nonetheless, the lure hypothesis is intuitively convincing, and one thinks immediately of a set of fishermen who fish the same lake, each with his favorite lure, one with rubber worms, one with shiner spoons, one with pop-up frogs, all of which work with varying and unpredictable degrees of success depending upon which fish are swimming by and biting. Working out the adaptive significance of the jaws and hairs of *Pyramica* and related genera should provide instructive enjoyment for several generations of myrmecologists.

ACKNOWLEDGMENTS

We thank Andrew Colaninno and Jim Ruhl of the Apalachicola National Forest for supporting the study of ants found in the forest. We are grateful to the managers past and present of the Apalachicola National Forest for their efforts in maintaining the natural habitats of the forest, with their vast assemblages of interesting organisms, including the ant described above. We thank Howard Horne for identifying plants, Mark Hollingsworth and Charlie Walker for their help in the field. We are particularly grateful to Walter Tschinkel for his encouragement and support of this and other myrmecological projects.

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A REVIEW OF THE *HYBOMITRA SONOMENSIS* GROUP (DIPTERA: TABANIDAE) IN WESTERN NORTH AMERICA, WITH EMPHASIS ON GEOGRAPHIC VARIATION IN ADULT *HYBOMITRA PHAENOPS*[1]

John F. Burger[2]

ABSTRACT: The *Hybomitra sonomensis* group of western North America is reviewed and a key to adults and immature stages is provided to assist in accurate identification. Accurate identification of adults in the past has been difficult due to extensive variation in coloration, particularly for *Hybomitra phaenops*. Variation in adult *Hybomitra phaenops* throughout its known range is reviewed in detail and variation in adult *H. enigmatica* is briefly summarized.

The Hybomitra sonomensis group includes three described species in western North America: *Hybomitra sonomensis* (Osten Sacken), *Hybomitra phaenops* (Osten Sacken), and *Hybomitra enigmatica* Teskey. Accurate identification of these species was difficult until their identities were clarified by Teskey (1982), who provided characters for separating the three taxa, as well as illustrations for *H. phaenops* and *H. enigmatica* adults and immature stages, and distribution maps for the 3 taxa. He did not, however, provide a key for separating these 3 taxa. Because of the extreme variability of *H. phaenops*, however, accurately identifying that species has still been difficult.

During a study of the immature Tabanidae of Arizona from 1968 to 1971, I collected and reared larvae of *H. phaenops* (as *H. sonomensis var. phaenops*) from northern Arizona, along the margins of a marshy lake south of Flagstaff (Coconino County) and in wet moss along the edge of a cienega (a distinctive, treeless permanently wet area where the water table is close to the soil surface) in the White Mountains of Arizona (Greenlee County) (Burger, 1977). The adults reared were strikingly different from the type material of *H. phaenops* in having almost entirely pale hairs on the head and mesopleuron, and a strongly reduced black midstripe on the abdomen, and I initially considered the Arizona specimens to represent an undescribed species.

However, examination of *H. phaenops* from throughout its known range revealed substantial variation in color of the body and hairs, from a nearly black, melanistic form in California and Oregon to a pale grayish form with white hairs on the head and thorax. Examination of additional specimens from throughout the range of the species in western North America revealed intermediates between the black and light form, so that it was not possible to con-

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ENT. NEWS 112(1): 22-30, January & February, 2001

sistently separate the variants into discrete groups. This review is designed to facilitate identification of the 3 species in the *H. sonomensis* group, since two of the species, *H. phaenops* and *H. enigmatica,* are, and have in the past been serious pests of livestock in western North America (Webb and Wells, 1924).

This review is based on examination of 979 specimens from the following institutions. National Museum of Natural History (USNM): *H. enigmatica* 16♀ paratypes, *H. phaenops* 347♀, 55♂, *H. sonomensis* 29 ♂, 1 ♂. University of New Hampshire collection (UNHC): *H. enigmatica* 3 ♀ paratypes and 3 ♀, *H. phaenops* 37♀, 5♂, *H. sonomensis* 3 ♀. Museum of Comparative Zoology, Harvard University (MCZC): *H. phaenops* 85 ♀, *H. sonomensis* 3 ♀. University of Arizona collection (UAIC): *H. enigmatica* 3 ♀, *H. phaenops* 44 ♀, 7 ♂. Canadian National Collection of Insects (CNCI): *H. enigmatica* holotype ♀, 123 ♀ paratypes, *H. phaenops* 2♀ paratypes, 121 ♀, 5♂, *H. sonomensis* 2 ♀ paratypes, 80 ♀, 5 ♂.

IDENTIFICATION OF SPECIES IN THE *H. SONOMENSIS* GROUP

The 3 species in the *H. sonomensis* group can be distinguished from other western North American *Hybomitra* by the following combination of characters summarized by Teskey (1982): abdomen with the sides of the first four tergites reddish orange (occasionally absent on tergite 4 or reduced on tergite 1); median black stripe on the abdomen narrowest on tergite 3 and outer margin often jagged; front of the female 3.0 - 4.5 times higher than a basal width of no more than 0.6 mm; antenna predominantly black; basal flagellomere usually entirely black but may be reddish orange basally, dorsal angle obtuse and excavation shallow; apical palpomere 2.5 - 3.2 times longer than the greatest width, usually sharply pointed. Mature larvae of species in the *H. sonomensis* group differ from other western North American *Hybomitra* in having dorsolateral pubescent spots on the anal segment.

Adults and immature stages of species in the *H. sonomensis* group can be separated by the following keys. Illustrations can be found for *H. sonomensis* larvae in Lane (1979) and for adults in Teskey (1990); for *H. enigmatica* adult and immature stages in Teskey (1982); and for *H. phaenops* adults in Teskey (1982) and immature stages in Burger (1977).

KEY TO ADULTS

1. Female with eye hairs relatively long and dense; male with eye hairs longer (0.20-0.23 mm); fork of veins R_4 and R_5 with at least a faint cloud; eye bands of female broader, reaching lateral margin of eye; upper and lower eye margins darkened; male with lower eye margin darkened; Pacific coastal .... *H. sonomensis* (Osten Sacken)

Female with eye hairs microscopic and scattered; male with eye hairs relatively short (0.15 -0.18 mm); fork of veins R_4 and R_5 lacking a darker cloud; species occurring inland 2

2. Female with eye bands very narrow, not reaching lateral margin of eye, intervening green areas between bands distinctly wider than dark bands; upper and lower eye margins green, not darkened; male with lower eye margin not darkened .... *H. phaenops* (Osten Sacken)

   Female with eye bands broader, reaching lateral margin of eye; intervening green areas between bands not distinctly wider than dark bands; upper and lower eye margins darkened; male with lower margin of eye darkened . *H. enigmatica Teskey*

KEY TO MATURE LARVAE

1. Mesothoracic pubescent annulus with four short projections laterally, the dorsolateral and ventrolateral ones longest; dorsolateral pubescent spots on anal segment larger, usually confluent; anal segment 1.5 times longer than tall; occurring in coastal salt marshes .... *H. sonomensis* (Osten Sacken)

   Mesothoracic pubescent annulus without lateral projections or with two short projections; dorsolateral pubescent spots on anal segment small, separated; anal segment not more than 1.2 times longer than tall; occurring in inland freshwater habitats 2

   Meso- and metathoracic pubescent annuli with two short lateral projections; anal segment about as long as tall.................. *H. phaenops* (Osten Sacken)

   Meso- and metathoracic pubescent annuli without lateral projections; anal segment 1.2 times longer than tall .... *H. enigmatica Teskey*

KEY TO PUPAE

1. Antennal ridges not encircled by deeply pigmented integument, surfaces of ridges pigmented; thoracic spiracles 0.79 - 0.94 mm long. *H. sonomensis* (Osten Sacken)

   Antennal ridges encircled by deeply pigmented integument; thoracic spiracles 0.5 - 0.6 mm long .... *H. phaenops* (Osten Sacken); *H. enigmatica Teskey*

Teskey (1982) summarized the distribution of the *H. sonomensis* group. *H. sonomensis* is a Pacific coast species that occurs from central California to Alaska. Only an occasional specimen has been collected away from the coast. The immature stages occur in salt marsh habitats (Lane, 1979). *H. phaenops* and *H. enigmatica* have broadly overlapping ranges from Oregon to Wyoming south to northeastern Utah. *H. enigmatica* extends north to British Columbia and Alberta, while *H. phaenops* extends from northern Oregon to southwestern Montana in the north, and to northern and eastern Arizona and northern New Mexico in the south.

VARIATION IN *HYBOMITRA PHAENOPS*

Stone (1938) designated one of four syntypes of *H. phaenops* in the Museum of Comparative Zoology, Harvard University, as lectotype (Type No. 14520). The type locality is Webber Lake, Sierra County, California. Unfortunately, the lectotype is not the specimen in the best condition in the type series. The lectotype female is closest to color form II of *H. phaenops*, described below. Front and subcallus dark gray tomentose; beard with pale hairs anteriorly and black hairs posteriorly; apical palpomere gray-black with mixed black and pale hairs; mesoscutum and scutellum glossy black; notopleural lobes reddish; pleuron entirely black haired, mesanepisternum with reddish tinges posteriorly; fore coxae entirely black haired; abdominal tergites 1-4 reddish orange laterally, black midstripe relatively broad; sternum entirely black haired.

Two paralectotype females are closest to color form III of *H. phaenops*. Beard entirely pale haired; apical palpomere creamy white with mostly white hairs; pleuron bearing mixed black and white hairs; sternites 2-4 pale yellowish haired, sternites 5-7 black haired. One paralectotype female is closest to the melanistic color form I of *H. phaenops*, described below. Beard entirely black haired except for small patch of pale hairs near base of maxillary palpi; apical palpomere blackish and entirely black haired; pleuron and fore coxae entirely black haired; wing vein R_4 with short spur.

H. phaenops can be divided into color forms, based on color of the body and hairs of the head and thorax, although the dividing line between variants is subjective. Color form I is the darkest, with a glossy black thorax and hairs of the head and thorax entirely black. Color form II is similar to form I, except there are scattered pale hairs intermixed among the black ones, particularly in the beard and on the mesopleuron. Color form III has a relatively even mixture of black and pale hairs in the beard and on the mesopleuron. Color form IV has the thorax dark grayish subshining tomentose and predominantly pale hairs in the beard and on the mesopleuron. Color form V is the palest, and has entirely white hairs on the head and thorax; the thorax is pale gray tomentose, especially on the mesopleuron, and the black midstripe on the abdominal tergites is always strongly narrowed and incomplete on tergite 3.

Twenty one characters were examined for variation: Background color of eyes (relaxed); width of dark eye bands; color/hairs of apical palpomere; color of basal flagellomere; color of front in females; color of beard hairs; color of mesoscutum; color of mesoscutal hairs; color of notopleural lobes; color of pleuron hairs; color of mesanepisternum; color of metanepimeron; color of fore coxal hairs; color of femoral hairs; wing tinting; R_4 vein with/without spur/length of spur; extent of lateral reddish orange area on abdominal tergites 1-4; width of dark midstripe on abdominal tergites; configuration of outer margins of abdominal midstripe; color of abdominal sternites; color of abdominal sternum hairs.

Color form I is the darkest of all the forms examined. The background color of the eyes (relaxed) is very light metallic green, and the dark eye bands are extremely narrow, much narrower than the intervening green areas. The apical palpomere varies from yellowish brown to blackish, and the hairs vary from entirely black to mixed black and pale hairs. The basal flagellomere is black. The front of females is dark gray to blackish gray, and the beard is entirely black haired (rarely a few scattered white hairs intermixed). The mesoscutum is glossy black with sublateral paler tomentose stripes barely apparent on the anterior margin. Some specimens from Summer Lake, Oregon have slightly more grayish tomentum anteriorly and laterally. The hairs of the mesoscutum in females are black except for some pale hairs on the lateral and anterior margins; the mesoscutal hairs in males are entirely black. The notopleural lobes are black, with only a trace of reddish tinge. Hairs of the pleuron, fore coxae and all femora are entirely black. The mesanepisternum and metanepimeron are blackish gray. The costal cell of the wing is very light brownish tinted, otherwise the wing is hyaline. Wing vein R_4 either lacks a spur or has a very short spur. Abdominal tergites 1-4 are usually broadly reddish orange laterally, but in some specimens, the reddish orange color extends only to tergite 3. The black midstripe is usually broadest on tergites 1-2, strongly narrowed on tergite 3 and broader on tergite 4, but the width can be highly variable, from very narrow to very broad; the outer margins are irregular. Abdominal sternites 1 and 5-7 are entirely black, sternite 2 is reddish with a median black square patch, and sternites 3-4 are reddish. Hairs of the sternum are predominantly black, except yellowish laterally on sternites 2-4. One specimen from Summer Lake, Oregon has the sternum hairs entirely black.

This melanistic form is confined to the western-most portion of the Great Basin, from eastern California (Mono County) to southeastern Oregon. It has been collected at elevations from 1,646 m (5,400 ft) to 3,231 m (10,600 ft) from May to September, but most specimens were collected in July and August.

Color form II is quite similar to form I, differing primarily in having more pale hair on the head and thorax. The apical palpomere is dark brownish black and may have entirely black hairs or pale and black hairs intermixed. The basal flagellomere has a trace of reddish color at the extreme base. The beard is pale haired anteriorly and black haired posteriorly. The hairs of the mesoscutum are mostly black, but there are scattered recumbent brassy hairs intermixed. The hairs of the pleuron are black, except for a patch of pale hairs adjacent to the wing base. Wing vein R_4 has a spur of variable length. Abdominal tergites 1-4 have conspicuous sublateral yellow oblique hair patches overlying the reddish orange color.

This form is widely distributed within the range of *H. phaenops* but there were no records from Montana and Arizona, at the northern and southern limits of the range. The lectotype female most closely resembles this color form. The elevational range for this form was 1,264 m (4,147 ft) to 3,688 m (12,100 ft). Collection records extend from May to September.

Color form III has the black and pale hairs of the head and thorax variably intermixed. The background color of the eyes is slightly darker metallic green and the width of the dark eye bands is slightly broader than in forms I and II. The apical palpomere varies from yellowish white to brownish and has dark and pale hairs intermixed. The basal flagellomere is faintly reddish at the extreme base. The front of the female is light gray tomentose, except slightly darker in the middle. The beard has predominantly pale hairs, with a few scattered black hairs intermixed. The mesoscutum is subshining black with faint grayish tomentose stripes to glossy black with sublateral stripes evanescent. The mesoscutum has black and brassy recumbent hairs intermixed. The notopleural lobes are reddish, contrasting with the darker mesoscutum. The mesanepisternum and metanepimeron are grayish tomentose, the former with reddish tinges posteriorly. The pleuron has black and pale hairs intermixed, but primarily black on the mesanepisternum. The fore coxal hairs are highly variable from entirely black to pale hairs basally and black hairs apically. The femora have mixed pale and black hairs. Wing with costal cell tinted as in forms I and II. Vein R_4 without a spur or with a very short spur. Tergites 1-4 usually reddish orange laterally, rarely confined to tergites 1-3 only, reddish orange area overlain by yellowish hair patches along the hind margins of the tergites. Sternite 1, the base of sternite 2 and sternites 5-7 dark gray tomentose. Sternites 2-4 yellowish brown. Sternal hairs predominantly pale yellow, except for some black hairs on sternites 6-7.

Color form III is widely distributed within the known range of *H. phaenops* as far south as central Utah and southern Colorado. It seems to be especially abundant in western Wyoming and the mountains of central Colorado. The elevational range for form III was 1,829 m (6,000 ft) to 3,688 m (12,100 ft). It has been collected from May to September.

Color form IV has predominantly white hairs on the head and thorax. General appearance is similar to variant III. The apical palpomere is yellowish white with black and white hairs intermixed. The basal flagellomere is distinctly reddish orange basally. The mesoscutum has anterior median and sublateral grayish tomentose stripes extending half its length. Recumbent mesoscutal hairs are brassy. The notopleural lobes are reddish orange. The hairs of the pleuron are mostly whitish, with only scattered black hairs on the mesanepisternum. The mesanepisternum is reddish tinged posteriorly; the metanepimeron is reddish tinged dorsally. The fore coxal hairs are white basally and black on the apical third. The apices of the mid and hind femora are reddish and are mostly white haired. The reddish orange color laterally on tergites 1-4 is similar to that of form III. One female from Elko, Nevada has the reddish orange area extended onto tergite 5. A female from Tennessee Pass, Colorado has the reddish orange area reduced on tergite 1 and absent from tergite 4. The black midstripe is broad on tergites 1-2 and highly variable on tergite 3, from a complete narrow stripe to a slender anterior triangle extending across the anterior third of the tergite. One female from Elko, Nevada had the midstripe narrowed on tergite 2 and absent on tergites 3-4. Abdominal sternum color and hairs are similar to form III.

Color form IV is widely distributed within the known range of *H. phaenops*, south to southern Utah and central Colorado. It has not been recorded from southern Colorado or Arizona. The elevational range of this form is 1,829 m (6,000 ft) to 3,309 m (10,856 ft) and it has been collected from May to September.

Color form V is the palest of all the *H. phaenops* forms. The eye background color and dark bands are similar to forms III and IV. The apical palpomere is pale yellowish white and has mostly white hairs with a few scattered black hairs. The basal flagellomere is reddish orange to the dorsal angle. The beard hairs are entirely white as are all the hairs of the face. The mesoscutum is blackish gray tomentose with conspicuous light gray tomentose median and sublateral stripes extending the entire length of the mesoscutum. The recumbent hairs are black on dark areas of the mesoscutum and brassy on the lighter areas. The notopleural lobes are reddish orange. The pleuron is light gray tomentose and the pleural hairs are mostly white with only scattered black hairs on the mesanepisternum. The mesanepisternum is broadly reddish posteriorly. The fore coxal hairs are entirely white in females and white basally and black apically in males. The mid and hind femora are light gray tomentose and broadly reddish apically in females and blackish gray in males. Females have the hairs of the mid femora black dorsally and white ventrally and predominantly white on the hind femora. The mid and hind femoral hairs of males are mostly black. The costal cell of the wing is light brown tinted and there is light brown tinting around the wing veins in Arizona specimens, but not in specimens from other localities. Vein R_4 has a short spur. The reddish orange color on the abdominal tergites extends to tergite 5 in females and tergite 4 in males. There are conspicuous sublateral yellow hair patches overlying the reddish orange area, and the hind margins of the tergites are broadly yellow haired. The dark midstripe is greatly reduced or absent on tergites 2-4. In most specimens, the midstripe is reduced to a narrow oval streak on tergite 2 and is reduced to a narrow anterior streak or is entirely absent on tergites 3-4. The sternum is wholly yellowish brown on sternites 1-5 and darkened on sternites 6-7 in most females. In males, sternites 1-2 are darker in the middle. The sternal hairs are entirely yellowish on sternites 1-5, predominantly yellow on sternite 6 and black on sternite 7.

Color form V occurs in the eastern part of the Great Basin and Rocky Mountains from Yellowstone Park in northwestern Wyoming south to the White Mountains in eastern Arizona, the southern limit of *H. phaenops*. This is the only form collected in Arizona. It has an elevational range of 2,211 m (7,255 ft) to 3,121 m (10, 240 ft). It seems to be restricted to areas above 2,000 m.

VARIATION IN *H. ENIGMATICA*

I examined the holotype female and all the paratypes of *H. enigmatica* in the Canadian National Collection of Insects and the National Museum of Natural History. Two female paratypes are misidentified and are *H. phaenops*. Nine other paratypes are questionably *H. enigmatica*. *H. enigmatica* exhibits considerable variation in common with *H. phaenops*, particularly in the color of the hairs on the head and thorax and in the width of the dark midstripe on the abdomen. It does not, however, exhibit the extreme dark and pale variation seen in *H. phaenops*. The beard hairs vary from entirely white to mixed black and white. The mesopleuron varies from having predominantly black hairs to predominantly white hairs, but no specimens examined had entirely white or black hairs on the pleuron. The hairs of the fore coxae varied from entirely black to entirely white. Some specimens had the reddish orange area on the abdomen reduced to tergites 2-3, and the black midstripe was strongly narrowed in a few specimens.

DISCUSSION

Although *H. phaenops* and *H. enigmatica* are very similar, and have broadly overlapping ranges in Idaho, Montana, Wyoming and Utah, they usually can be distinguished by differences in the eye pattern, as given in the key, because usually there is very little variation in the eye pattern. However, examination of a long series of specimens from Pinedale, Wyoming (Sublette County), where both *H. phaenops* and *H. enigmatica* occur, revealed exceptional variation in the widths of the dark eye bands of *H. phaenops*. Specimens of *H. enigmatica* had broader eye bands that extended to the lateral margin of the eye, the background color was dark green, and the upper and lower margins of the eye were darkened. The long series of *H. phaenops* exhibited the following variation in the size of the eye bands: (1) all three bands equal in width; (2) middle band narrower than the upper and lower band; (3) all bands exceptionally narrow and the upper band abbreviated, much shorter than the middle and lower band; (4) upper and lower bands narrower than the middle band; (5) upper band narrower than the middle and lower bands. Most of these specimens could be identified as *H. phaenops* by the bands not reaching the lateral margin of the eye and the light green upper and lower eye margins. Two specimens from Pinedale could not be certainly determined. The eye pattern was similar to *H. enigmatica* (relatively broad, complete eye bands on a dark green background), but there was no darkening of the upper and lower eye margins.

ACKNOWLEDGMENTS

I wish to thank the curators of the Canadian National Collection of Insects, Ottawa, Ontario, the National Museum of Natural History, Washington, D. C., University of Arizona, Tucson, and the Museum of Comparative Zoology, Harvard University, for the loan of specimens and paratypes of *Hybomitra enigmatica* and type material of *Hybomitra phaenops*. I also thank D. S. Chandler, Department of Zoology, University of New Hampshire, and J. S. Weaver, Department of Plant Biology, University of New Hampshire, for reviewing the manuscript. I especially acknowledge the work of the late Herbert J. Teskey on western North American horse flies and the many valuable discussions we had on the status of western species groups. This is Scientific Contribution Number 2044 of the New Hampshire Agricultural Experiment Station.

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NEW DATA ON PALEARCTIC *APHTHONA* (COLEOPTERA: CHRYSOMELIDAE) WITH DESCRIPTION OF A NEW SPECIES: TAXONOMIC AND FAUNISTIC RESULTS OF BIOLOGICAL CONTROL EXPLORATION[1]

Alexander S. Konstantinov[2], Mark G. Volkovitsh[3], Massimo Cristofaro[4]

ABSTRACT: The results of biological control explorations for *Aphthona* spp. on leafy spurge in Russia are reported. One new species is described based on adults and larvae: *Aphthona russica*, sp. nov. (Russia: Taman' Peninsula). Distributions and host plants of 10 other *Aphthona* species are recorded. *Aphthona gracilis* is reported from Siberia for the first time feeding on *Euphorbia virgata*, and *Euphorbia squamosa* is recorded as a host plant of *A. testaceicornis* for the first time.

The genus *Aphthona* Chevrolat is one of the most speciose flea beetle genera with more than 300 species distributed in the Palearctic, Oriental, Afrotropical and Australian Regions (Konstantinov 1998). A number of *Aphthona* species feed on Euphorbiaceae, especially on *Euphorbia esula* and *E. virgata* (two of the most important noxious weeds in North America). Six Palearctic species of *Aphthona* have already been released in North America as biological control agents of these weeds (White 1996), but additional species are needed to control the weeds in the variety of habitats they have invaded, especially in the forest and mountain areas of the western United States. For the purpose of collecting new, potential biological control agents, field work was conducted in Russia in June and July of 1998. Three major regions were explored: Krasnodar, Novosibirsk and Irkutsk (Fig. 1). The Krasnodar region is located near the Black Sea, northwest of the Caucasus Mountains. The area is heavily cultivated, but some "wild" areas were found close to the seashore and in the mountains. The region includes lowlands (Krasnodar area and Taman' Peninsula) with typical steppe and semidesert vegetation, and Western foothills and low altitude mountains of the Great Caucasus ridge with Caucasian nemoral forest and submediterranean vegetation. The Novosibirsk region is situated in southwestern Siberia with a moderately continental climate. The collecting occurred in relatively small patches of coniferous and deciduous forests (Iskitim Territory), open areas with small birch and aspen

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[1] Received June 15, 2000. Accepted July 25, 2000.

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ENT. NEWS 112(1): 31-41, January & February, 2001

woods and wild grasses (forest-steppe), and near several salty lakes (Karasuk Territory). The Irkutsk region (southeastern Siberia) has a unique mountain landscape with mixed forest (taiga) and open spaces (forest-steppe and steppe). The altitude in the area ranged from 300 to more than 2,000 meters above sea level.

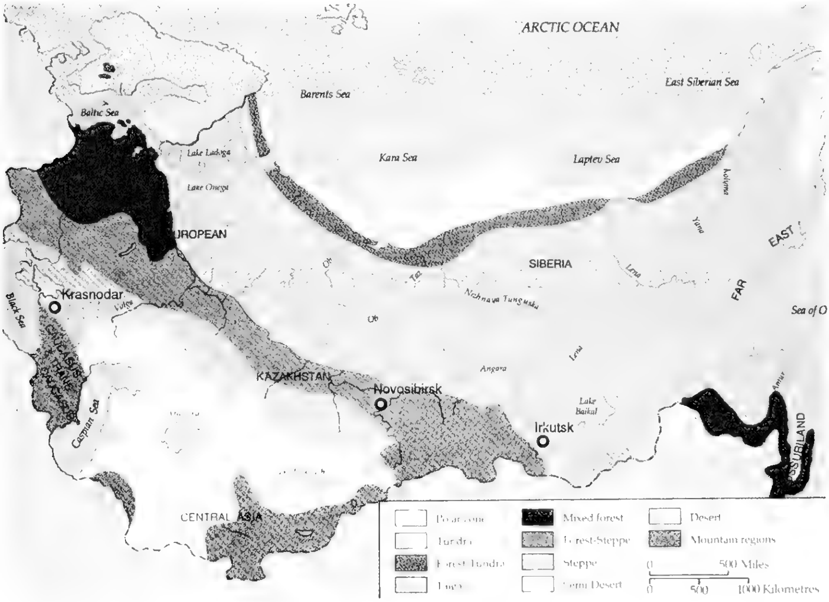


Fig. 1. Map of Russia with collecting locations.

A recently published revision of the Palearctic species of *Aphthona* (Konstantinov 1998) discussed the variability of genitalic structures in *A. lacertosa*. Material collected in 1998 and 1999 provided additional information which led us to the conclusion that *Aphthona* specimens previously identified as *lacertosa* from the Taman' Peninsula are a new species. Study of the biology of this species and preliminary feeding tests conducted in the Laboratory of Systematic Foundation of Biological Control, Zoological Institute, St. Petersburg showed that this species has great potential to become an important agent for control of leafy spurge, especially in wet habitats with heavy clayish soil. During our explorations, new distributional and host plant data for several *Aphthona* species also were collected (Table 1). For adults, we follow the terminology of Konstantinov (1998) and for larvae we use terms proposed by Anderson (1938), Lee et al. (1998), Medvedev and Zaitsev (1978), and Ogloblin and Medvedev (1971).

Aphthona russica, NEW SPECIES

(Figs. 2-4, 7, 11-20)

Description: Adult, female. Body narrow, flat in lateral view. Length 2.60 - 3.85 mm. Width 1.68 - 1.89 mm.

Color black or piceous with light metallic blue luster. Ventral part of body brown. Last 5 antennomeres, dorsal side of metafemur light brown. Rest of legs and basal 6 antennomeres dark yellow.

Head slightly convex in lateral view. Vertex shiny, with fine, sparse punctures. Frontal ridge as wide as antennal callus, widening anteriorly, moderately long, more or less flat, lateral sides parallel between antennal sockets. Antennal calli 1.33 wider than long, moderately convex, contiguous, nearly trapezoidal, forming obtuse angle to each other. Anterofrontal ridge concave, in middle as high as frontal ridge. Supracallinal sulcus slightly curved. Clypeus 3.80 times wider than long. Orbit 0.75 wider than antennal callus. Second antennomere shorter than third and fourth separately, fifth antennomere much longer than fourth and sixth.

Pronotum shiny, flat in lateral view. Base 1.13 wider than apex, almost as wide as elytral base. Lateral margin more or less narrowly explanate. Anterolateral callosity nearly transverse, short, low, with obtuse denticle, straight. Posterolateral callosity poorly developed. Punctures coarse, poorly defined, forming longitudinal wrinkles at base. Basal part of pronotum with denser punctures than apical. Interspaces densely covered with small punctures and wrinkles.

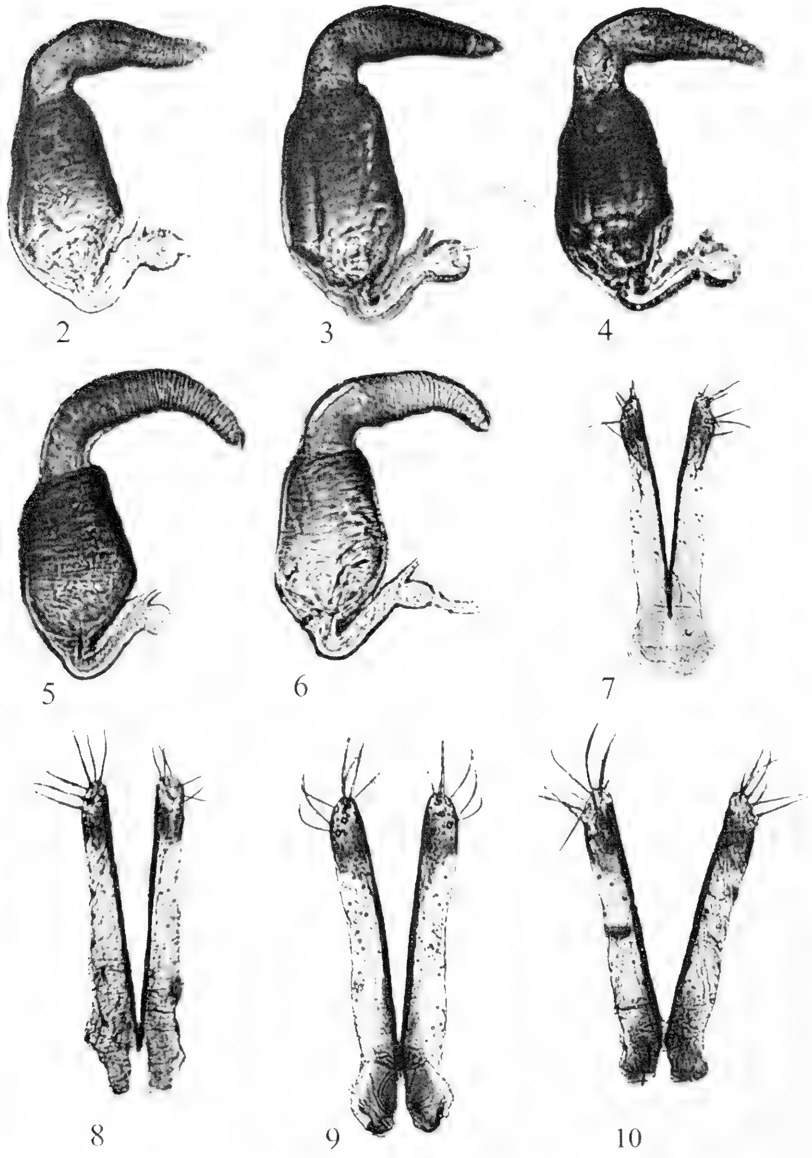
Scutellum wider than long, broadly rounded on top, lateral sides strongly converging. Elytron with poorly developed humeral callus and apical declivity, extremely flat. Lateral sides of elytra almost parallel. Maximum width in middle. Apical margin broadly rounded, straight and obtusely angulate at apex. Punctures coarse, poorly defined, not forming striae on disc, mostly 1.5 - 2 times as large as interspaces.

Metatibia slightly curved in lateral view, abruptly widening apically. Flat dorsally at apical 2/3. Medial ridge better developed than lateral ridge. Apex of first metatarsomere slightly wider than base from dorsal view, much narrower than third metatarsomere in female. Second metatarsomere nearly 1.33 times longer than third, 1.25 times shorter than fourth.

Receptacle of spermatheca (Figs. 2-4) 1.20 - 1.25 times longer than pump, apically wider than base of pump. Inner surface slightly more convex than outer surface. Vertical part of pump moderately short, narrower than horizontal part at base. Horizontal part moderately short, usually straight. Duct almost without loop away from receptacle. Anterior sclerotization of tignum slightly curved, normally long, thin in middle, abruptly widening anteriorly. Posterior sclerotization wide, poorly delineated posteriorly. Apical sclerotization of vaginal palpus much shorter than basal. Lateral side of palpus concave before apex.
Male unknown.

Mature larva. Body (Fig. 11) 5.1-7.1 mm long, whitish, subcylindrical, slightly C-shaped, long and slender. All segments elongate, with secondary folds and very sparse, short setae, without distinct tergal sclerite. Head and mandible brown, legs, spiracles, and anal plate apically pale brown to yellowish.

Head 3.5 - 3.9 mm wide, hypognathous, slightly elongated, 1.20-1.25 times as long as wide, almost parallel-sided; moderately sclerotized. Epicranial suture (Fig. 12, EpS) short, endocarina (Fig. 12, Enc) well developed, stronger sclerotized than frons, moderately wide. Frontal suture (Fig. 12, FS) moderately divergent forming 55E angle, nearly straight. Frons (Fig. 12) with three pairs of long frontal setae and two pairs of frontal sensilla. Epicranium (Fig. 12, Ep) with seven pairs of long epicranial setae and eight pairs of epicranial sensilla of which five posterior pairs located by two groups at posterolateral parts of epicranial halves. Ocelli not found. Antenna (Figs. 12, 13) 2-segmented, attached to anterolateral corners of epicranium by articular membrane; antennomere 1 (Fig. 13, A1) moderately sclerotized, bearing large cone-like sensory appendage apically, two campaniform sensilla on lateral sclerite, one trichoid and one campaniform sensilla at base of sensory appendage. Antennomere 2 (Fig. 13,



Figs. 2-10. Female genitalia. 2-6. Spermathecae. 7-10. Vaginal palpi. 2-4, 7 - *Aphthona russica* sp. nov; 5, 6, 8-10 - *A. lacertosa* Rosenhauer.

A2) rudimentary with poorly sclerotized annuliform base, located at anterior part of antennomere 1, bearing large, elongated, cone-like sensory papilla and one seta apically. Clypeus (Figs. 12, 14, Cl) transverse, narrow, covered with angular epistomal projections (Fig. 14, EpP) which bear pair of dipped setae on lateral corners and three pairs of sensilla. Labrum (Figs. 12, 14, Lb) trapezoidal with large, curved, well sclerotized palantine sclerite (Fig. 14, PlS), bearing pair of setae and pair of campaniform sensilla medially, pair of long setae laterally, and two groups of two normal and three flattened, curved epipharingeal setae on anterolateral corners. Mandible (Figs. 15, 16) palmate, well sclerotized, with four long and one small teeth, two mandibular setae externally, and well developed penicillus (Fig. 16, Pe). Penicillus consisting of one thick curved papilla and six or seven long wavy cilia. Cardo (Fig. 17, Cd) narrow, attached to base of stipes, strongly sclerotized and bearing one seta on external margin. Stipes (Fig. 17, St) slightly sclerotized with much stronger sclerotized long anterior projection reaching mala; two setae and one campaniform sensilla present externally. Maxillary palpus (Fig. 17, Plp) 3-segmented, located on palpifer (Fig. 17, Pgr) with hemi-circular narrow basal sclerite bearing two setae (on Fig. 17 the left palpifer with only one seta, which could be a result of reduction that frequently occurs in coleopterous larvae). First and second maxillary palpomeres with narrow, annuliform, sclerotized bases. First palpomere with two campaniform sensilla, second palpomere with one seta. Third palpomere elongate, with one seta and indistinct structure (probably sensory papilla) externally. Mala (Fig. 17, Ma) with sclerotized base and external margin, galea bearing one large sensory papilla located on sclerotized base, three basiconic sensilla and two long peg-like sensilla; lacinia with group of six long, peg-like setae. Ligula (Fig. 17, Lg) broadly rounded anteriorly, without microsetae along anterior margin (probably due to damage during dissection), not separated from prementum. Prementum with well sclerotized horseshoe-shaped mental sclerite (Fig. 17, MSc) bearing two short setae at base, that encircles area comprising labial palpi and three pairs of premental sensilla and three pairs of short premental setae. Labial palpus (Fig. 17, Lbp) 2-segmented, poorly sclerotized, with indistinct structure (probably sensilla) externally. Postmentum with two pairs of postmental setae.

Thoracic segments whitish, sclerites transparent. Thoracic setae short, hyaline, hardly visible (according to Medvedev and Zaitsev (1978), the pronotum of *Aphthona* larvae bears eight setae on anterior margin and six on posterior). Mesothoracic spiracle annuliform, situated on epipleuron. Femur (Fig. 18, Fe) stout, with four setae, one campaniform sensilla ventrally, and six setae around apical margin. Tibia (Fig. 18, Ti) elongated, with fringe of five setae on anterior third. Tarsungulus (Fig. 18, Ta) falciform, strongly curved anteriorly, base with seta. Pulvillus (Fig. 18, Pu) round, as long as tarsungulus.

Abdominal segments with secondary folds, intersegmental limits hardly visible (Fig. 11). External sclerites transparent, inconspicuous, setae well visible only on the lateral parts of abdominal segments. Abdomen with eight pairs of abdominal spiracles (Fig. 19), the peritreme circular. Anal plate (Fig. 20) poorly sclerotized, yellowish, with widely rounded posterior margin, without any trace of urogomphi, bearing 12 pairs of long blunt setae including two pairs situated on ventral surface at margins of pygopod (Fig. 20, Py), four pairs positioned along posterior margin, and one pair located at anterolateral part of anal plate. Tenth abdominal segment well developed, with ventrally directed pygopod (Figs. 11, 20, Py).

Type material. Holotype ♀. Russia, Krasnodar reg. Taman' Peninsula, 10 km. E. Taman', 01.VI.1999, leg. Konstantinov, Volkovitsh ♀ Cristofaro (USNM[5]). Paratypes, same data as holotype (8♀ USNM, 3♀ ZMAS[6]); Myshastovskaya, 21.VI.1998 (7♀ USNM, 4♀ ZMAS); 7 km E. Taman', salt lake near Veselovka, 22.VI.1998 (6♀ USNM, 3♀ ZMAS).

Larval material examined. Larvae reared in the laboratory from the eggs laid during July-August 1998 by the beetles collected in June 1998 in the Krasnodar region. Samples were

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[5] USNM - National Museum of Natural History, Washington, DC, USA.

[6] ZMAS - Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia.

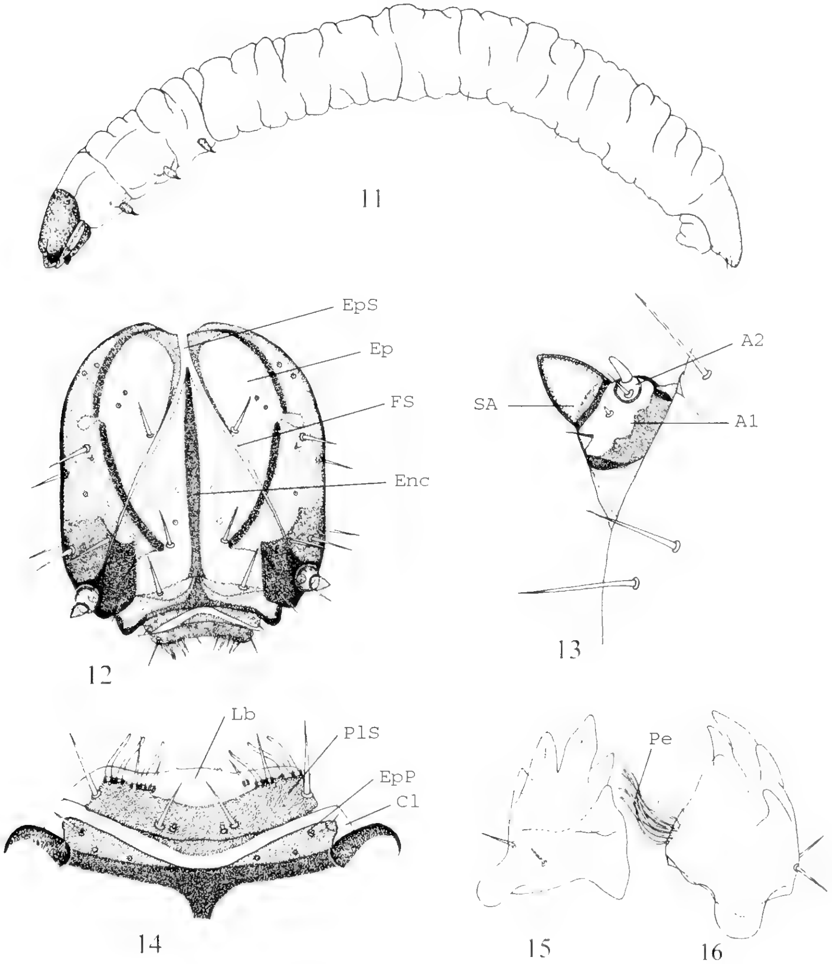

Fig. 11-16. Mature larva. 11- lateral view. 12. Head capsula, dorsal view (mandibles and labio-maxillary complex are removed). 13. Left antenna, dorsal view. 14. Clypeus and labrum, dorsal view. 15. Right mandible, buccal view. 16. Left mandible, ventral view. A1- antennomere 1; A2- antennomere 2; SA - sensory appendage; Cl - clypeus; Enc - endocarina; Ep - epicranium, EpP - epistomal projection; EpS - epicranial suture; FS - frontal suture; Lb - labrum; Pe - penicillus; PlS - palantine sclerite; Py - pygopod.

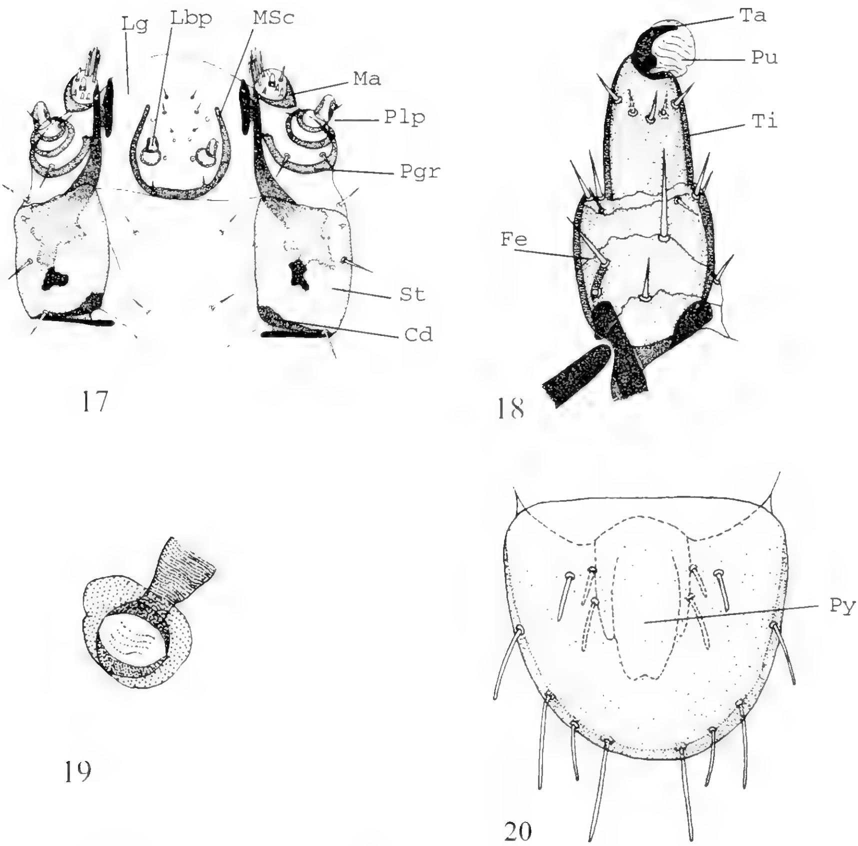

Fig. 17-20. Mature larva. 17. Labio-maxillary complex, ventral view. 18. Left hind leg, ventral view. 19. Left 3rd abdominal spiracle. 20. Anal plate, dorsal view. Cd - cardo; Fe - Femur; Lbp - labial palpi; Lg - ligula; Ma - mala; MSc - mental sclerite, Pgr - palpifer; Plp - maxilary palpi; Pu - pulvillus; Py - pygopod; St - stipes; Ta - tarsungulus; Ti - tibia.

taken from soil in potted plants of *Euphorbia esula* on 2 November, 10 December 1998, and 3 January 1999 (10 ZMAS, 5 USNM).

Comments: In the key to the Palearctic species (Konstantinov 1998) *Aphthona russica* keys out together with *A. lacertosa*. It can be separated from *A. lacertosa* by the following characters: base of pronotum with coarser punctures situated

Table 1. Distribution and host plants of *Aphthona* species collected in Russia.

Aphthona species name	Author	Locality	Date	Habitat	Number of specimens	Host plant
abdominalis	(Duftschmidt)	Irkutsk region: env. Bokhan.	07/07/1998	sunny, dry road side	≈ 200	*Euphorbia virgata*
beckeri	Jacobson	Irkutsk region: 20 km NW Irkutsk.	05/07/1998	road side	3	*E. virgata*
franzi	Heikertinger	Novosibirsk region: Road Novosibirsk - Karasuk.	27/06/1998	field/forest border	1	?
gracilis[7][8]	Faldermann	Novosibirsk region: 20 km N. Novosibirsk, Toguchinskii ter.;	26/06/1998	field with a few leafy spurge plants	12	*E. virgata*
		Iskitim ter. 3 km NW Stepnoe;	02/07/1998		7	*E. virgata*
		Ordynsk ter. 5 km W Rogalevo;	01/07/1998		2	*E. virgata*
		env. Karasuk	30/06/1998		1	*E. virgata*
nigriscutis	Foudras	Novosibirsk reg. Road Novosibirsk - Karasuk.	27-28, 30/06/1998	road side, fields	≈ 200	*E. virgata*
placida	Kutschera	Krasnodar region. Black Sea coast between Utrish and Betta.	23/06/1998	field/forest border	1	?

[7] new distyributional record [8] new host plant record

Aphthona species name	Author	Locality	Date	Habitat	Number of specimens	Host plant
pygmaea	Kutschera	Krasnodar region. Env. Anapa, Black Sea Coast	23, 24/06/1998	field/forest border	60	*Euphorbia*
rugipennis	Ogloblin	Krasnodar reg. Taman' peninsula. Salt lake near Veselovka.	22/06/1998	lake side	15	?
russica	sp. nov.	Krasnodar region: Taman' Peninsula: Myshastovskaya;.	21/06/1998	small valley between sea and road	11	*E. virgata*
		7 km E. Taman' env. Veselovka;	21/06/1998	lake shore	9	*E. virgata*
		10 km E. Taman'	01/06/1999		11	*E. virgata*
testaceicornis 8	Weise	Krasnodar region, Road Dzhubga/Krasnodar. 13 S Mirnoe.	24/06/1998	forest	50	*E. squamosa*
tolli	Ogloblin	Novosibirsk reg. Iskitim ter. 3 km NW Stepnoe.;	02/07/1998	field	40	*E. virgata*
		5 km. W. Rogalevo	01/07/1998	field	3	*E. virgata.*
		Irkutsk region, 20 km NW. Irkutsk.	05, 11/07/1998	field/forest border	70	*E.virgata*

close to each other, forming coarse longitudinal wrinkles (in *A. lacertosa*, punctures usually are well separated from each other and do not form wrinkles); receptacle of spermatheca (Fig. 2-4) 1.20 - 1.25 times longer than pump (in *A. lacertosa* receptacle is 1.08 - 1.13 times as long as pump (Figs. 5, 6)), horizontal part of pump moderately short, usually straight (in *A. lacertosa* it is relatively longer, curved). Lateral side of vaginal palpus concave before apex (in *A. lacertosa* this part of palpus is straight).

Notes on *Aphthona* species of potential importance for biological control of leafy spurge

As indicated in Table 1, five other species of *Aphthona* (*A. abdominalis* (Duftschmidt), *A. gracilis* Faldermann, *A. nigriscutis* Foudras, *A. pygmaea* Kutschera, and *A. tolli* Ogloblin) were also collected in large numbers. Field observation showed that they control leafy spurge under natural conditions. *Aphthona abdominalis* and *A. nigriscutis* already have been released in the United States and Canada. The latter species is established in sunny and dry habitats and effectively controls leafy spurge mainly due to the damage produced by beetle larvae and the soil pathogens. The former species is not well established, probably because its biotype originates from Italy which has a mild, Mediterranean climate. Siberian biotypes of these species should be better adapted to the severe climate of the northwestern United States.

ACKNOWLEDGMENTS

The authors are grateful to Neal Spencer (USDA, ARS, Northern Plains Agricultural Research Laboratory, Sidney, MT) and Gaetano Campobasso (USDA, ARS, European Biological Control Laboratory, Rome, Italy) for the idea and efforts in organizing this exploration. We thank Alexander Alexeev (Institute of Chemical Kinetics, Novosibirsk, Russia), Margarita Dolgovskaya (Laboratory of Systematic Foundation of Biological Control, Zoological Institute, St. Petersburg, Russia), Sergey Reznik (Laboratory of Experimental Entomology, Zoological Institute, St. Petersburg, Russia), Victor Shilenkov (Irkutsk State University, Irkutsk, Russia), and Vadim Zaitsev (Zoological Institute, St. Petersburg, Russia) for their help during the exploration. Konstantin Baikov (Central Siberian Botanical Garden, Novosibirsk, Russia) identified *Euphorbia* species. Olesya Moskaleva (St. Petersburg State University) inked figures of the beetle larva.

We also thank Javier Blanco (Department of Entomology, Smithsonian Institution, Washington, DC), and Allen L. Norrbom and F. Christian Thompson (USDA, ARS, Systematic Entomology Laboratory, Washington, DC) for their comments on the earlier versions of the manuscript. This study was partly funded by Grant No. 98-04-49763 from the Russian Foundation for Basic Research.

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A NEW SPECIES OF *ANASA* (HEMIPTERA: COREIDAE) FROM THE DOMINICAN REPUBLIC[1]

Harry Brailovsky[2]

ABSTRACT: A new species of *Anasa* from the Dominican Republic is described and illustrated. A key to the known Dominican species is included.

Brailovsky (1985) reviewed the genus *Anasa* Amyot and Serville and recognized, described, or redescribed each of 63 species. Drawings of the head, pronotum, male genital capsule, parameres, female genitalia, and spermatheca were provided, as well as a key to the known taxa. Later Brailovsky (1990) added three new species from México, El Salvador, and French Guyana

The genus is characterized by hind femora that usually are armed with one or more subdistal spines, humeral angles that are not acutely spined, a tylus that is not compressed and is elevated slightly above the juga, a rostrum that reaches or extends beyond the middle third of the mesosternum, and a head that below the antenniferous tubercles lacks a raised shelflike plate.

Two species of *Anasa*, *A. bellator* (Fabricius) and *A. scorbutica* (Fabricius), presently are known from the Dominican Republic. In this paper a third species is described.

Acronyms used: University of Georgia, Museum of Natural History, Athens, Georgia (UGCA), and Colección Entomológica, Instituto de Biología, Universidad Nacional Autómoma de México (UNAM).

All measurements are given in millimeters.

Anasa bellator (Fabricius)

Figures 2, 6, 10

Cimex bellator Fabricius, 1787. Man. Ins. II: 286.

This species is distinguished easily by the following characters:

Head behind each base of antenniferous tubercle armed with short acute spine that reaches base of antennal segment I, spine shorter than diameter of eye; pronotum declivent, with short setigerous hairs slightly longer than the semidecumbet hairs of corium and clavus; humeral angles slightly exposed, weakly angulate; femora unarmed; antennal segments II-III yellow with two wide black rings, antennal segment IV black with apical third yellow (Figs. 2, 6).

Distribution. This species is widely distributed throughout Mexico, Central America, West Indies, and South America. It has been recorded in Dominican Republic from La Plata and 21 km N of Higuey (Brailovsky 1985).

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ENT. NEWS 112(1): 42-49, January & February, 2001

Anasa pisina Brailovsky, NEW SPECIES

Figures 1, 3, 7, 11

Description. Structure. Male. Head wider than long, quadrate, dorsally flat, nondeclivent; tylus unarmed, extending anteriorly to juga, slightly raised in lateral view; juga unarmed, thickened; head behind each base of antenniferous tubercle armed with short acute spine that reaches base of antennal segment I, spine shorter than diameter of eye; preocellar pit deep; postocular tubercle protuberant; vertex with deep longitudinal furrow; buccula rounded, without teeth, short, elevated, not projecting beyond antenniferous tubercles; rostrum reaching middle third of mesosternum.

Thorax. Pronotum wider than long, trapezoid, declivent, bilobed; collar wide; anterior lobe shorter than posterior lobe, with anterolateral margins nodulose and serrate; posterior lobe with anterolateral margins slightly dentate; posterolateral border sinuate, smooth; posterior border straight, smooth; triangular process short, acute; callar region slightly convex, behind it with two short longitudinal depressions lateral to midline; frontal angles with broad conical lobe; humeral angles exposed, produced laterally, directed upward, with upper border smooth, inner border sparsely tuberculate. Anterior lobe of metathoracic peritreme reniform; posterior lobe acute, short (Figs. 3, 7).

Legs. Front and middle femora unarmed; hind femur ventrally armed with blunt and inconspicuous subdistal spinelike tubercles.

Hemelytra. Macropterous, reaching apex of last abdominal segment.

Abdomen. Connexivum widely exposed, with posterior angles complete, not projected into spines.

Genital capsule. Posteroventral border with small U-shaped concavity at middle third (Fig. 11).

Integument. Body surface dull; posterior lobe of pronotal disc, scutellum, clavus, corium, propleura, mesopleura, and metapleura densely punctate; head, anterior lobe of pronotal disc, prosternum, mesosternum, metasternum, and abdominal sterna with scattered punctures; connexival segments without punctures. Head dorsally, antennal segments, pronotum, scutellum, clavus, corium, prosternum, mesosternum, metasternum, legs, connexival segments, and abdominal sterna with short decumbent to suberect setigerous hairs; head ventrally, propleura, mesopleura, and metapleura glabrous. Ventral surface of head including bucculae, and femora with scattered black tubercles.

Dorsal coloration. Ground color dark orange with punctures and tubercles black; antennal segments chestnut orange with scattered reddish brown tubercles on segments I to III; connexival segments III to VII black with anterior third orange-yellow; head black with short stripe near eyes, tylus, juga, and postocular tubercle dark orange; triangular process of pronotum yellow; hemelytral membrane dark brown; dorsal abdominal segments bright orange.

Ventral coloration. Including rostral segments, legs, and genital capsule pale orange with following areas black to reddish brown: apex of rostral segment IV, punctures, and few scattered discoidal spots on coxae, trochanters, femora, tibiae, and abdominal sterna; anterior and posterior lobe of metathoracic peritreme creamy yellow.

Female. Similar to male. Connexival segments VIII-IX black with anterior third orange; genital plates pale orange with black to reddish brown punctures.

Measurements. First male, then female. Head length 1.24, 1.32, width across eyes 1.30, 1.68, interocular space 0.86, 0.96, interocellar space 0.42, 0.48, preocular distance 0.72, 0.80; length of antennal segments: I, 1.64, 1.76, II, 1.76, 2.06, III, 1.72, 2.04, IV, 1.50, 1.72. Pronotum: Length 2.50, 2.78, width across frontal angles 1.24, 1.32, width across humeral angles 4.64, 5.40. Scutellar length 1.48, 1.64, width 1.76, 1.96. Body length 10.90, 13.40.

Type material. Holotype: ♂, Dominican Republic: La Vega, vic. Salto de Aguas Blancas, 19-VII-1996, R. Turnbow (UGCA). Paratypes. 2♀, same data as holotype (UGCA, UNAM).

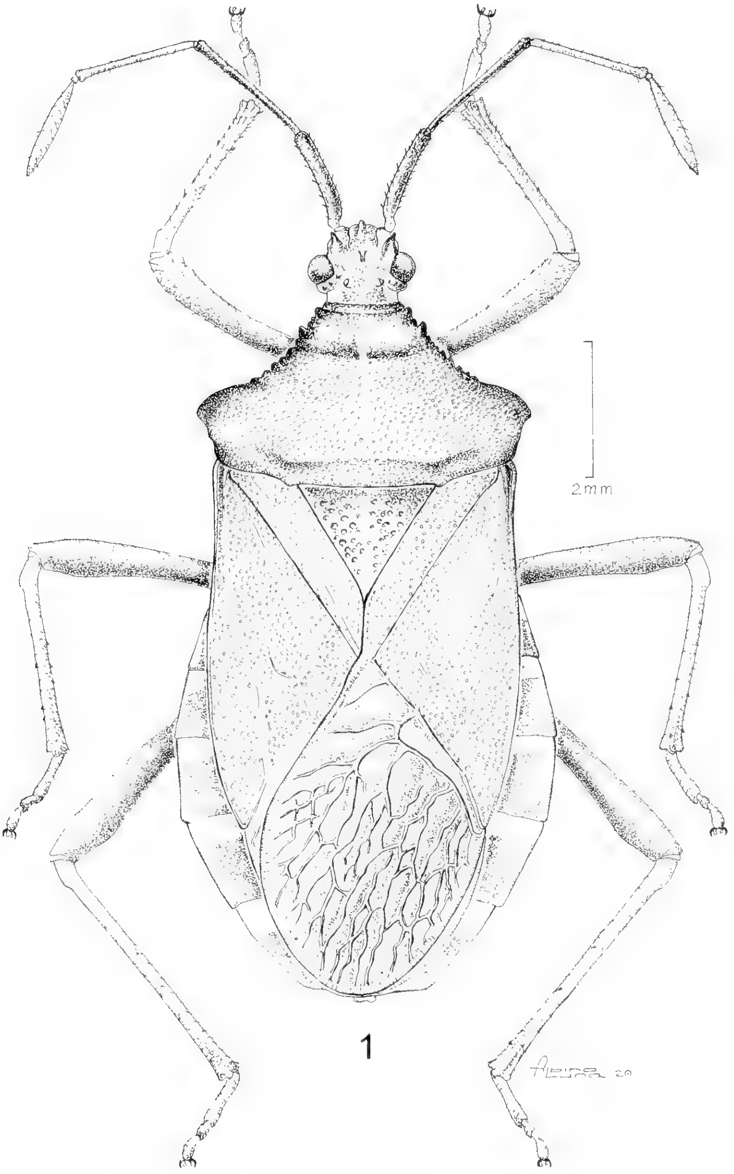


Figure 1. *Anasa pisina* Brailovsky, dorsal view. Male.

Discussion. This species resembles *A. tenebricosa* Distant in having the humeral angles exposed, produced laterally, similar to short wing directed upward, antennal segments I-IV chestnut orange, femora with black discoidal spots, and pronotum not strongly declivent, and with short hairs.

In *A. pisina*, the head behind base of each antenniferous tubercle armed with short acute spine (Figs. 2, 7), the front and middle femora are unarmed, and the dorsal abdominal segments are bright orange. In *A. tenebricosa* the head behind base of each antenniferous tubercle is unarmed (Figs. 5, 9), the front and middle femora are armed ventrally, and the dorsal abdominal segments are black with odoriferous scars IV-V, and V-VI dark yellow. Posteroventral edge of male genital capsule in caudal view slightly distinct (Figs. 11, 13).

Etymology. From the Latin "*pisina*", small.

Anasa scorbutica (Fabricius)

Figures 4, 8, 12

Cimex scorbuticus Fabricius, 1775. Syst. Ent.: 706.

This peculiar bug is recognized by the following characters:

Head behind base of each antenniferous tubercles armed with prominent spine, spine longer than diameter of eye, pronotum strongly declivent, bearing numerous erect setigerous hairs that contrast strongly with semidecumbent hairs of clavus and corium, humeral angles rounded, slightly exposed, femora armed ventrally with two subdistal spines; antennal segments II-III uniformly yellow to pale orange, IV orange hazel (Figs. 4, 8).

Distribution. This species is widely distributed, ocurring in the United States, Mexico, Central America, West Indies, South America, and the Galapagos Archipelago. It has been recorded in Dominican Republic from Santo Domingo, Ciudad Trujillo, Pedro Sanchez, Puerto Plata, Villa Rivas, La Vaca (6 km W of Jayaco), San Cristobal, Rocachica and La Vega (30 km E of El Rio) (Brailovsky 1985).

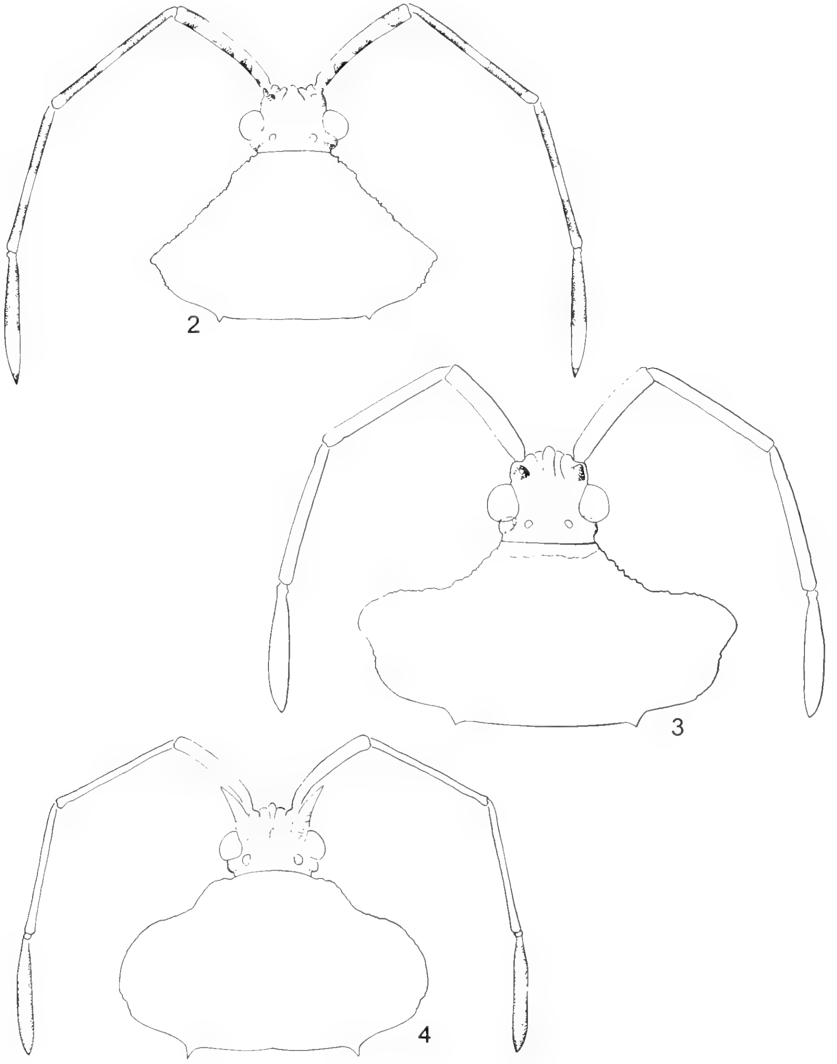
Key to the Species of *Anasa* from the Dominican Republic

1 Antennal segments II-III distinctly annulate, alternating yellow and black rings (Fig. 2); hind femora unarmed .... *bellator* (Fabricius)

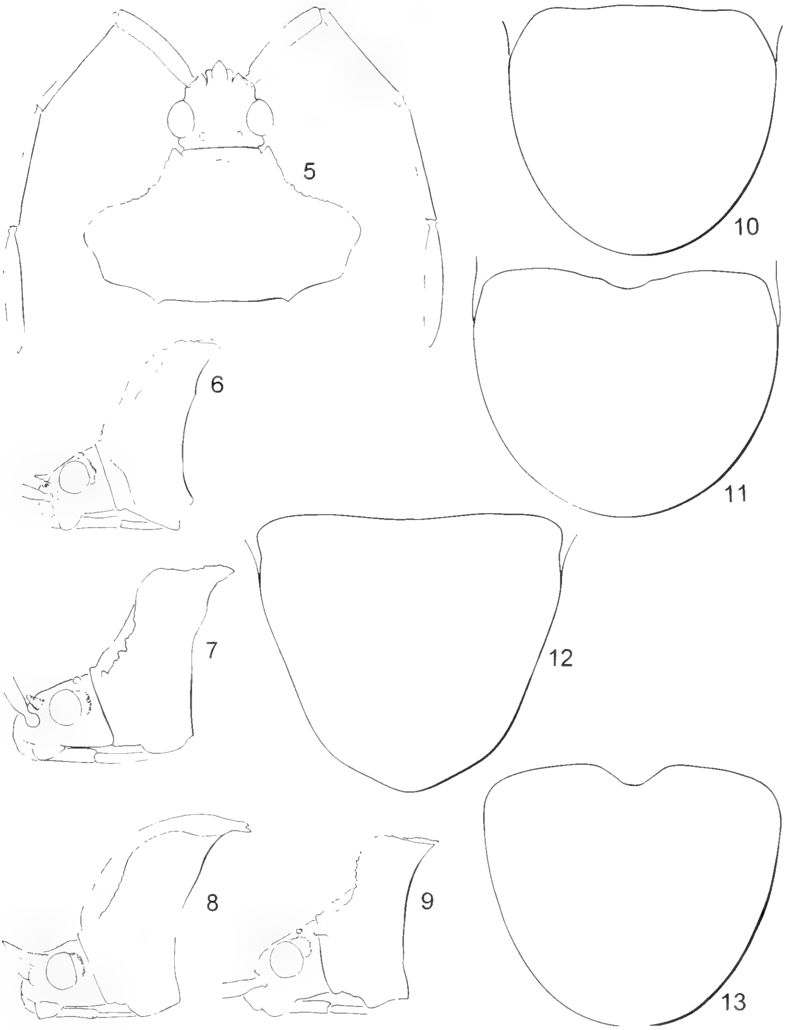
1' Antennal segments II-III, usually yellow to chestnut orange; hind femora armed ventrally 2

2 Head behind base of each antenniferous tubercle armed with prominent spine, spine longer than diameter of eye (Figs. 4, 8); front and middle femora armed; pronotal disc with numerous erect setigerous hairs, contrasting with semidecumbent hairs of clavus and corium .... *scorbutica* (Fabricius)

2' Head behind base of each antenniferous tubercle armed with short spine, spine shorter than diameter of eye (Figs. 3, 7); front and middle femora unarmed; pronotal disc, clavus and corium with short setigerous hairs ... *pisina*, new species



Figures 2-4. Head and pronotum, *Anasa* spp. 2. *A. bellator* (Fabricius). 3. *A. pisina* Brailovsky. 4. *A. scorbutica* (Fabricius).



Figures 5-13. *Anasa* spp. 5. Head and pronotum, dorsal view, *A. tenebricosa* Distant. 6-9. Head and pronotum, lateral view. 6. *A. bellator* (Fabricius). 7. *A. pisina* Brailovsky. 8. *A. scorbutica* (Fabricius). 9. *A. tenebricosa* Distant. 10-13. Male genital capsule, caudal view. 10. *A. bellator* (Fabricius). 11. *A. pisina* Brailovsky. 12. *A. scorbutica* (Fabricius). 13. *A. tenebricosa* Distant.

ACKNOWLEDGMENTS

I thank Cecil Smith (UGCA) for the loan of specimens, and Ernesto Barrera (UNAM) and Albino Luna (UNAM) for the illustrations.

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STABILITY IN MODEL POPULATIONS. L.D. Mueller & A. Joshi. 2001. Princeton University Press, Princeton, NJ 08540. 319 pp. ppbk, $29.95; Cloth $79.50.

In this book, the authors examine current theories of population stability and show how recent laboratory research on model populations contributes to our understanding of population dynamics and the evolution of stability. They review the general theory of population stability and critically analyze techniques for inferring whether or not a given population is in balance.

MITES: ECOLOGY, EVOLUTION, AND BEHAVIOR. D.E. Walter & H.C. Proctor, 1999. (Oxford University Press. 322 pp. Cloth $70.00.

This book surveys life cycles, feeding behavior, reproductive biology, and host associations of mites. Topics include: evolution of mites and other arachnids, mites in soil and water, mites on plants and animals, sperm transfer and reproduction, and mites as models of ecological and evolutionary theories.

PHEROMONES OF NON-LEPIDOPTERAN INSECTS ASSOCIATED WITH AGRICULTURAL PLANTS. J. Hardie & A.K. Minks, eds. 1999. CABI Publishing. 466 pp. Cloth $140.00.

This book presents research from leading authorities on the most important insect groups (other than Lepidoptera) detailing the current progress of research within these groups.

ON THE IDENTITY OF *OTIORHYNCHUS SAYI* (COLEOPTERA: CURCULIONIDAE)[1]

Richard T. Thompson[2]

ABSTRACT: Study of the type of *Otiorhynchus sayi* Boheman, 1843 shows that it is an unusual variant, and therefore a junior synonym, of *Otiorhynchus sulcatus* (Fabricius, 1775) [New synonymy].

Otiorhynchus sayi Boheman is a forgotten species, the identity of which has never been established. Boheman (in Schönherr, 1843: 323) attributes the name to Chevrolat and gives the type locality as 'America borealis'. It is listed as a valid species by Melsheimer (1853: 94), Gemminger and Harold (1871: 2267) and Lona (1938: 533). It is also listed in Sherborn (1930: 5764). LeConte and Horn (1876: 61) suggest that it may be a synonym of *Otiorhynchus sulcatus* (Fabricius). Their doubts probably arose from the fact that *O. sulcatus* is a very common European species which Schönherr, in the same work (1843: 371), records as occurring in North America. If *O. sayi* was the same species, surely Schönherr (and Chevrolat) would have recognized it?

Examination of the type material of *O. sayi* has shown that it is a variant form of *O. sulcatus*. I am therefore able to confirm the synonymy proposed by LeConte and Horn.

The material standing as *O. sayi* in the Stockholm Museum comprises six specimens: four typical *O. sulcatus*, one *O. singularis* and one variant *O. sulcatus* which fits Boheman's description and can be accepted as a syntype. I therefore make the following designation:

Lectotype of *Otiorhynchus sayi* Boheman, female, with 'Typus' (curator's label), 'Ot: Sayi Chevr./ Amer. bor. Chevr.' (Schönherr's hand) in the Swedish Museum of Natural History, Stockholm. I have added a lectotype disc, a determination label showing the designation and another showing the synonymy.

The lectotype (Fig. 1) is small (8.2mm, rostrum excluded) and somewhat narrower than normal. The elytra are not flattened on the disc and they lack the pale scale-flecks of normal *sulcatus*. Close examination (Fig. 2) shows that patches of small whitish setiform scales are present but these are neither large enough nor dense enough to form visible flecks. In all other respects the specimen conforms with normal *sulcatus* (Figs 3, 4). When received, there was beneath the specimen a large mass of brown water-soluble glue to which the detached right hind leg was stuck (the left hind leg and right middle leg are missing). The specimen was immersed for three days in distilled water, to

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[1] Received May 15, 2000. Accepted June 16, 2000.

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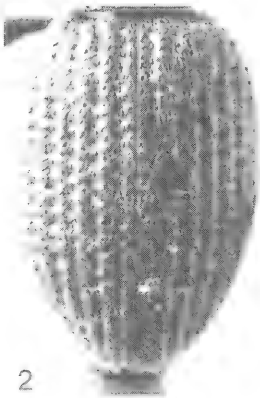

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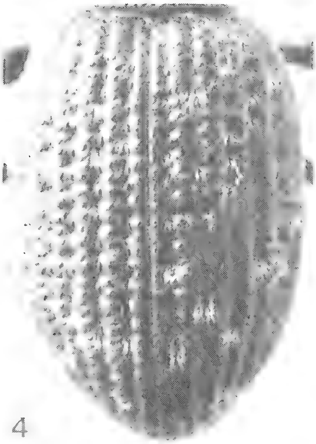

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Figs 1-2. *Otiorhynchus sayi* Boheman, lectotype female. Fig. 1 habitus; Fig. 2 elytra.

Figs 3-4. *Otiorhyncus sulcatus* (F.). English specimen (female). Fig. 3 habitus; Fig. 4 elytra.

which a trace of household detergent had been added. The glue dissolved, releasing the leg and revealing an insoluble ashy deposit, traces of which remain on the specimen. Careful brushing removed loose dust but original extraneous material is still present, especially on the pronotum. The specimen was dried, pinned from below and the detached leg replaced. After photography the specimen was remounted on the original pin and the labels attached.

In a detailed study of *O. sulcatus*, Magnano (1978) has shown that the parthenogenetic and bisexual forms of this species differ morphologically. At first sight, it seems that the type of *O. sayi* could belong to the bisexual form but the eighth sternite (fortunately exposed) conforms closely with Magnano's figures of the parthenogenetic form (especially Fig. 9) as would be expected in an expatriate population.

There is, in The Natural History Museum, a specimen taken at Weymouth, Nova Scotia in 1900 which closely resembles the type of *O. sayi.*

ACKNOWLEDGMENTS

I am very grateful to Bert Viklund of the Swedish Museum of Natural History for sending me Schönherr's specimens and to the staff of The Natural History Museum Photographic Unit for preparing the photographs reproduced here as Figs 1-4.

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A NEW SPECIES OF *DICENTROPTILUM* (EPHEMEROPTERA: BAETIDAE) FROM KENYA[1]

C. R. Lugo-Ortiz[2], W. P. McCafferty[3,4]

ABSTRACT: *Dicentroptilum clandestinum*, new species (Ephemeroptera: Baetidae), is described from Kenya and is unique in the genus *Dicentroptilum* by having dorsal abdominal tuberculation in the larval stage. The species is known as larvae only, and is distinguished from other species of *Dicentroptilum* by the presence of single, apically blunt, medial tubercles on abdominal terga 1-7; characteristic labrum, mandibles, and labial palp segment 2; the presence of procoxal papillae; and the specific color pattern of the abdomen. *Dicentroptilum* represents only the third genus of the *Centroptiloides* complex of Afrotropical genera to demonstrate the recurrent trait of dorsal abdomimal tuberculation.

Wuillot and Gillies (1994) erected the Afrotropical genus *Dicentroptilum* for *D. decipiens* (Gillies) (type of the genus), *D. papillosum* Wuillot, and *D. spinulosum* (Demoulin). Later, Lugo-Ortiz and McCafferty (1998) added *D. merina* Lugo-Ortiz and McCafferty. *Dicentroptilum decipiens* and *D. papillosum* are known from larvae and male adults (Gillies 1990, Wuillot and Gillies 1994), *D. spinulosum* is known from male adults (Demoulin 1970), and *D. merina* is known from larvae (Lugo-Ortiz and McCafferty 1998). *Dicentroptilum decipiens, D. papillosum,* and *D. spinulosum* have been reported from continental Africa, whereas *D. merina* is the only species of the genus reported from Madagascar (Demoulin 1970, Gillies 1990, Wuillot and Gillies 1994, Lugo-Ortiz and McCafferty 1998).

Lugo-Ortiz and McCafferty (1998) assigned *Dicentroptilum* to the *Centroptiloides* complex of Afrotropical genera because its larvae have two rows of denticles on the tarsal claws (Fig. 9; Lugo-Ortiz and McCafferty 1998: Fig. 66). Within this complex, *Dicentroptilum* is distinguished by the presence of a medially raised, broad, and long labrum (Fig. 1; Lugo-Ortiz and McCafferty 1998: Fig. 59) and a dorsal row of long, fine, simple setae on the tibiae and tarsi (Fig. 8; Lugo-Ortiz and McCafferty 1998: Fig. 65).

Herein, we describe a distinctive new species of *Dicentroptilum* based on a unique larval specimen collected from Kenya by George and Christine Edmunds in 1971. The material upon which the new species is based demonstrates the presence of a significant feature and biodiversity previously not associated with the genus *Dicentroptilum*. Material examined is deposited in the Purdue Entomological Research Collection, West Lafayette, Indiana.

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Dicentroptilum clandestinum Lugo-Ortiz and McCafferty, NEW SPECIES

Larva. Body length: 8.5 mm; cerci length: 6.0 mm; median caudal filament length: 3.0 mm. Head: Coloration pale yellow-brown to medium brown; small, vermiform pale yellow-brown markings on vertex and large, round, pale yellow-brown marking on frons. Antennae approximately 1.5x length of head capsule. Labrum (Fig. 1) dorsally with submedial pair of long, fine, simple setae and anterior submarginal row of eight to nine long, fine, simple setae. Hypopharynx as in Figure 2. Left mandible (Fig. 3) with incisors with five denticles (two well defined, three poorly developed); prostheca robust, apically denticulate; tuft of short, fine, simple setae between prostheca and mola. Right mandible (Fig. 4) with outer set of incisors with two denticles, inner set with three poorly developed denticles; prostheca slender, apically bifid; tuft of short, fine, simple setae between prostheca and mola. Maxillae (Fig. 5) with four long, fine, simple setae near medial hump; palp segments subequal in length. Labium (Fig. 6) with glossae slightly shorter than paraglossae, medially and apically with long, fine, simple setae; paraglossae apically with abundant long, fine, simple setae, and few apically pectinate setae; palp segment 1 slightly shorter than segments 2 and 3 combined; palp segment 2 basally narrow, distomedially produced, with five long, fine, simple setae dorsally; palp segment 3 short, broadly subconical. Thorax: Coloration pale yellow-brown to medium brown, with complex markings. Pronotum with raised ridge along posterior margin; meso- and metanotum posteromedially with single, small, apically blunt tubercles. Procoxae (Fig. 7) with ventral pair of papillae. Legs (Fig. 8) pale yellow-brown to medium brown; femora dorsally with row of long, robust, simple setae and ventrally with minute, sharp, simple setae; tibiae dorsally with long, fine, simple setae and ventrally with minute, sharp, simple setae; tarsi dorsally with long, fine, simple setae and ventrally with row of robust, sharp, simple setae, increasing in length apically; tarsal claws (Fig. 9) with two rows of six blunt denticles each. Abdomen (Figs. 11, 12): Terga 1-7 with single, apically blunt, medial tubercles. Coloration pale yellow-brown to medium brown. Terga 1 and 2 with large posteromedial medium brown subtriangular marking; tergum 3 with large anteromedial medium brown oblong marking; tergum 4 with anteromedial pair of small medium brown oblong dots; tergum 5 with anteromedial triad of small medium brown oblong dots; tergum 6 with large posteromedial medium brown subtriangular marking; tergum 7 with anteromedial small medium brown round marking; tergum 8 with medial pair of small medium brown round dots; terga 9 and 10 yellow-brown, with medial pair of faint brown round dots. Sterna medium yellow-brown to pale brown. Gills (Fig. 10) well tracheated, marginally serrate and with minute, fine, simple setae. Paraprocts with sharp spines, increasing slightly in size distally. Caudal filaments light brown; cerci without medial sinuosities.

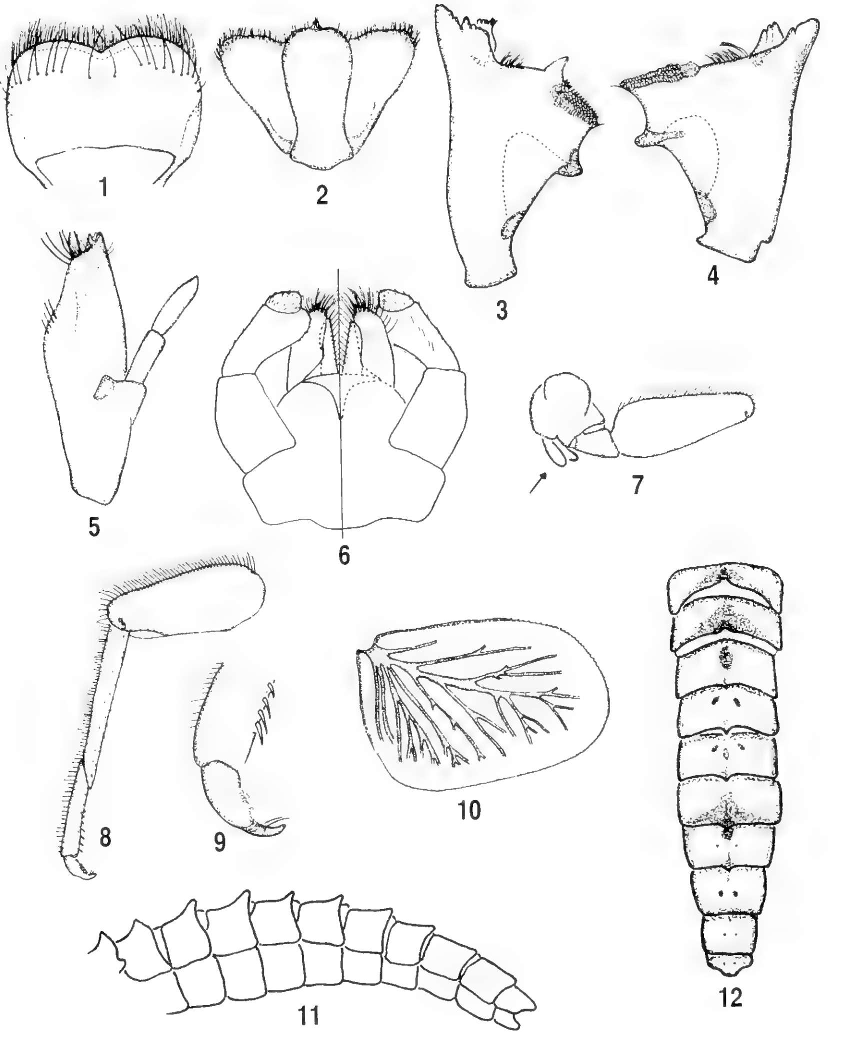
Adult. Unknown.

Material examined. Holotype: Larva, Kenya, Marira River, near Meru, 22-XI-1971, G. F. and C. H. Edmunds [mouthparts, right foreleg, and gill 4 mounted on slide (medium: Euparal)].

Etymology. The specific epithet is from the Latin, meaning hidden.

Discussion. *Dicentroptilum clandestinum* is most easily distinguished from *D. decipiens, D. merina,* and *D. papillosum* by the presence of single, apically blunt, medial tubercles on terga 1-7 (Figs. 11, 12). Other features that, in combination, aid in distinguishing *D. clandestinum* include the dorsal setation of the labrum (Fig. 1), the denticulation of the mandibles (Figs. 3, 4), the morphology of labial palp segment 2 (Fig. 6), the presence of procoxal papillae (Fig. 7), and the coloration of the abdomen (Fig. 12).

Dicentroptilum clandestinum appears most closely related to *D. papillosum.* Both species have similar labial morphology (Fig. 6; Wuillot and Gillies 1994:



Figs. 1-12. *Dicentroptilum clandestinum,* new species. 1. Labrum (dorsal). 2. Hypopharynx. 3. Left mandible. 4. Right mandible. 5. Left maxilla. 6. Labium (left-ventral; right-dorsal). 7. Procoxal papillae (pointer towards papillae). 8. Right foreleg. 9. Tarsal claw. 10. Gill 4. 11. Abdomen (lateral). 12. Abdomen (dorsal).

Fig. 8) and possess procoxal papillae (Fig. 7; Wuillot and Gillies 1994: Fig. 10). Interestingly, *D. papillosum* has a small medial tubercle on the metanotum (Wuillot and Gillies 1994: Fig. 12); however, in *D. clandestinum,* the metanotal tubercle is much more developed and erect (Fig. 11).

Superficially, the appearance of the larva of *D. clandestinum*, with its rather narrow body and long legs, is reminiscent of larvae of the southern African *Baetis* complex genus *Demoreptus* Lugo-Ortiz and McCaffery (1997).

The extensive development of dorsal abdominal tubercles in *D. clandestinum* (Figs. 11, 12) is significant because such tuberculation has not been associated with the genus and indicates its additional presence in the *Centroptiloides* complex (Lugo-Ortiz and McCafferty 1998). The only genera within that complex previously known to have dorsal abdominal tubercles are *Acanthiops* Waltz and McCafferty and *Thraulobaetodes* Elouard and Hideux (Lugo-Ortiz and McCafferty 1998, Elouard and Hideux 1991).

ACKNOWLEDGMENTS

We thank G. F. Edmunds (Salt Lake City, Utah) for the donation of the material examined in this study. The South African National Research Foundation is thanked for providing funds to CRLO to conduct postdoctoral research at the Albany Museum, Grahamstown. The Directorate of Museums and Heritage (Eastern Cape Province, South Africa) is also thanked for providing research facilities. This paper has been assigned Purdue Agricultural Research Program Jounal No. 16266.

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NUNAVUT MAYFLIES (EPHEMEROPTERA) A SUPPLEMENT FOR FAR NORTHERN NORTH AMERICA[1, 2, 3]

R. P. Randolph, W. P. McCafferty[4]

ABSTRACT: *Acentrella feropagus, Acerpenna pygmaea, Baetis bundyae, B. flavistriga, B. foemina, Diphetor hageni, Ephemerella aurivillii, Leptophlebia nebulosa,* and *Metretopus borealis* are Ephemeroptera species found in the new northern Canadian province of Nunavut. Of these, *B. foemina, L. nebulosa,* and *M. borealis,* along with 43 other species occur in the newly restricted Northwest Territories. No species are endemic to Nunavut, but *B. foemina* is endemic to northern Canada.

McCafferty and Randolph (1998) reported 321 species of mayflies in Canada and provided an annotated checklist for each of the provinces and territories officially recognized at that time. Sixty-two mayfly species were reported from northern Canada (28 from the Yukon Territory and 52 from the Northwest Territories). From all of far northern North America (including Alaska), some 63 species are known (McCafferty 1985, 1994, McCafferty and Randolph 1998). In 1993, the Canadian government formally passed the Nunavut Land Claims Agreement (NLCA), creating the new territory, Nunavut, for an area of land that represented a large eastern portion of the former Northwest Territories (Fig. 1) (Salloum 1999). In 1999, the NLCA officially went into effect, and Nunavut became a recognized territory. Nunavut encompasses a 1.9 million square kilometer region (nearly 1/5 the area of Canada) but which harbors a human population of only about 25,000 (Anonymous 1999). It might also be noted that in the future many Nunavut locality names will revert to their original Inuit names.

The mayflies reported from the Northwest Territories by McCafferty and Randolph (1998) need to be revised to show species recorded from Nunavut. Nine of the 52 former Northwest Territories species are found in Nunavut. They include *Acentrella feropagus* Alba-Tercedor and McCafferty, *Acerpenna pygmaea* (Hagen), *Baetis bundyae* Lehmkuhl, *B. flavistriga* McDunnough, *B. foemina* McDunnough, *Diphetor hageni* (Eaton), *Ephemerella aurivillii* Bengtsson, *Leptophlebia nebulosa* (Walker), and *Metretopus borealis* (Eaton).

For the most part, initial locale records for Nunavut may be found under NW (Northwest Territories) under the species treatments in McCafferty and Randolph (1998). In the case of *B. foemina, L. nebulosa,* and *M. borealis,* which occur in both Nunavut and the Northwest Territories, additional records

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[1] Received April 13, 2000; Accepted May 1, 2000.

[2] Research supported by NSF grant (DEB-9901577).

[3] This paper has been assigned Purdue Agricultural Research Program Journal Number 16259.

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ENT. NEWS 112(1): 56-58, January & February, 2001

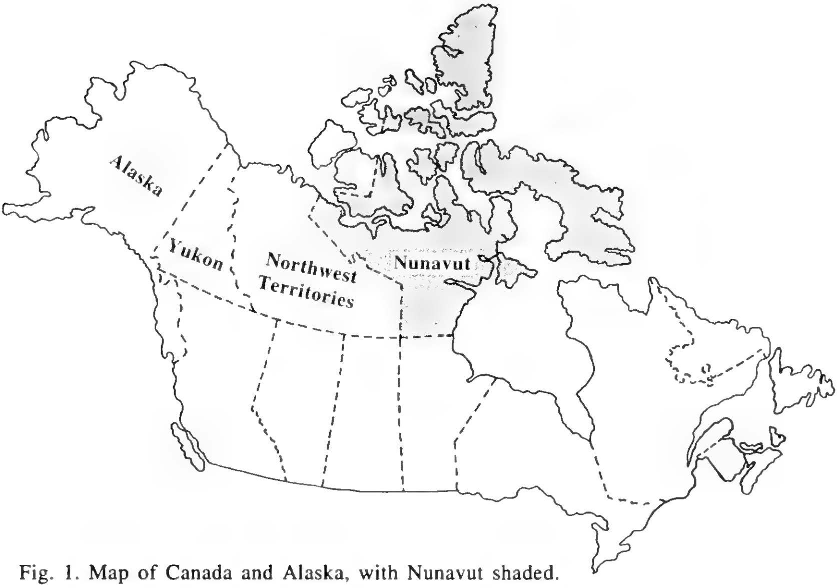

Fig. 1. Map of Canada and Alaska, with Nunavut shaded.

that establish their presence in either Nunavut or the Northwest Territories may be found in McDunnough (1936), Wiens et al. (1975), Cobb and Flannagan (1980), and Harper and Harper (1981). The records for *A. feropagus* will appear under the former name, *A. lapponica* (Bengtsson) (Alba-Tercedor and McCafferty 2000). No mayfly species are endemic to Nunavut; however, *B. foemina* apparently is endemic to far northern Canada.

With respect to the northern North America distribution (northern Canada and Alaska) of the Nunavut mayflies, *A. feropagus* is also known from Alaska, *B. bundyae* from Alaska and the Yukon, *B. foemina* from the Northwest Territories s.s., *E. aurivillii* from Alaska, *L. nebulosa* from the Northwest Territories s.s.; and *M. borealis* from the Northwest Territories s.s. and the Yukon (McCafferty and Randolph 1998).

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NEW RECORDS OF THE MILLIPED FAMILY PYRGODESMIDAE (POLYDESMIDA) FROM THE SOUTHEASTERN UNITED STATES, WITH A SUMMARY OF THE FAUNA[1]

Rowland M. Shelley[2], Sergei I. Golovatch[3]

ABSTRACT: Published records of the six pyrgodesmid millipeds in the United States are summarized and new ones are provided in detail. *Poratia obliterata* is newly recorded from the country along with the following new state records: *Calyptodesmus sanctus* from Alabama and *Myrmecodesmus digitatus* from Mississippi. A key and pertinent illustrations are provided to facilitate identifications.

The milliped family Pyrgodesmidae comprises small, ornate polydesmids that occur in the United States along the Gulf Coast from Texas to Florida, ranging inland some 150 miles (240 km) in Alabama. Four genera and six species are represented that are thought to be introduced from a more southerly range in the Caribbean and Mexico/Central America (Hoffman 1999). We summarize published records from the United States and present new records discovered by the second author during museum research; a key is provided to facilitate identifications. Specimens are deposited in either the North Carolina State Museum of Natural Sciences (NCSM) or the Virginia Museum of Natural History (VMNH).

Key to Genera and Species of Pyrgodesmidae in the U. S. A.

1\. Collum with 10 strongly incised, somewhat upturned, marginal scallops (occasionally lateralmost scallops less deeply incised)............*Poratia* 2
— Collum with 10 rather poorly incised marginal scallops 3
2\. Adults with 19 segments, largely with three paranotal lobes on segments 16-18 .... *Poratia digitata* (Porat)
— Adults with 20 segments, largely with four paranotal lobes on segments 16-18 .... *Poratia obliterata* (Kraus)
3\. Ozopore formula normal (5, 7, 9, 10, 12, 13, 15...), porosteles present on segments 5, 7, 9, 10, 12, 13, and 15; longitudinal crests of caudalmost terga absent or inconspicuous 4
— Ozopore formula almost normal, ozopores/porosteles absent from segment 9; 2+2 middorsal longitudinal crests of caudalmost terga very conspicuous; with three lobes on 2nd paranota and two lobes on all subsequent paranota . . *Myrmecodesmus*. . 5

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4. Porostele-bearing segments mostly with two lobes anterior to porostele, 5th segment with only one, porosteles located at caudolateral corners of paranota; with three lobes on all nonporiferous segments until 15th, four on subsequent ones .... *Psochodesmus crescentis* Cook

— With three lobes on 2nd paranota and two on remaining paranota; porosteles located between lobes .... *Calyptodesmus sanctus* Schubart

5. Caudalmost tubercles on segment 19 strongly dactyliform, produced caudad and considerably surpassing tip of epiproct, latter invisible dorsad .... *Myrmecodesmus formicarius* Silvestri

— Caudalmost tubercles on segment 19 weakly dactyliform, almost reaching, to slightly surpassing, tip of epiproct, latter visible dorsad between tubercles .... *Myrmecodesmus digitatus* (Loomis)

Species Records

Calyptodesmus sanctus Schubart, 1944.

Published records: FLORIDA, *Alachua* and *Columbia* cos. (Causey 1960 [as *C. schubarti* Causey], Hoffman 1993); said by Hoffman (1999) to be nearly statewide.

New records: (all collected by D. P. Wojcik, except where indicated, and deposited in the NCSM. Most samples contain numerous females, too many to count; males are unknown.): ALABAMA: *Tallapoosa Co.*, ravine 4 mi. (6.4 km) SW Percyville, 2F, 24 July 1960, L. Hubricht (VMNH) **New state record.** FLORIDA, *Clay Co.*, Middleburg, 4 February 1976. *Duval Co.*, Maxville, 20 February 1976; and 2 mi (3.2 km) SW Jacksonville Beach, Dee Dot Ranch, 17 April 1973. *Hernando Co.*, Brooksville, 17 November 1975. *Highlands Co.*, Avon Park, 18 August 1978. *Hillsborough Co.*, Lutz, 31 July 1975. *Jefferson Co.*, Capps, 8 September 1974, D. M. Hicks, J. K. Plumley. *Leon Co.*, Tall Timbers Res. Sta., 8 September 1974; and 5 mi. (8 km) E Tallahassee, Southwood Plantation, 9 October 1974. *Levy Co.*, Otter Creek, 3 October 1975. *Marion Co.*, Belleview, 9 April 1975; and Summerfield, 30 April 1980. *Pasco Co.*, Zephyrhills, 17 November 1975. *St. Lucie Co.*, Ft. Pierce Beach, 1 November 1975; and Ft. Pierce, edge of Savannah's City Park, 9 May 1976. *Taylor Co.*, Perry, 9 May 1976. GEORGIA, *Glynn Co.*, Blythe Island, 17 January 1977. *Grady Co.*, Rocky Hill, Birdsong Plantation, 27 January 1977. *Turner Co.*, Asburn, 26 April 1972.

Myrmecodesmus digitatus (Loomis, 1959)

Published records: LOUISIANA, *Allen Par.*, between Kinder and LeBlanc (Loomis 1959).

New record: MISSISSIPPI, *Hancock Co.*, lakeshore along railroad, F, 16 March 1968, L. Hubricht (VMNH) **New state record.**

Myrmecodesmus formicarius Silvestri, 1910. Figs. 1-2.

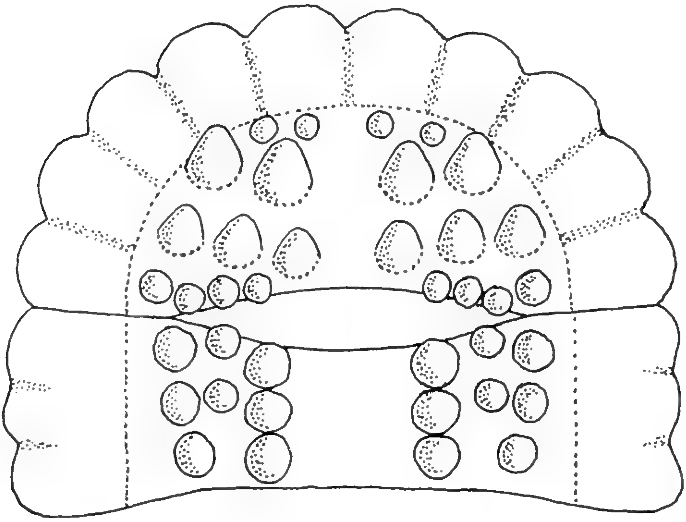
Published records: TEXAS, *Cameron Co.*, "Rabb Ranch" nr. Southmost (Loomis 1959); *Goliad Co.*, Goliad St. Pk. (Hoffman 1973); *Guadeloupe Co.*, nr. Guadeloupe R. at Sequin (Hoffman 1973). LOUISIANA, *Plaquemines Par.*, Venice (Loomis 1944; Hoffman 1973, 1999). FLORIDA, *Calhoun Co.* (as *M. digitatus*) (Hoffman 1999).

New records: LOUISIANA, *Orleans Par.*, New Orleans, 523 Henry Clay, in moist oak litter, 3M, 4F, 1 juv., 30 December 1974, M. R. Cooper (NCSM). *Pointe Coupee Par.*, nr. Lottie, 1 mi. (1.6 km) N jct. La. hwy. 81 and US hwy. 190, MM, FF, 12 May 1960, H. F. & E. M. Loomis (VMNH).

Poratia obliterata (Kraus, 1960).

Published records: None.

New record: GEORGIA, *Glynn Co.*, nr. Brunswick, St. Simons I., rd. to Fort Frederica, pine-oak association, F, juv. F, 19 June 1977, R. L. Hoffman (VMNH). **New state and country record.**



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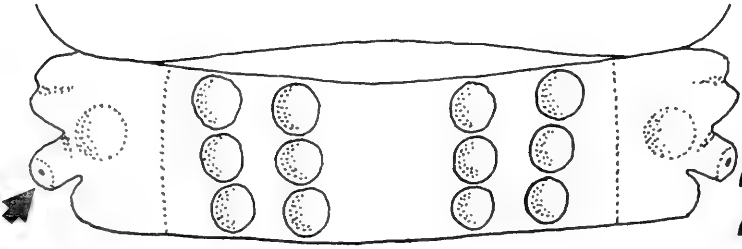

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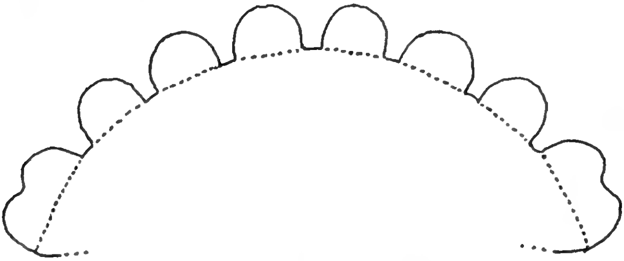

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Figs. 1-2. 1-2, *Myrmecodesmus formicarius*. 1, collum and 2nd segment, dorsal view. 2, 5th segment, lateral view, arrow denoting the porostele. 3, *Poratia digitata*, anterior margin of collum, dorsal view.

Remarks. *Poratia obliterata* is a new record for the United States. The species has hitherto been recorded from Brazil (Amazonia) (bisexual populations), Costa Rica (VMNH, bisexual populations), and a greenhouse in Germany (parthenogenetic population) (Adis et al. 2000, Golovatch and Sierwald 2001). Based on geographic evidence, the Georgia population, obviously introduced, can be expected to be all female (thelytokous), but more material is necessary to confirm this assumption.

Poratia digitata (Porat, 1889) Fig. 3.

Published records. FLORIDA, *Dade Co.*, Miami (Loomis 1973, Hoffman 1999). U. S. VIRGIN ISLANDS, *St. John*, Hawksnest Bay area (Loomis 1970, Hoffman 1999).

New records. None.

Remarks. This basically European greenhouse species has been reported from the United States under the synonyms *Poratioides virginalis* Loomis, 1970 (Virgin Islands) and *Poratioides disparatus* Loomis, 1973 (Florida) (Golovatch and Sierwald 2001). All samples are of thelytokous populations; the source area, presumably in Central America, remains dubious (Golovatch and Sierwald 2001).

Psochodesmus crescentis Cook, 1896.

Published records: FLORIDA, *Putnam Co.*, Crescent City, and between Crescent City and Palatka (Cook 1896, Loomis 1934). *Indian River Co.*, Vero Beach (Loomis 1934). *Dade Co.*, Miami, Coconut Grove (Loomis 1934). Southern two-thirds of Florida peninsula (Hoffman 1999).

New records. None.

ACKNOWLEDGMENTS

We thank R. L. Hoffman for access to the VMNH collections. The second author's visit to the United States was supported by the Robert O. Bass Visiting Scientist Fund of the Field Museum of Natural History. Figs. 1-3 were prepared by Renaldo G. Kuhler, NCSM Scientific Illustrator.

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FIRST ISOLATION OF A *SPIROPLASMA* (MOLLICUTES: SPIROPLASMATACEAE) FROM BITING MIDGES (DIPTERA: CERATOPOGONIDAE)[1]

Mark F. Frana[2], Gail E. Gasparich[3], William L. Grogan, Jr.[2]

ABSTRACT: A survey of biting midges during 1997 in Maryland for the presence of the cell wall-less prokaryotes, *Spiroplasma*, yielded an isolate (GNAT3597) from the ceratopogonid genus *Atrichopogon*. This is the first report of a biting midge-spiroplasma association and preliminary serological comparisons with all other spiroplasma isolates for which antisera are available indicate that GNAT3597 is an undescribed species.

Spiroplasmas are helical, cell wall-less prokaryotes belonging to the class Mollicutes. They have a small genome size (941-2200 kbp), and are associated with insect and tick hosts, where they inhabit the hemocoel, the gut and other tissues (Hackett et al. 1990). Since the first spiroplasma was isolated and cultivated (Saglio et al.1973), more than 1000 spiroplasma isolates have been obtained (Hackett et al. 1990; Hackett and Clark 1989; French et al. 1990).

The discovery of the first spiroplasma pathogen of insects in honeybees was reported by Clark (1977). Several spiroplasmas have subsequently been shown to be widespread as commensals or pathogens in their insect hosts, most of which are from holometabolous groups such as Diptera, Hymenoptera or Coleoptera (Hackett and Clark 1989; Clark 1982; Clark et al. 1984). In Diptera, they have been recorded from several genera of mosquitoes (Culicidae) (Chastel and Humphery-Smith 1991), from a single species of flower fly (Syrphidae) (Whitcomb et al. 1996), and from several genera of deer and horse flies (Tabanidae) (Whitcomb et al. 1997).

In light of previous isolations of spiroplasmas from three other families of Diptera, we began attempts to isolate these organisms from biting and predaceous midges (Ceratopogonidae). Herein we provide details of the first isolation of these mollicutes from the ceratopogonid genus *Atrichopogon*, and this isolate appears to be an undescribed species of *Spiroplasma*. Detailed information on the life cycle of *Atrichopogon*, including illustrations of immature stages, are presented in Ewen and Saunders (1958) and Boesel and Snyder (1944).

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[1] Received December 23, 1999. Accepted July 5, 2000.

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MATERIALS AND METHODS

Collection, Identification and Processing of Biting Midges

Insects were captured with a standard New Jersey light trap into saline solution from the environs of Salisbury, Wicomico County, Maryland. Other small Diptera were field collected from flowers and vegetation with a fine-mesh insect net and aspirated into plastic vials, either refrigerated or frozen, and subsequently placed in saline. The saline solution consisted of Dulbecco's phosphate buffered salt solution (Cellgro^{TM}) to which Penicillin G (1000 units/500 ml) and several drops of a surfactant (Tween 20) were added. Ceratopogonids were removed from collected material and sorted in the saline solution using a dissecting microscope, identified to genus or species, and transferred to snap-cap culture tubes containing fresh saline. If collections yielded large numbers of specimens, they were processed immediately; if not, specimens were pooled in lots of up to 100 individuals, and chilled or frozen for later processing.

Since spiroplasmas and entomoplasmas are known inhabitants of insect gut tissues, other researchers have extracted the entire gut or portions thereof from large insects for their mollicute isolation attempts (Markham et al. 1983; Wedincamp et al. 1996). Due to the small size of biting midges, we ground up entire insects, often in pooled samples of up to 100 individuals if large numbers were available, similar to what others had done when attempting to isolate mollicutes from mosquitoes (Chastel et al. 1990; Chastel and Humphery-Smith 1991). Midges were transferred from storage vials to depressions in white porcelain plates, surface sterilized with 0.5% sodium hypochlorite for 20-30 seconds, and immediately rinsed 3 times with sterile distilled water. Specimens were finely ground in porcelain plate depressions, using the sanded end of a glass rod and a small amount of R_2 medium (Chang 1989). The resulting mixture was extracted with a hypodermic needle and syringe into the remaining portion of about 2 ml of R_2, filtered through 0.2 µm filters, and the filtrate was deposited in sterile snap-cap culture tubes. Tubes were incubated at 26-30° C for up to one month and checked periodically for a pH change (color change from clear red to clear yellow), indicating the presence of mollicutes. Tubes that became contaminated with other microbes typically turned cloudy yellow or whitish and were discarded. Voucher specimens of the *Atrichopogon* are in WLG's synoptic collection of biting midges at Salisbury State University (SSU) and isolates of our *Spiroplasma* are maintained at SSU and Towson University (TU).

Cultivation Techniques

The isolate was grown in primary culture (Markham et al. 1983) and was subsequently triple cloned (Tully 1983) in M1D medium (M1D) (Whitcomb 1983). Growth of the organisms was determined by the phenol red indicator color changes as described above, which are caused by acidic metabolic waste products excreted by the mollicutes, and by examining the cultures using dark-field microscopy at 450X and 1000X to determine microbial activity and helicity. Cultures were maintained by regular 1:10 dilution passes into M1D. Growth in M1D containing penicillin at 1000 units/ml indicates penicillin insensitivity, a primary characteristic of spiroplasmas (Whitcomb et al. 1987).

Serological Analysis

A spiroplasma deformation test (DF) (Williamson et al. 1978) was performed to compare the new midge isolate with all previously described spiroplasmas type strains for which antisera are available (Williamson et al. 1998). Hyperimmune antisera to this set of previously established *Spiroplasma* species were obtained from reference collections at TU. For the DF test, 50 µl of diluted antiserum (1:10) was added to each well on a microtiter plate. Then, 50 µl of our *Spiroplasma* isolate culture was added to each well to give a final dilution of 1:20. Cultures of this isolate were allowed to incubate for 30 min., and drops of the culture were placed on a clean slide, covered with an 18-mm cover glass and viewed at 1000X using dark-field microscopy. Controls consisted of adding our isolate to wells without antisera. Positive deformation tests were performed using spiroplasma strains EA-1, DF-1 and TAAS-1 against their respective antisera. A specific homologous antiserum deformed spiroplasma cells into spheroidal grape-like forms, which could be readily identified. Quantitative relationships among various sera dilutions were determined by dark-field microscopy, and samples containing sera dilutions and a measured number of organisms were kept constant.

RESULTS

Table 1 presents genera and/or species of 409 biting midges processed

TABLE 1. Biting midges examined for the presence of spiroplasmas during 1997.

Genus/species	Subfamily	Tribe	No. processed
Atrichopogon geminus+levis	Forcipomyiinae	Forcipomyiini	259*
Forcipomyia (*F.*) *bystraki*	"	"	6
Forcipomyia (*F.*) sp.	"	"	19
F. (*Caloforcipomyia*) *glauca*	"	"	26
Culicoides sp.	Ceratopogoninae	Culicoidini	86
Downeshelea stonei	"	Ceratopogonini	4
Monohelea bifurcata	"	"	2
Stilobezzia stonei	"	"	3
Clinohelea bimaculata	"	Heteromyiini	1
Bezzia nobilis	"	Palpomyiini	1
Palpomyia plebeja	"	"	1
Phaenobezzia opaca	"	"	1
		Total processed	409

* indicates sample that yielded GNAT3597

during 41 separate isolation attempts during 1997, of which only one pooled sample (males and females) of 33 specimens of *Atrichopogon* was positive for the presence of spiroplasmas, herein designated as GNAT3597. Growth of GNAT3597 in media containing penicillin (R_2 and M1D) and examination under dark-field microscopy revealed the characteristic helical morphology and motility characteristic of spiroplasmas. In addition, serological assays were performed against all available spiroplasma antisera series, none of which cross-reacted with GNAT3597.

DISCUSSION

This is the first report of spiroplasmas from Ceratopogonidae. Our preliminary serological analyses suggest that GNAT3597 is an undescribed species of *Spiroplasma*. At least 4 different species of spiroplasmas are known from mosquitoes (Williamson et al. 1998), which are closely related to biting midges, as both families are members of the infraorder Culicomorpha of Nematocera, the more primitive suborder of Diptera (Wood and Borkent 1989). Because spiroplasma infection rates in Culicidae are typically less than 10%, all of these mosquito spiroplasmas were obtained from pooled samples of 20 or more individuals that were processed at one time (Chastel and Humphery-Smith 1991). Spiroplasmas are more readily isolated from abdominal viscera of Tabanidae and Syrphidae, members of the more derived suborder of Diptera (Brachycera), with an overall infection rate of about 50% (French et al. 1990). Presently, 14 different species of spiroplasmas are known from tabanids and one species is known from a flower fly (Williamson et al. 1998). Our discovery suggests that spiroplasmas will prove to be even more widespread among other families of Diptera.

Atrichopogon levis (Coquillett) is a widespread biting midge in North America, that is often so common in suitable habitats, including residential lawns, that Boesel and Snyder (1944) nicknamed it "the grass punky". Due to variation within *A. levis*, Boesel (1973) proposed the new species, *A. geminus*, and noted that all of the specimens studied and illustrated by Boesel and Snyder (1944), actually pertain to *A. geminus*. However, in order to accurately distinguish between these two very similar species, specimens must be mounted on microscope slides, and detailed measurements obtained for several sections of the wings of both sexes (Boesel 1973). Obviously, this was impossible for those specimens that were processed for isolation of spiroplasmas. Several individuals of both sexes from our collection sites were slide-mounted in Canada balsam (Wirth and Marston 1968) and compared with material in the SSU synoptic collection of ceratopogonids. Both species were present in our field-collected material, but, *A. levis* was much more common than *A. geminus*. Because of the very real difficulty in distinguishing between individual specimens belonging to these two apparently sibling species, no attempts were to distinguish the specimens that were processed, and we have referred to all specimens in this study as *A. geminus + levis.*

Adult females of most species of *Atrichopogon* have well developed mandibles and maxillae which they employ as ectoparasites to obtain a blood meal from other insects (Wirth 1956b). For example, species in the subgenus *Meloehelea* are ectoparasites of blister beetles (Meloidae) (Wirth 1956a, 1980). Females of other species of *Atrichopogon* with well developed mandibles and maxillae are presumed ectoparasites of other insects, but feeding records are unknown for these (Wirth 1979, 1994). However, females of some *Atrichopogon* have vestigial mandibles and maxillae that resemble these structures in nonblood-feeding males. Such is the case with females of *A. geminus* and *A. levis,* which are autogenous and capable of producing an egg clutch from food reserves obtained as larvae. As in all other ceratopogonids, both sexes of these nonblood-feeding species of *Atrichopogon* obtain nectar from flowers.

An understanding of how ceratopogonids acquire spiroplasmas is important, particularly if they have potential as a pathogenic agent, and there are several possibilities. Boesel and Snyder (1944) made detailed observations of the feeding habits of the larvae of *A. geminus* (as *A. levis*) that they reared on algal covered pieces of soil. Therefore, larval *Atrichopogon* may become infected with spiroplasmas when they graze on algae. Adult females that are ectoparasites of blister beetles may become infected from their hosts' hemolymph. Finally, adults may infect themselves as they probe flowers for nectar or sponge honeydew excreted by Homoptera on leaf surfaces.

In the case of GNAT3597, we rule out the possibility that these adult *Atrichopogon* became infected from the hemolymph of other insects because both sexes are incapable of taking blood meals. We have recently obtained a spiroplasma isolate from an all-male pooled sample of the predaceous midge genus, *Monohelea* (unpublished). This discovery suggests that males or females (or both) in our mixed sample of *Atrichopogon* may have been the source of GNAT3597. Although larvae of *Atrichopogon* may become infected with spiroplasmas as a result of their feeding on algae, we are not confident that they do so. Given that many species of spiroplasmas are known inhabitants of vascular plants, the most likely hypothesis is that biting midges become infected as adults from flowers or leaf surfaces.

ACKNOWLEDGMENTS

The antisera used in the preliminary serological analyses were produced by J. G. Tully, NIH-AID Mycoplasmology Laboratory, Frederick, MD (now stored at TU). Special thanks are due to Frank French who supplied us with R_2 media and provided numerous helpful suggestions on laboratory techniques. We also thank F. French, A. Scarbrough and three anonymous reviewers for their helpful reviews of an earlier draft of the manuscript.

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SCIENTIFIC NOTE

OBSERVATIONS ON THE BREEDING BEHAVIOR OF THE SPIDER *GLENOGNATHA HELEIOS* (ARANEAE: TETRAGNATHIDAE)[1]

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In collections of storm tide detritus (wrack) from Great Sippiwisset Marsh, West Falmouth, Barnstable County, Massachusetts, made on January 1, 2000, the tetragnathid spider *Glenognatha heleios* Hormiga, known from New Jersey, was found. Five adult males, 35 adult females, and one penultimate male were taken from approximately 2 m² of wrack. Two males were missing tegula on one palpus but retained the cymbium and paracymbium. At the time of these collections, the breeding habits of other spiders from the marsh were being studied, and it was decided to see if adult *G. heleios* would also breed. Three individuals of each sex were separately placed in 50 mm Petri dishes with absorbent pads (Fisher Scientific No. 09-753-53 C) and kept at 20° C. The pads were moistened with two drops of water. The specimens were fed with vestigial-winged fruit flies (*Drosophila*), and small sand fleas (*Orchestia sp.*), both of which they ate. Occasionally the spiders moved around on the bottom of the Petri dish, making a little webbing with no obvious structure. Detailed observations were carried out with a Bausch & Lomb Stereo-Zoom 7® binocular microscope.

When males were placed with females (two instances) on January 2, the two sexes came together almost immediately, and so precipitously at first that it appeared to be an attack. The male, in one instance, gripped both chelicerae of the female firmly with his chelicerae on the frontal surface with the fangs around and behind the female's chelicerae. In the second instance, the male gripped only one of the female's chelicerae.

In the first instance, the male pushed the female into an almost upright position and began probing with the left palpus for the left side of the epigynium. Once located, five insertions of lengthy duration (± 30 seconds) followed with the hematodocha remaining expanded. After four minutes, the hematodocha deflated and the right palpus was inserted into the right side of the epigynum. This was followed by 18 slow, rhythmic inflations without removing the embolus. The male occasionally pushed the female back with third and fourth legs. The female also occasionally touched the tegulum with her third leg. For the next two hours, the embolus remained inserted, with the hematodocha regularly, but slowly, pulsing from deflated to fully inflated in five to eight seconds, remaining fully expanded for longer periods (up to one minute after two hours). As the duration of the expansions increased, the legs tended to straighten with the expansion of the hematodocha, and conversely relax and curl up with deflation. Eventually, the male's grip on the female became even looser, and shortly thereafter they separated with much struggling. One egg sac was produced on 25 Jan., with an outer, white, fluffy covering, 7 X 5 mm, lenticular and fastened to the side of the dish. Inside was a denser but still fluffy layer of silk, also white. This sac had the appearance and shape of that of *Leucauge venusta* (Walckenaer) illustrated in Levi 1980, (Plate 3, p. 24). When opened on 10 February, the egg sac contained 12 amber colored, 0.5 mm developing eggs.

In the second instance, the legs of the mating pair were loosely engaged, with the fourth pair mostly in contact. The male had difficulty inserting the right palpus, but then succeeded in inserting the left. Once insertion occurred the embolus remained in place for nearly two hours. Initially, the hematodocha 'pulsed' at a rate of ± 4 seconds for nearly 30 minutes, after which a

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ENT. NEWS 112(1): 71-72, January & February, 2001

longer inflation-deflation cycle of three to four minutes occurred for the next 70 minutes. Shortly thereafter, the female began to struggle to disengage. The chelicerae were only loosely held by either sex, and the male was forced to withdraw the embolus and momentarily separate from the female. The male regained the mating position almost immediately and again inserted the left embolus. After four brief inflations they separated again for the last time. An egg sac was produced on 27 January, in structure exactly as the first, and contained 9 eggs. The eggs were well advanced when the egg sac was opened on 12 February.

Barrows' (1919) description of the mating of *Glenognatha foxi* (McCook) is similar to that of *G. heleios* Hormiga but differs in one particular feature, namely the description of alternate insertions; "the male inserts the palpal organs alternately, keeping each inserted for perhaps five minutes," and that "This copulation occupied about fifteen minutes, during which time each bulb was inserted twice." In our two observations, after some trial and error with one palp, only the other palp was fully utilized, and the embolus remained inserted for more than two hours. Further, there appeared to be no attempt on the part of either sex to "grasp each other with their legs". Barrows' fig. 2 (page 211) is generally the way our spiders appeared, with the slight exception that the tegulum of the free palp was held much closer to the eyes of the male.

In their New Jersey marsh study, Hormiga and Döbel (1990) found just a few adults as late as June, with the juveniles peaking in August. Adults reappeared from September on. Our spiders were ready to mate in January, perhaps because we provided temperatures in the laboratory more like those in the marsh in early spring. The missing tegulum of two of the males collected may indicate these spiders had mated earlier.

ACKNOWLEDGMENT

Eric H. Edwards assisted in the observations and kindly critiqued the first draft.

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US ISSN 0013-872X
VOL. 112 MARCH & APRIL, 2001 NO. 2

ENTOMOLOGICAL NEWS

SCIENTIFIC NOTES

THE AMERICAN ENTOMOLOGICAL SOCIETY

ENTOMOLOGICAL NEWS is published bi-monthly except July-August by The American Entomological Society at the Academy of Natural Sciences, 1900 Benjamin Franklin Parkway, Philadelphia, Pa., 19103-1195, U.S.A. AES office phone: 215-561-3978; e-mail: aes@ansp.org; website: http://www.ansp.org/aes.

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DESCRIPTION OF MATURE LARVAE OF *MEGACHILE ROTUNDATA, M. APICALIS,* AND THEIR PARASITE, *COELIOXYS RUFOCAUDATA* (HYMENOPTERA: MEGACHILIDAE)[1]

F. Torres,[2] S. F. Gayubo[2]

ABSTRACT: A description is offered of the mature larvae of two leaf-cutter bees: *Megachile apicalis* and *M. rotundata* as well as of their natural enemy *Coelioxys rufocaudata* comparing them with the previously described larvae of the genera *Megachile* and *Coelioxys*, respectively. The most outstanding morphological aspects are the presence of tegumental microspicules in *M. rotundata* and *C. rufocaudata*, with a different arrangement in each of them, and the mandibular morphology of *C. rufocaudata*, with strong superficial setae and a marked tooth on the cuspal area.

Megachile apicalis Spin. and *M. rotundata* (F.) are two related species from Eurasia that, via different routes, have colonised the north of the American continent. The former has been reported in the U.S.A. and Canada since the 1980's while presence of the latter has been recorded since the 1930's (Cooper, 1984; Eves, 1982; Hurd, 1954; Stephen & Torchio, 1961). *Coelioxys rufocaudata* Sm. is associated with these species phylogenetically and through its cleptoparasitic activity. It parasitizes principally *M. rotundata* (Asensio, 1982), although to a lesser extent its presence has also been detected in nests of *M. apicalis* (Torres, 1992). This cleptoparasite is the main menace to the natural populations of *M. rotundata* (Asensio & Rodríguez, 1972; Carré & Py, 1981; Manninger, 1972; Tasei, 1975), although in North America it is no more than a second-order natural enemy (Waters, 1971).

The commercial interest in *M. rotundata* as an alfalfa pollinator, has resulted in several studies about its biology, nesting behavior and embryogenesis (Gerber & Klostermeyer, 1972; Klostermeyer, 1982; Klostermeyer et al. 1973). To a lesser extent, the same is the case of *M. apicalis.* At locations where the populations of both species overlap, competition for nesting holes has been observed (Trostle & Torchio, 1994). Life history data are also available for *Coelioxys rufocaudata* (Carré & Py, 1981). However, no studies about the morphology of the mature larvae of any of the species have been conducted. Here we characterize the morphology of the mature larvae of all three species.

MATERIALS AND METHODS

We studied ten postdefecating larvae of *M. apicalis* collected at Barrios de

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ENT. NEWS 112(2): 73-84, March & April, 2001

Sala, León, Spain (reference 9502001) and Villarino de los Aires, Salamanca, Spain (references 950401 and 950505); twelve postdefecating larvae of *M. rotundata* collected at Barrios de Sala (reference 9501014) and from a Canadian commercial origin; and ten postdefecating larvae of *C. rufocaudata* collected at Salvatierra de Tormes, Salamanca, Spain (reference 94090801013) and Villarino de los Aires (reference 950302). All larvae were obtained from trap-nests established in the field in 1994-1995, except the Canadian larvae.

Both adult and immature specimens are deposited in the Collection of the Departamento de Biología Animal, Ecología, Parasitología y Edafología of the Universidad de Salamanca, Spain.

Descriptions are based on postdefecating larvae preserved in 70% EtOH, which were cleared in KOH, colored with basic Fuchsine, and were examined in glycerine.

The terminology we use in the descriptions follows that of Eickwort (1973), Michener (1953), and Rozen (1994).

In our use of the term "setiform spicules" we have followed the approach of Rozen (1987). However, the difference between seta and setiform spicule is not always clear, and would be necessary to carry on a detailed histological study to come up with a better distinction between these structures (Rozen, pers. com.).

DESCRIPTIONS OF LARVAE

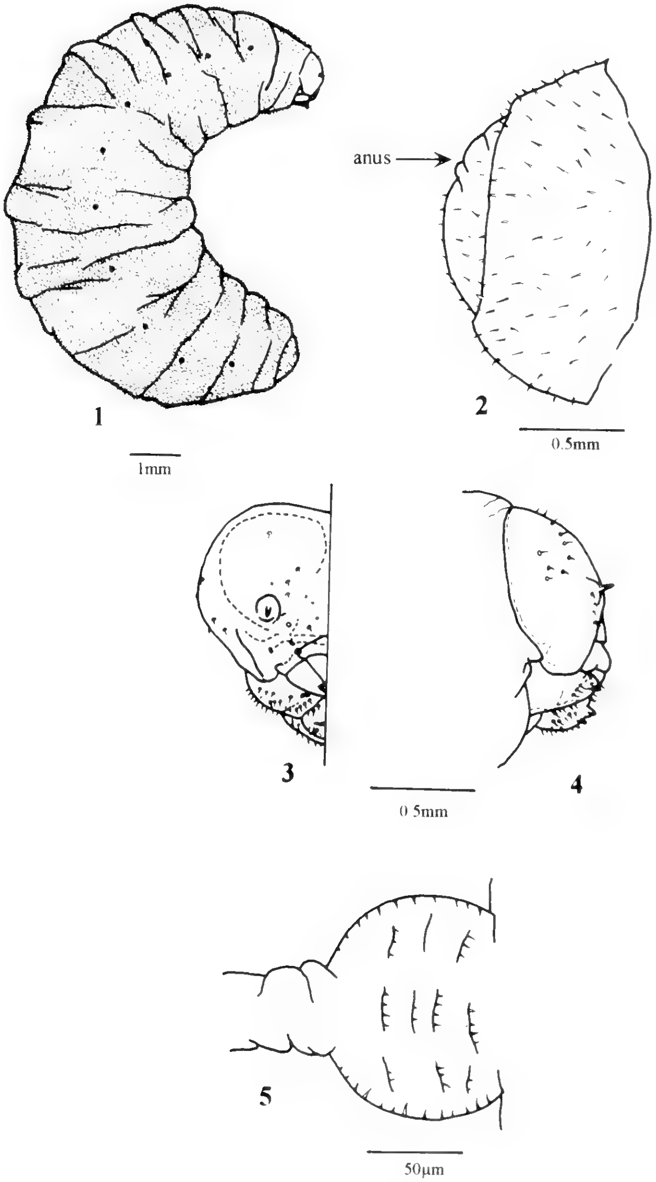
Megachile apicalis Spinola

Figures 1-10.

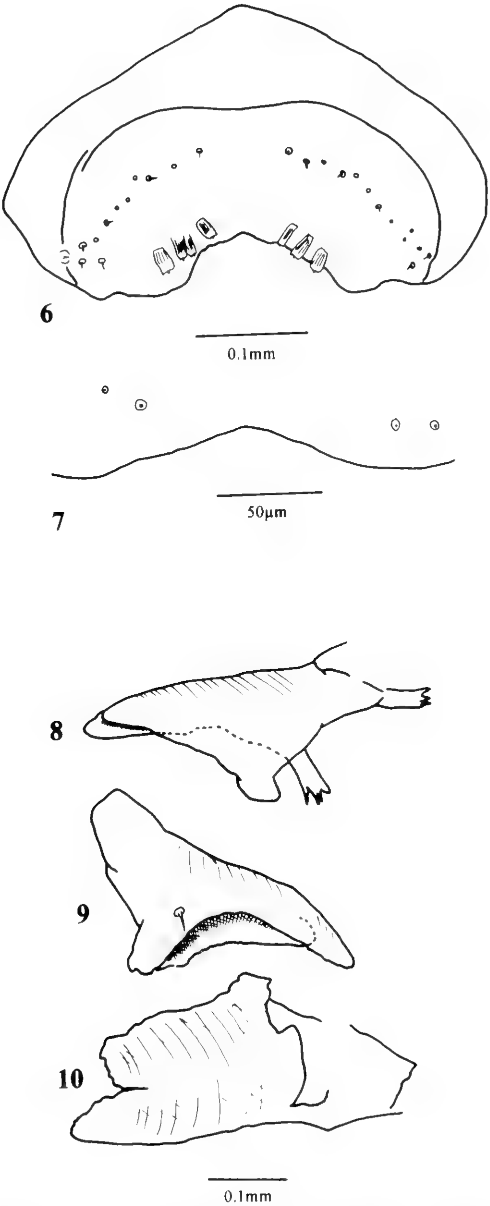
Body (Fig. 1): C-shaped, robust (length (l) = 11.4mm; width (w) at widest = 3.4mm), with maximum width at abdominal segment IV. Color yellowish white. Intersegmental lines clearly visible on dorsal and ventral areas. Cephalic and caudal annulets with poorly defined separation (but more than in *M.rotundata*). Middorsal tubercles marked, mainly on abdominal segments I-V. No lateral tubercles. Integument with numerous large setiform spicules (~50µm) distributed across whole of surface. Abdominal segment X centered on segment IX (Fig. 2). Anus dorsoapical, transverse, with two labia bordering it. Spiracles (height (h) of atrium: range (r) = 69-70µm; n = 4; mean (m) = 69.25µm; diameter: (d): range (r) = 107-113µm, n = 4, mean (m) = 109.5µm) without sclerites. Atrium hemispherical (Fig. 5), slightly projecting from integument surface, with spines forming irregular linear groups. Primary tracheal opening narrow, without spines. Subatrium formed by a varying number of chambers with smooth walls.

Head (Fig. 3): (h = 1.24mm; w = 1.22mm). Integument relatively well sclerotized; mandibular apices, labrum and parts of tentorium more pigmented; setae dispersed, relatively abundant on pleurostomal areas and on frons; placoid sensilla (pore-like sensilla of Eickwort, 1973) dispersed and scarce. Anterior and posterior tentorial arms, pleurostomal ridge, and hypostomal ridge well developed. Anterior and posterior tentorial pits visible. Parietal bands inconspicuous. Antennal discs (d = 0.57mm) elevated. Antennal papilla (l = 1.39µm; w = 25µm) slightly narrowed towards apex, with three small sensilla.

Vertex without protuberances (Fig. 4). Frontoclypeal suture absent. Postoccipital ridge visible but not very marked. Frontoclypeal area smooth, without well defined pore-



Figs. 1-5.- *Megachile apicalis*, mature larva; 1, lateral view; 2, right side view of anal opening and IX-X abdominal segments; 3, frontal view of head; 4, lateral view of head; 5, spiracle.



Figs. 6-10.- *Megachile apicalis*, mature larva; 6, frontal view of labrum; 7, frontal view of epipharynx. 8, dorsal view of right mandible; 9, ventral view of right mandible; 10, inner view of right mandible.

like sensilla distributed over surface except on central zone; seven dome-shaped sensilla (elevated submarginal sensilla of Eickwort, 1973) on anterior margin (Fig. 6). Labral tubercles absent. Labral margin arcuate and undulating. Epipharynx nonspiculate (Fig. 7) with two pairs of pore-like sensilla.

Mandibles bidentate, with ventral teeth larger (Fig. 8); mandibular apices meeting at mid-line; a strong seta on ventral surface (Fig. 9); edges irregular (Fig. 10); inner concavity clearly defined; cusp not developed. Labiomaxillary region projecting in lateral view. Maxillae differentiated from labium, scarcely sclerotised, and with pronounced setae distributed over outer surface, without spicules; cardo and stipes present. Maxillary palpus on apical third of external surface; subapical in lateral view (l = 35μm; w = 18μm); two small sensilla on apex. Galeae absent. Labium divided into prementum and postmentum, sparingly sclerotized (although more so than maxillae). Labial palpus (l = 40μm; w = 16μm) slightly below salivary lips, narrowing towards apex and with three small sensilla on its end. Salivary lips broad, flattened and prominent. Prementum with numerous strong setae on lower part, on both sides of salivary lips. Hypopharyngeal area nonspiculate, without noteworthy characteristics.

Megachile rotundata (Fabricius)

Figures 11-20

Same as *M. apicalis* except:

Body (Fig. 11): (l = 9.3mm; w at widest = 3.2mm) with maximum width at abdominal segment VI. Intersegmental lines well marked ventrally, less visible dorsally, and disappearing in pleural areas. Small middorsal tubercles on intersegmental zones, mainly marked on middle segments (thoracic II and abdominal I-VII). Lateral bulging marked, mainly among abdominal segments I-VII. Integument with setiform spicules (~100μm) abundant on dorsal surface, lateral tubercles and region ventral to anus; longer on thoracic and last abdominal segments; ventrally, spicules are shorter and scarcer. Anus with two labia bordering it (Fig. 12). Setiform spicules dispersed over surface of abdominal segments IX and X. Large number of tiny spines (~1.5μm), mainly ventrolateral to anus, on ventral areas of abdominal segments IX and X. Ventral to anus, at center of segment X, pore-like sensilla in large numbers with a diameter of ~1.5μm. Spiracles globular, flattened apically (height: r = 55-57μm, n = 4, m = 56.25μm; diameter: r = 98-99μm, n = 4, m = 98.75mm); atrial walls slightly ringed externally and internally (Fig. 15). Subatrium with tiny spines arranged in small ridged bands inside.

Head (Figs. 13, 14): (h = 1.07 mm, w = 1.28 mm). Setae dispersed, more abundant on genal and frontal areas. Some pore-like sensilla on surface. Antennal papilla (l = 45μm, w = 36.5μm).

Labrum presenting setiform and pore-like sensilla irregularly dispersed over whole surface; seven elevated submarginal sensilla in the margin (Fig. 16). Epipharynx with two groups of sensilla (4+4) arranged diagonally to both sides (Fig. 17).

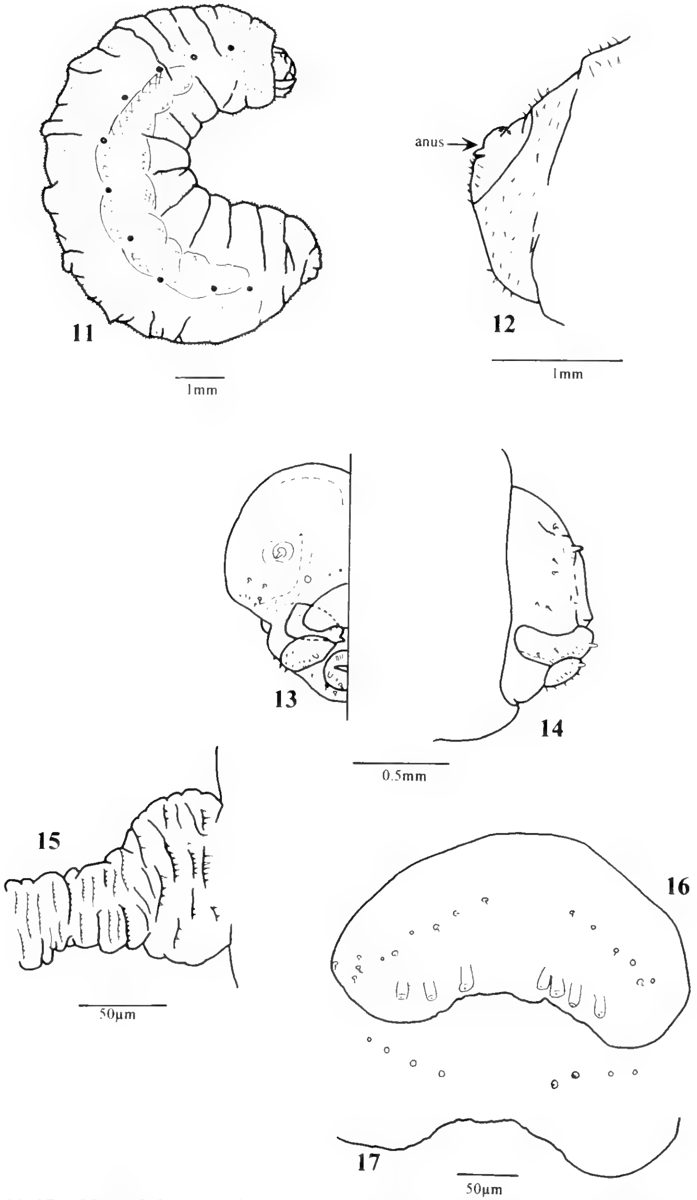
Mandibles (Figs. 18, 19) with parallel longitudinal striae on surface; edges smooth with exception of apex of dorsal tooth, slightly serrated (Fig. 20). No setae on outer surface. Maxillary palpus (l = 36.5μm, w = 19 μm) with three small sensilla visible at apex. Labial palpus (l = 34.9μm, w = 22.2μm) with three small sensilla at apex. Ventral surface of labium with more or less dispersed setae. Salivary lips projected strongly in lateral view, occupying slightly more than half of width of prementum.

Coelioxys rufocaudata Smith

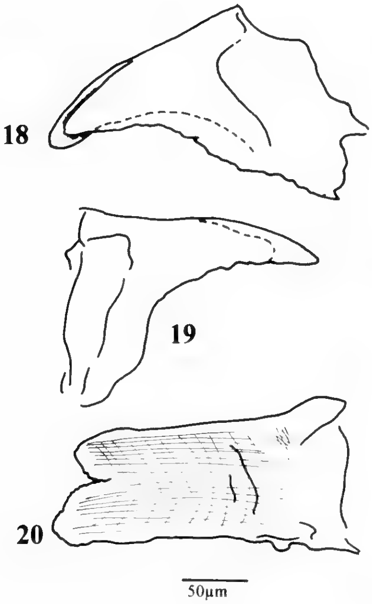
Figures 21-31

Similar to *M. apicalis* except:

Body (Fig. 21): (l = 11.1mm; w at widest = 2.9mm) with maximum width at abdominal segment IV. Small middorsal tubercles at intersegmental zone, well marked on ab-



Figs. 11-17.- *Megachile rotundata*, mature larva; 11, lateral view; 12, right side view of anal opening and IX-X abdominal segments; 13, frontal view of head; 14, lateral view of head; 15, spiracle; 16, frontal view of labrum; 17, frontal view of epipharynx.



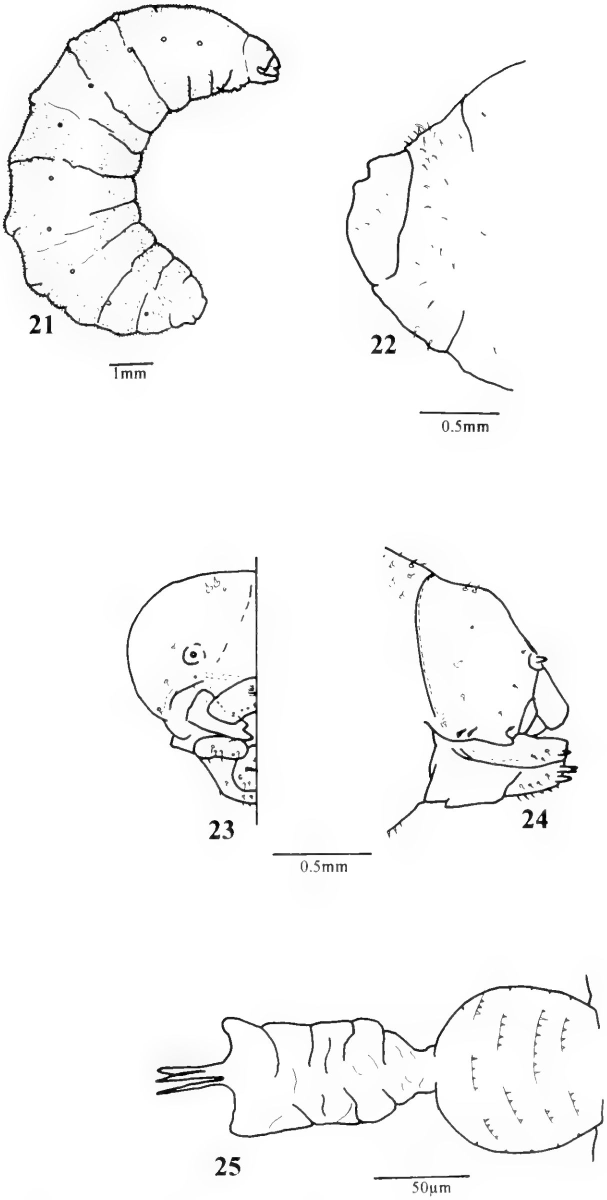
Figs. 18-20.- *Megachile rotundata*, mature larva; 18, dorsal view of right mandible; 19, ventral view of right mandible; 20, inner view of right mandible.

dominal segments II-V. Small spicules (similar to those seen in *M. rotundata*) distributed across surface. Abdominal segment IX centered on X (Fig. 22). Abundant setiform spicules on abdominal segments IX and X. Spiracles more pigmented than in the other two species described; atrium (height: r = 85-87µm, n = 4, m = 86µm; diameter: r = 95-96µm, n = 4, m = 95.5µm); atrial wall slightly ringed externally and internally; internal wall with abundant spines and denticles of varying length (Fig. 25).

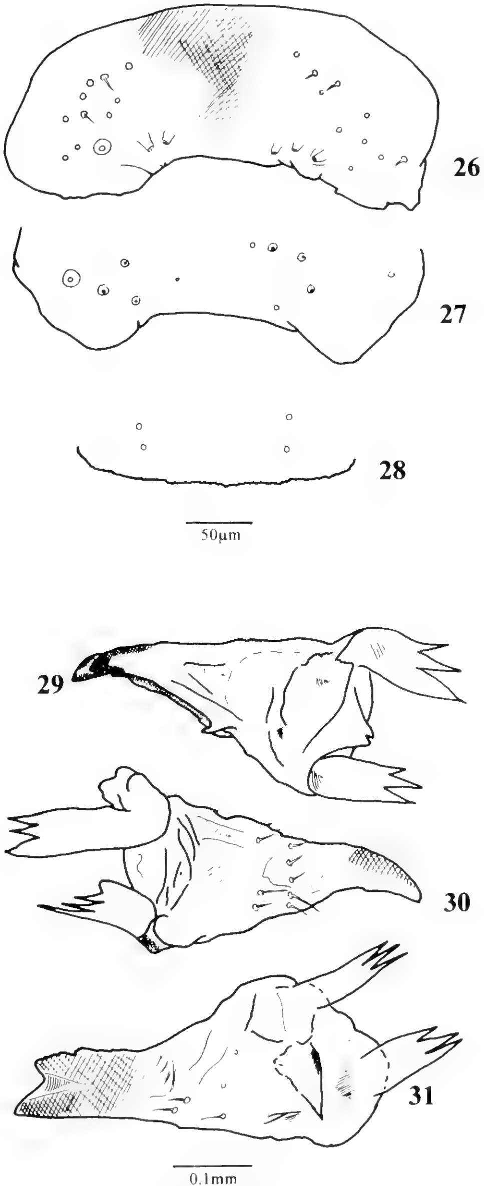
Head (Fig. 23): (h = 1.17mm, w = 1.27mm). Setae and pore-like sensilla scanty and dispersed. Antennae slightly prominent; antennal papilla (l = 35µm; w = 26µm) with four small apical sensilla. Vertex more or less uniformly rounded (Fig. 24). Frontoclypeal suture absent. In lateral view, labrum strongly projected towards the exterior, displaying setiform and pore-like sensilla irregularly dispersed over whole surface. Six elevated submarginal sensilla in the margin (Fig. 26). Epipharynx with 11 sensilla arranged on both sides (Fig. 27).

A projection extending downwards immediately behind the mandible can be observed in the lateral view.

Mandibles (apices not meeting at midline) with external edge of dorsal tooth serrated at its end (Fig. 29); inner concavity not very deep and marked by a well developed tooth on the cuspal area (Fig. 30); three setae on internal face (adoral) and eight on external face (aboral) (Fig. 31). Maxillary palpus (l = 32µm; w = 16µm) with one sensilla at apex. Labial palpus (l = 50µm, w = 17µm) with two small sensilla at apex. Ventral surface of labium with more or less dispersed setae. Hypopharynx smooth, with four pore-like sensilla (Fig. 28).



Figs. 21-25.- *Coelioxys rufocaudata*, mature larva; 21, lateral view; 22, right side view of anal opening and IX-X abdominal segments; 23, frontal view of head; 24, lateral view of head; 25, spiracle.



Figs. 26-31.- *Coelioxys rufocaudata*, mature larva; 26, frontal view of labrum; 27, frontal view of epipharynx; 28, frontal view of hypopharynx; 29, dorsal view of right mandible; 30, ventral view of right mandible; 31, inner view of right mandible.

DISCUSSION

Bearing in mind that as mature larvae, the members of the Megachilinae are homogeneous, including even the parasitic forms such as *Coelioxys* (Baker, 1971; Rozen, 1973), the diagnostic differences among the three species studied are based on minimal variations in morphological characters.

Most previous studies on the larval morphology of different species of *Megachile* and *Coelioxys* have been limited to describing the species, without establishing any bases by which one species can be distinguished from others (Baker, 1971; Baker et al. 1985; Buysson, 1902; Danks, 1970; Grandi, 1961; King, 1984). Both the previously known larvae and those described here show considerable morphological similarity. Thus, with the rest of the species of *Megachile,* both *M. apicalis* and *M. rotundata* share an abundant body pilosity due to a broad distribution of setiform spicules. Furthermore, in both species the head capsule is round, unlike those of other known species such as *M. nigriventris* Schenck (Michener, 1953) and *M. mendica* Cresson (Baker et al. 1985), which have head tubercles, or *M. lagopoda* (L.), which has depressions on its head (Buysson, 1902).

With *M. argentata* (F.) and *M. centuncularis* (L.) (Grandi, 1961), *M. apicalis* shares the presence of two sensilla on the maxillary palpus and does not show any outstanding characters that allow its specific differentiation.

M. rotundata also shows shared characters with some previously described species, such as lateral tubercles (also present in *M. mendica* (Baker et al. 1985) and a spiracular subatrium with small spicules (a character shared with *M. brevis* Say (Michener, 1953) and *M. montivaga* Cresson (Baker et al. 1985). Additionally, this species has characters that have not been observed in previously described species such as the existence of perianal pore-like sensilla and the presence of microspicules on the tegumental surface. This latter character, however, is shared with *C. rufocaudata*, although in the case of *M. rotundata* their presence is restricted to the perianal zone whereas in *C. rufocaudata* the microspicules are distributed across the whole of the body.

Of the genus *Coelioxys*, although some immature larval stages, corresponding to *C. modesta* Sm. (Baker et al. 1985) and *C. elongata* Lep. (Iwata, 1939), are known, only the mature larvae of *C. octodentata* Say and *C. sayi* Robertson were known previously (Baker, 1971; Baker et al. 1985; Michener, 1953). Both these species and *C. rufocaudata* (described here) always have mandibles with a marked and setose cusp (with a varying number of setae, but always many) and a lateral cephalic projection behind the mandible, as a reminiscence of the well developed head capsule of previous larval stages. Accordingly, these two characters could be taken as valid for a generic separation between the mature larvae of *Coelioxys* and those of *Megachile*. In particular, the occurrence of a mandibular cusp and of long labial palpi (both considered primitive (Michener, 1953)), together with the presence of the lateral projection on the head, are perhaps the most outstanding characters of *C. rufocaudata* mature larvae.

Finally, the presence of sensilla on the perianal zone of *M. rotundata* allows us to add another character to the list of those shared between Megachilidae and Fideliidae established by Rozen (1979) and also between those two groups and *Pararhophites* (McGinley & Rozen, 1987; Roig-Alsina & Michener, 1993).

ACKNOWLEDGMENTS

The authors are specially grateful to C.D. Michener (Snow Entomological Museum, University of Kansas, Lawrence, USA) and J.G. Rozen, Jr. (American Museum of Natural History, New York) for revising this manuscript and their helpful comments to improve the final draft.

A grant from research project DGES PB-97-1345 partly supported this study.

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CADDISFLY (TRICHOPTERA) RECORDS FROM THE APACHE NATIONAL FOREST, EASTERN ARIZONA[1]

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ABSTRACT: Fifty-one caddisfly species were collected from 14 sites in the Apache National Forest in eastern Arizona during May 1998 and June 1999. Of these, 33 are reported from the forest for the first time, five are recorded from the state for the first time, one is tentatively recorded from the United States for the first time, and three are new to science. The level of discovery of unreported species during this limited study suggests that documentation of much of the Arizona fauna remains incomplete.

The caddisfly fauna of Arizona is not well known; even a basic checklist for the state is yet to be compiled. Regional and watershed-level studies have recently documented undescribed species and state records (Gray 1981, Moulton et al. 1994, Govedich et al. 1996, Ruiter 1996, 1999). Approximately 118 species are reported from the state, largely through collections made in the 1940s through the 1960s by D. G. Denning and H. H. Ross and through systematic revisions of certain genera (e.g., Flint 1974, 1984, Gordon 1974, Parker and Wiggins 1985). Approximately 176 and 200 species, respectively, are known from the adjacent states of Colorado (Herrmann et al. 1986) and Utah (Baumann and Unzicker 1981).

Arizona shares affinities with both the Nearctic and Neotropical regions due to its geographic location and the presence of the Rocky Mountains. The southwestern one third of the state is composed of the American and Chihuahuan Desert biotic provinces characterized by desert plains below sea level, isolated mountain peaks, and a hot arid climate with few permanent streams (Figure 1) (Bailey 1980). The Rocky Mountains pass through the northeastern two thirds of the state and give rise to the Colorado Plateau Semidesert and Mountain Semidesert–Alpine Meadow biotic provinces which have higher elevation and a cooler climate. The latter province is characterized by elevation frequently greater than 3500 m, snowfall during the winter, and cool permanent mountain streams. The statewide ecological diversity suggests a diverse and interesting fauna although this might be offset somewhat by Arizona's arid climate.

The Apache National Forest encompasses over one million acres in eastern Arizona all contained within the Mountain Semidesert–Alpine Meadow biotic province (Figure 1). The forest's elevation varies from 1130 to 3710 m and contains habitats ranging from alpine forests and meadows to high desert

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[1] Received June 5, 2000. Accepted July 25, 2000.

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ENT. NEWS 112(2): 85-93, March & April, 2001

plateau and chaparral. There has not been a concerted effort to inventory the caddisflies of the forest. To date, 31 species have been reported, largely through piecemeal collections (Table 1). The purpose of this research was to study the summer-emergent caddisflies of the forest in order to increase the knowledge of the overall statewide fauna.

STUDY SITES

Caddisflies were collected from the following 14 sites within the Apache National Forest. Sites 1–12 were located in Apache County; sites 12–14 in Greenlee County. Latitude, longitude, and elevation were recorded at all sites with a handheld GPS unit. Site numbers correspond to those in Table 2 and Figure 1.

Site 1: Mineral Creek, Forest Road 64, N 34.1810°, W 109.6300°, 2438 m
Site 2: Fish Creek, State Highway 260, N 34.0512° W 109.5430°, 2957 m
Site 3: South Fork, Little Colorado River, South Fork Campground, N 34.0782°, W 109.4104°, 2347 m
Site 4: West Fork, Little Colorado River, Forest Road 575, near Greer, N 33.9938°, W 109.4649°, 2713 m
Site 5: Headwaters, East Fork, Little Colorado River, Forest Road 113, N 33.9312°, W 109.4872°, 2530 m
Site 6: East Fork, Black River, Three Forks Crossing, Forest Road 249, N 33.8550°, W 109.3148°, 2530 m
Site 7: Unnamed Spring into Site #6
Site 8: Nutrioso Creek, U.S. Highway 191, N 33.9185°, W 109.1818°, 2469 m
Site 9: West Fork, Black River, West Fork Campground, N 33.7779°, W 109.4048°, 2438 m
Site 10: East Fork, Black River, Forest Road 276, near Aspen Campground, N 33.8044°, W 109.3194°, 2286 m
Site 11: San Francisco River, Luna Lake Spillway, Forest Road 570, N 33.8280°, W 109.0809°, 2408 m
Site 12: Black River Mainstem, Forest Road 25, N 33.7052°, W109.4526°, 2164 m
Site 13: Blue River, Forest Road 281, near Upper Blue Campground, N 33.6635°, W 109.0917°, 1768 m
Site 14: Blue River, Forest Road 475, N 33.2833°, W 109.1833°, 1280 m

MATERIALS AND METHODS

Larvae and pupae were collected by hand-picking from riverine rocks and woody debris from sites 2 and 4–7 in early May 1998, and from site 8 in late June 1999. Some larvae were preserved in 70% EtOH. The remainder were air-transported to Minnesota where they were reared to adult in a 3 m x 0.6 m x 0.6 m refrigerated tank with simulated ambient temperature, current, and photoperiod.

Adults were collected from sites 1, 3–4, 6, and 8–14 in mid–late June 1999 using either an 8-watt portable ultraviolet light placed over a white enamel pan filled with 70% EtOH, or with two 15-watt ultraviolet lights suspended adjacent to a white bedsheet with subsequent capture of specimens in a cyanide

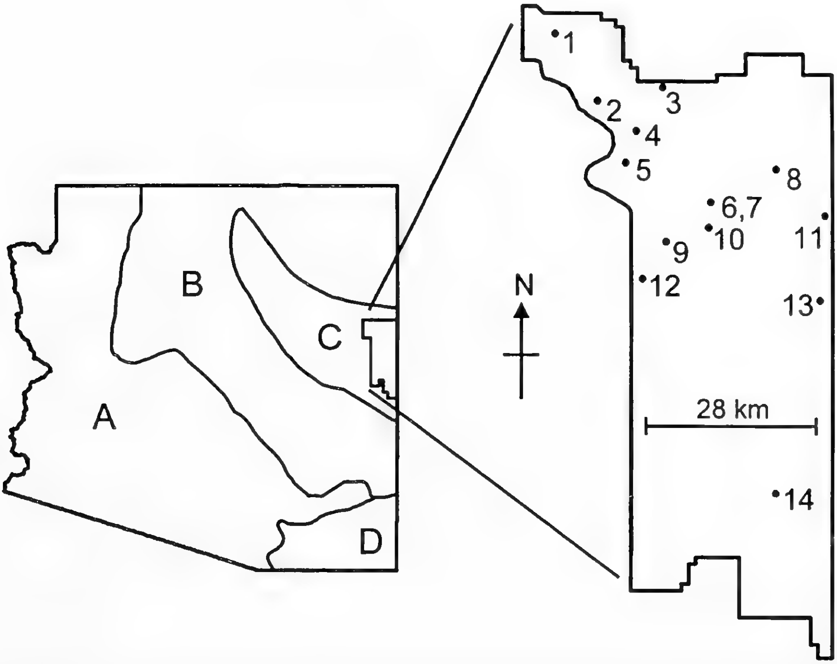

Figure 1. The state of Arizona showing the location of the Apache National Forest and the four biotic provinces occurring within the state, A: American Semidesert and Desert, B: Colorado Plateau, C: Arizona/New Mexico Mountain Semidesert–Alpine Meadow, D: Chihuahuan Desert. Inset: Area of Apache National Forest in greater detail showing collecting localities. Site numbers correspond to Table 2 and "Study Sites" section.

killing jar. Both of these methods were employed shortly before dusk until approximately two hours after dusk. Adults were also collected by diurnal sweeping of riparian vegetation and by passing an aerial net through mating swarms. All specimens mentioned herein are deposited in the University of Minnesota Insect Collection, Saint Paul, Minnesota (UMSP).

RESULTS AND DISCUSSION

Table 2 summarizes the 51 species collected from the 14 localities and denotes forest, state, and country records. Thirty-three species are reported from the forest for the first time, bringing the known total to 46. Sites were not sampled with equal collecting effort so Table 2 should not be interpreted as an exhaustive site comparison.

Five species are reported from Arizona for the first time, all of which have been collected previously from the western United States. *Cheumatopsyche enonis* Ross has been reported from Colorado, Idaho, Montana, Nevada, New

Mexico, Oregon, Utah, and Wyoming (Gordon 1974, Anderson 1976, Roemhild 1982, Ruiter and Lavigne 1985, Herrmann et al. 1986); *Culoptila thoracica* (Ross) from Colorado, New Mexico, Utah, and Wyoming (Flint 1974, Baumann and Unzicker 1981, Waltz and McCafferty 1983); *Micrasema onisca* Ross from California, Nevada, Oregon, and Utah (Ross 1947, Anderson 1976, Chapin 1978, Baumann and Unzicker 1981); *Neotrichia osmena* Ross from Colorado, Utah, and Wyoming (Blickle 1979, Herrmann et al. 1986); and *Protoptila erotica* Ross from Colorado, Montana, New Mexico, Utah, and Wyoming (Baumann and Unzicker 1981, Roemhild 1982, Waltz and McCafferty 1983, Ruiter and Lavigne 1985, Herrmann et al. 1986). The presence of these species in eastern Arizona is not unexpected and the lack of prior documentation probably reflects infrequent regional collecting.

Oecetis metlacensis Bueno, a common Neotropical species ranging from Costa Rica north through Mexico (Flint et al. 1999), is tentatively reported from both Arizona and the United States for the first time. This species is a component of the *Oecetis avara* group which has been the source of considerable taxonomic confusion; species of *O. avara* (Banks), *O. disjuncta* (Banks), and *O. metlancensis* exhibit substantial genitalic similarity (e.g., Smith and Lehmkuhl 1980, Chen 1993, R. J. Blahnik, personal communication). The male genitalia and wing length of specimens collected in this study match those of UMSP specimens of *O. metlacensis* collected from Costa Rica more closely than they do a selection of United States specimens of *O. avara* and *O. disjuncta*. The Arizona specimens do not, however, have the wing spots characteristic of all three species and so it is possible that they might represent an additional, undescribed *O. avara* group species.

Three species new to science were collected in conjunction with this study. *Lepidostoma* sp. 1 known only from its type locality, Site 13, is currently being described by the author (Houghton in press). The two *Neotrichia* species are being described by Keth and Harris as part of a review of the genus and are likely to occur in other areas of the southwestern United States (A. C. Keth, personal communication).

Additionally, two other noteworthy species were collected during this study. *Ithytrichia mexicana* Harris and Contreras was previously known from only five specimens collected from three localities in Arizona, New Mexico, and Tamaulipas, Mexico (Moulton et al. 1999). I collected 128 specimens from Sites 3, 9, and 10 combined suggesting that this species is more common than previously reported. *Limnephilus sperryi* Banks was known previously from the holotype and allotype collected from "the White Mountains of Arizona" (Banks 1943)—both specimens are now missing (Ruiter 1995)—and from three males collected near Greer, Arizona (near Site #4) in 1962 (Ruiter 1995). I reared a single adult male collected during May 1998 from Site #7, an ephemeral snowmelt tributary of Site #6.

Table 1. Caddisflies known from the Apache National Forest prior to 1998 along with the locality reference. All taxa are arranged alphabetically. Specimens were not confirmed.

Taxon	Reference
APATANIIDAE	
Apatania arizonica Wiggins	Ruiter 1996
BRACHYCENTRIDAE	
Brachycentrus americanus (Banks)	Flint 1984
B. occidentalis Banks	Flint 1984
GLOSSOSOMATIDAE	
Culoptila kimminsi Denning	Denning 1965
C. moselyi Denning	Denning 1965
Glossosoma ventrale Banks	Ruiter 1996
HYDROBIOSIDAE	
Atopsyche sperryi Denning	Moulton et al. 1994
HYDROPSYCHIDAE	
Cheumatopsyche arizonensis (Ling)	Gordon 1974
HYDROPTILIDAE	
Hydroptila consimilis Morton	Ross 1944
LEPIDOSTOMATIDAE	
Lepidostoma knulli Ross	Moulton et al. 1994
L. ormeum Ross	Ruiter 1996
L. unicolor (Banks)	Ruiter 1996
LEPTOCERIDAE	
Oecetis disjuncta (Banks)	Ruiter 1996
Ylodes reuteri MacLachlan	Glover 1996
LIMNEPHILIDAE	
Anabolia bimaculata (Walker)	Ruiter 1996
Clistoronia maculata (Banks)	Banks 1943
Hesperophylax magnus Banks	Parker and Wiggins 1985
H. occidentalis (Banks)	Parker and Wiggins 1985
Limnephilus abbreviatus Banks	Ruiter 1996
L. diversus (Banks)	Ruiter 1996
L. frijole Ross	Ruiter 1995
L. lithus (Milne)	Ruiter 1995
L. moestus Banks	Ruiter 1996
L. sperryi (Banks)	Ruiter 1995
L. spinatus Banks	Ruiter 1995
Onocosmoecus unicolor (Banks)	Ruiter 1996
POLYCENTROPODIDAE	
Polycentropus arizonensis Banks	Ruiter 1995
P. gertschi Denning	Ruiter 1996
RHYACOPHILIDAE	
Rhyacophila rotunda Banks	Ruiter 1996
SERICOSTOMATIDAE	
Gumaga griseola (MacLachlan)	Ruiter 1996
UENOIDAE	
Oligophlebodes minutus (Banks)	Moulton et al. 1994

Table 2. The 51 caddisfly species collected from 14 sites within the Apache National Forest, eastern Arizona in 1998 and 1999. All taxa are arranged alphabetically. Forest, state, and national records denoted by single, double and triple asterisks, respectively. Undescribed taxa are in **boldface** type. Site numbers correspond with those in Figure 1 and in the "Study Sites" section.

	Site													
Taxon	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
BRACHYCENTRIDAE														
Brachycentrus americanus (Banks)									X					
B. occidentalis Banks					X									
Micrasema onisca Ross **						X								
CALAMOCERATIDAE														
Phylloicus aeneus (Hagen) *						X								
GLOSSOSOMATIDAE														
Culoptila cantha (Ross) *														X
C. moselyi Denning			X											
C. thoracia (Ross) **										X				X
Glossosoma ventrale Banks				X		X		X	X	X				
Protoptila erotica Ross **														X
HELICOPSYCHIDAE														
Helicopsyche borealis (Hagen) *		X	X	X		X			X	X	X	X	X	X
H. mexicana Banks *		X	X			X								
HYDROBIOSIDAE														
Atopsyche sperryi Denning			X			X			X	X				
HYDROPSYCHIDAE														
Cheumatopsyche arizonensis (Ling)			X			X					X		X	
C. enonis Ross **														X
C. pinula Denning *						X			X	X		X	X	
Hydropsyche auricolor Ulmer *													X	X
H. occidentalis Banks *						X			X	X		X	X	
H. oslari Banks *			X	X		X		X	X	X				
H. venada Ross *	X					X								
Smicridea dispar (Banks) *														X
HYDROPTILIDAE														
Hydroptila arctia Ross *			X			X			X	X		X	X	X
H. hamata Morton *			X										X	
H. rono Ross *			X							X				
Ithytrichia mexicana Harris & Contreras*			X						X	X				
***Neotrichia* sp. 1**						X								X
***N.* sp. 2**												X		X
N. osmena Ross **										X			X	
Ochrotrichia dactylophora Flint *			X							X		X	X	X
O. ildria Denning & Blickle *			X							X				
O. stylata (Ross) *														X
Zumatrichia notosa (Ross) *										X		X		
LEPIDOSTOMATIDAE														
***Lepidostoma* sp. 1**													X	
L. knulli Ross						X			X					
L. ormeum Ross				X										

Table 2 (continued)

	Site													
Taxon	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
LEPTOCERIDAE														
Nectopsyche stigmatica (Banks) *						X			X					
Oecetis disjuncta (Banks)			X	X		X			X		X		X	X
O. metlacensis Bueno ***						X			X					
Ylodes reuteri (MacLachlan)											X			
LIMNEPHILIDAE														
Clistoronia maculata (Banks)				X										
Hesperophylax magnus Banks								X						
H. occidentalis (Banks)				X	X	X								
Limnephilus lithus (Milne)			X			X			X				X	
L. sperryi (Banks)							X							
ODONTOCERIDAE														
Marilia flexuosa Ulmer *						X				X				
PHILOPOTAMIDAE														
Chimarra ridleyi Denning *														X
C. utahensis Ross *			X			X			X	X				X
POLYCENTROPODIDAE														
Polycentropus arizonensis Banks			X	X					X					
P. halidus Milne *													X	X
PSYCHOMYIIDAE														
Psychomyia flavida Hagen *										X		X		
SERICOSTOMATIDAE														
Gumaga griseola (MacLachlan)			X		X	X		X						
UENOIDAE														
Oligophlebodes minutus (Banks)				X										

Approximately 18% (9 of 51) of the caddisflies collected during this study were previously unknown from Arizona. Other recent regional inventories in the state have had discovery levels of 20% (10 of 49) (Moulton et al. 1994) and 18% (7 of 40) (Ruiter 1996). The discovery of 26 state species records for Arizona in these three limited studies confirms the lack of taxonomic knowledge of the Arizona caddisfly fauna. A total of 124 species have now been reported from the state. There are likely many additional Arizona species and records awaiting discovery in this ecologically diverse state.

ACKNOWLEDGMENTS

J. Ward, Springerville Ranger District, Springerville, Arizona, provided collecting permits 2107-01 and 2107-02 as well as advice on collecting localities. R. M. Newman, Department of Fisheries and Wildlife, University of Minnesota, allowed use of his rearing facilities. R. J. Blahnik, C. R. Parker, and D. E. Ruiter each examined certain specimens and helped confirm the identity of several species. V. F. Lee, California Academy of Sciences, and C. Favret, Illinois Natural History Survey, made available several holotypes. The comments of R. W. Holzenthal, A. L. Prather, and two anonymous reviewers improved earlier versions of the manuscript. This research was supported by grants from the James W. Wilkie Fund for Natural History, James Ford Bell Museum of Natural History, University of Minnesota; the Theodore Roosevelt Fund, American Museum of Natural History; and additional support from the University of Minnesota Insect Collection. To all the preceding individuals and institutions I extend my sincere appreciation. This is paper number 00-117-0019, Scientific Journal Series, Minnesota Agricultural Experimental Station, Saint Paul, Minnesota.

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GENERA OF PSOCOPTERA NEW TO MEXICO[1]

Alfonso Neri García Aldrete[2]

ABSTRACT: Descriptions of one new species each, in the genera *Nepticulomima* and *Seopsocus*, and a record of *Nadleria mariateresae* are here presented. The specimens studied were collected by canopy fogging in the Lacandonian forest, Chiapas, México. These three genera of psocids had not previously been recorded in México. The types are deposited in the National Insect Collection, Instituto de Biología, UNAM., México City.

RESUMEN: Se presentan en éste trabajo descripciones de especies de los géneros *Nepticulomima* y *Seopsocus*, y un registro de *Nadleria mariateresae*. Los ejemplares estudiados fueron colectados mediante nebulización insecticida del dosel de árboles en la selva Lacandona, en Chiapas. Los tres géneros de psócidos no habían sido registrados previamente en México. Los tipos de las especies descritas están depositados en la Colección Nacional de Insectos, Instituto de Biología, UNAM., México, D. F.

The psocid fauna of Mexico consists of 646 species, in 97 genera and 31 families (Mockford & García Aldrete 1996). This paper documents the presence in Mexico of three additional genera, previously unrecorded in the country: *Nepticulomima, Seopsocus* and *Nadleria*. Species of the first one are diverse in the Oriental-West Pacific Region, where 14 species have been recorded; there are three Neotropical species (two Brazilian and one in the Galapagos Archipelago); two Australian and one Ethiopian; besides, one undescribed species each are known in peninsular Florida, Dominican Republic, Nicaragua and Ecuador. All the described species of *Seopsocus* are Brazilian, although several undescribed species are known in the Tambopata Reserved Zone, in the Peruvian Amazonia (Smithsonian Institution Canopy Fogging Project, conducted by Terry Erwin; unpublished results), and in Amazonian Ecuador, collected also by Terry Erwin. The four described species of *Nadleria* occur in the Amazon Basin, one of them extending its range to Trinidad (García Aldrete 1996); one additional undescribed species occurs in Amazonian Ecuador (unpublished results). Presently then, 100 of the 277 described genera of Psocoptera (36%), and 649 species (ca. 8% of the world psocid fauna) occur in Mexico, a fact that gives another indication of the biological megadiversity of the country.

In the descriptions presented below, color was recorded by observation of the specimen with a stereoscopic microscope at 100X, under direct yellow light.

Measurements, given in microns, are the usual, (cf. García Aldrete 1990, 1999) and were taken on parts mounted on slides in Euparal, with a filar micrometer whose measuring unit is 1.53 microns for wings and 0.53 microns

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[1] Received January 25, 2000. Accepted October 23, 2000.

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for other parts. The types of the species here described are deposited in the National Insect Collection, Zoology Department, Instituto de Biología, UNAM, México City.

Lepidopsocidae

Nepticulomima campechensis, NEW SPECIES (♀)

(Figs. 1-7)

Female. Color (in 80% alcohol). Reddish brown. Compound eyes black, ocelli hyaline, with ochre contripetal crescents. On each genae, a reddish brown band from lower rim of compound eye to lower gena, next to antennal fossae, without enclosing them. A pale slender band across frons, bordered by ochre pigmented spots, having 3rd ocellus as center. Antennae and maxillary palps pale brown. Legs brown, femora with reddish brown area on anterior margin and apex; tibiae with dark brown bands near proximal and distal apices. Fore wing pale brown, clothed with brown scales. Hind wing hyaline, slightly fumose.

Morphology. Lacinial apex tridentate (Fig. 3). Fore and hind wing venation (Fig. 2). First valvulae of gonapophyses short, slender, slightly dilated distally (Fig. 4). Third valvulae elongate, stout, wide in the middle, setose as illustrated (Fig. 4). Sclerite of spermathecal duct (Fig. 5) arched, with arms more pigmented than apex. Paraprocts (Fig. 6), elongate, slender, setose, with seven trichobothria on sensory field, one without basal rosette. Epiproct (Fig.7), with base wide and sides converging to round apex; setal field as illustrated.

Measurements. FW: 2344, HW: 1893, F: 641, T: 1113, t_1: 413, t_2: 72, t_3: 66, ctt_1: 18, Mx4: 126, f_1: 111, f_2: 106, f_3: 103, f_4: 109, f_5: 92, f_6: 64, f_7: 66, f_8: 70, IO: 39, D: 318, d: 165, IO/D: 1.23, PO: 0.52.

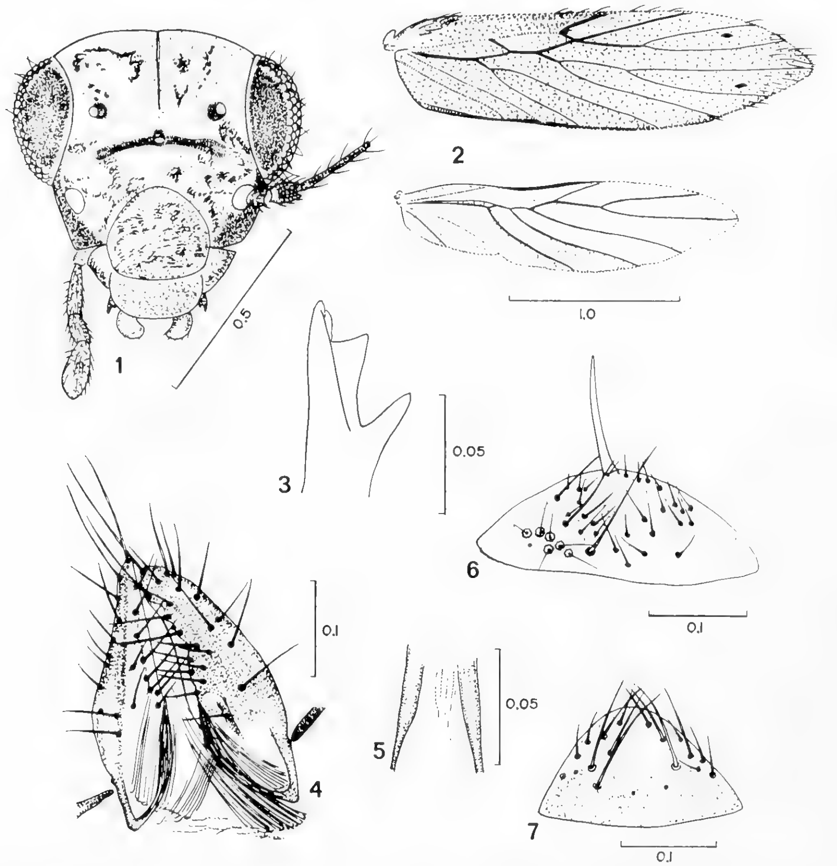
Type Locality. MEXICO. Campeche. Ca. Zoh–Laguna, 18°35'N, 89°25'W, 327m., next Calakmul Biosphere Reserve, 25.IX.1997, on surface of abandoned termite nest, holotype ♀, paratype ♀; Malaise trap, three paratypes (23-24.IX.1997), light trap, one paratype (23.IX.1997); beating shrubs with dead, hanging leaves, one paratype (23.IX.1997).

Comments. *N. campechensis* is the first species of its genus to be recorded in Mexico. The genus presently includes 20 described recent species, and a fossil one (*N. mortua* [Hagen], from Zanzibar), plus several undescribed ones, from peninsular Florida, Dominican Republic, Nicaragua and Ecuador. The genus is quite diverse in the Oriental-West Pacific region, where 14 species occur. The neotropics follow in species richness, with seven species; two species are known in Australia, and one species occurs in Africa (New 1975a, 1975b; Smithers 1967, 1992; Thornton 1981, Thornton, Lee & Chui 1972, Thornton & Woo 1973; Vaughan, Thornton & New 1989, 1991).

Most of the described species of *Nepticulomima* (18) are known from females only. The male sex is known only in the African *N. hosemanni* (Enderlein), and in the Australian *N. saltuaria* Smithers. Both males and females are quite homogeneous morphologically, and the species in the genus have been separated in the past by small wing venation features or by differences in facial pattern. The sclerite of the spermathecal duct varies inter species, and constitutes a good diagnostic character, but other than for *N. hosemanni*, it has not been described for other species (cf. Badonnel 1979,

Fig. 17). The pretarsal claw's pulvillus presents two character states: broad (in *N. orientalis* New, *N. pulvillata* New, *N. saltuaria* Smithers, and *N. scottiana* Enderlein), or slender, pointed (in undescribed species from Florida, Dominican Republic, Nicaragua, Ecuador, and in *N. campechensis)*; the character state is not known in the other described species.

N. campechensis differs from the Micronesians *N. bothriata* and *N. lineata* (Thornton, Lee & Chui 1972), by not having groups of sockets in the fore wing membrane. It differs from *N. orientalis* New, *N. pulvillata* New, *N. saltuaria*



Figures 1-7. *Nepticulomima campechensis* n. sp. (Female). 1. Front view of head. 2. Fore and hind wings. 3. Apex of right lacinia. 4. Gonapophyses. 5. Sclerite of spermathecal duct. 6. Left paraproct. 7. Epiproct. Scales in mm.

paraproct. 7. Epiproct. Scales in mm.

Smithers, and *N. scottiana* Enderlein, in having the pulvillus of the pretarsal claw slender and pointed, and from all the others (*N. biroiana* [Enderlein], *N. brasiliensis* [Enderlein], *N. cavagnaroi* Thornton & Woo, *N. chalcomelas* Enderlein, *N. essigkeana* Enderlein, *N. hosemanni* [Enderlein], *N. jacobsoni* Enderlein, *N. latisqueama* Enderlein, *N. lusiae* Thornton, *N. penicillata* Enderlein, *N. sakuntala* Enderlein, *N. sumatrensis* Vaughan, Thornton & New, *N. tridentata* Smithers, and *N. uniformis* Vaughan, Thornton & New), in the distinct facial pattern (Fig. 1), unique in the genus.

Amphientomidae

Seopsocus lacandonicus, NEW SPECIES

(Figs. 8-18)

Female. Color. (in 80% alcohol). Body reddish brown. Compound eyes black, with horizontal banding; head pattern as in Fig. 8, ocelli ringed in dark purplish brown. Scape and pedicel reddish brown; flagellum medium brown. Legs brown, coxae with ochre irregular spots, trochanters white, femora with ochre large areas on outer surface, tibiae distally with an ochre band, tarsomeres brown. Thoracic pleurae with an irregular ochre band next to coxae. Forewing (Fig. 9) medium brown, fumose, veins on distal half dark brown. Colorless marginal spots on cells R_1, R_3, R_5, M_1, M_2, and M_3. Hindwing (Fig. 9), almost hyaline, unmarked, with slight reddish brown wash, veins dark brown. Abdomen with ochre transverse bands. Subgenital plate, clunium, paraprocts, and epiproct medium brown.

Morphology. Epicranial sulcus well defined, without lateral arms. Ocelli close together. Lacinial tip as in Fig. 10. Fore femur with row of 20-22 pointed teeth along anterior carina (Fig. 12). Pretarsal claw as in Fig. 13. Wing venation normal for the genus. Subgenital plate (Fig. 18) broad, setose; T-shaped sclerite with stem long, curved; lateral arms short. Spermapore small, surrounded by an elliptical ring bearing a short, distal process (Fig. 15). Ovipositor valvulae as in Fig. 15. Paraproct elongate (Fig. 16), densely setose; sensory field not well defined, with 8-9 slender setae. Epiproct (Fig. 16), straight anteriorly, rounded posteriorly; setal field as illustrated.

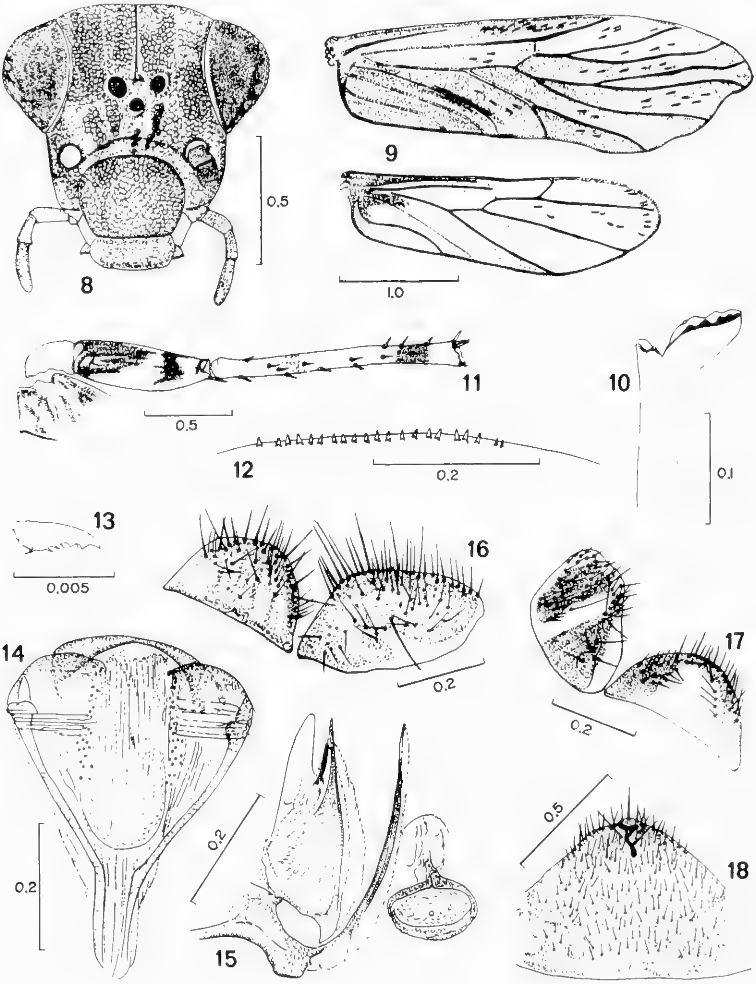
Measurements. FW: 3460, HW: 2747, F: 784, T: 1293, t_1: 763, t_2: 110, t_3: 141, ctt_1: 27, Mx4: 146, f_1: 284, f_2: 185, f_3: 204, f_4: 182, IO: 487, D: 403, d: 235, IO/D: 1.20, PO: 0.58.

Male. Color (in 80% alcohol). Same as the female.

Morphology. Epicranial sulcus, ocelli, row of teeth on fore femur and pretarsal claw as in the female. Hypandrium (not figured) broad, posteriorly rounded, setose. Phallosome (Fig. 14), Y shaped, lateral struts slender; distal end complex, with a distinct arch (fused inner lobes?), outer lobes basally wide, bending inwards to become continuous with inner membranous region, bearing numerous pores. Paraproct (Fig. 17) broad; setae and pigmented areas as illustrated; sensory field with four slender setae. Epiproct (Fig. 17), anteriorly straight, rounded posteriorly; setal field marginal, pigmented as illustrated.

Measurements. FW: 3620, HW: 2716, F: 771, T: 1338, t_1: 851, t_2: 115, t_3: 127, ctt_1: 32, Mx4: 175, f_1: 326, f_2: 259, f_3: 272, f_4: 249, f_5: 175, f_6: 168, f_7: 91, f_8: 101, IO: 500, D: 402, d: 246, IO/D: 1.24, PO: 0.61.

Type Locality. MEXICO. Chiapas. Biosphere Reserve "Montes Azules", Chajul Biology Station, 16°54'25"N; 92°05'46"W, 900m. Canopy fogging, holotype ♂, 25.VII.1994, allotype ♀, 27.VII.1994, paratype ♀, 29.VII.1995, paratype ♂, 25.VII.1994. J. G. Palacios et al.



Figures 8-18. *Seopsocus lacandonicus* n. sp. 8. Front view of head, male. 9. Fore and hind wings, male. 10. Apex of right lacinia, male. 11. Coxa, trochanter,femur and tibia of hind leg, male. 13. Pretarsal claw, male. 14. Phallosome, male. 15. Gonapophyses and spermapore sclerite, female. 16. Left paraproct and epiproct, female. 17. Right paraproct and epiproct, male. 18. Subgenital plate, female. Scales in mm.

Comments. *S. lacandonicus* is the seventh species described in the genus *Seopsocus* (if the Argentinian *S. annulipes* Badonnel,1962 described from a larva is accepted as valid); the five species described from adults are all Brazilian: *S. acuminatus* Roesler (1940) and *S. rotundatus* Roesler (1940), from Nova Teutonia, Santa Catarina, in SE Brazil, and *S. albiceps* Mockford (1991), *S. fasciatus* Mockford (1991), and *S. rafaeli* Mockford (1991), from Roraima, in NW Brazil. *S. lacandonicus* then occurs isolated from the general range of the other species in the genus, at the northern end of the neotropics. It differs from *S. albiceps* Mockford, *S. fasciatus* Mockford, *S. rafaeli* Mockford, and *S. rotundatus* Roesler, in having less teeth on the anterior carina of the front femora (20-22 versus 36, 35, 42, and 27-30 respectively). Besides, the distal arch of the phallosome is more robust in the former, and the base is broader in *S. fasciatus.*

The pigmented areas of the subgenital plates, the T shaped sclerites, and the spermapore sclerites in *S. lacandonicus* and in *S. albiceps* are clearly different; in addition, the former presents one apical macrosetae in the subgenital plate, versus two in the latter species. *S. lacandonicus* can also be separated from *S. rafaeli* in that the latter has a distinctive facial color pattern (compare Fig. 8 in this paper with Fig. 31 in Mockford 1991).

S. lacandonicus differs from *S. acuminatus* and from *S. rotundatus* in that the female is fully winged (the fore wing is pointed and the hind wing is micropterous in *S. acuminatus; S. rotundatus* is brachypterous). Besides, the facial patterns are different in *S. lacandonicus* and in *S. acuminatus* (see Fig. 8 in this paper and description of *S. acuminatus* in Roesler (1940).

Lachesillidae

Nadleria mariateresae García Aldrete

N. mariateresae García Aldrete 1996, p. 29.

This species was described from the southwestern edge of the Amazon Basin, in the Tambopata Reserved Zone, Peru. The three other species known in the genus, also occur in the Amazon Basin and one of them has been recorded in Trinidad (García Aldrete 1996).

One female specimen of *N. mariateresae* was collected by canopy fogging in the Lacandonian forest, Chiapas, Mexico (Biosphere Reserve "Montes Azules". Chajul Biological Station, 16°54'26"N, 92°05'46"W, 900m., 21.VII.1994), by the team conducted by José G. Palacios, of the Facultad de Ciencias, UNAM. The specimen was compared with females from Tambopata, Peru; the gonapophyses, the pigmented area of the ninth sternum, the subgenital plate, epiproct, paraprocts, as well as the wings and head are virtually identical in the Mexican specimen.

This record constitutes an extension of almost 30° to the north of the previously known distribution of the species.

ACKNOWLEDGMENTS.

Collecting in Campeche, Mexico, was financed by CONABIO (Project M003). The specimens of *S. lacandonicus* and *N. mariateresae* were donated for study by José G. Palacios (Facultad de Ciencias, UNAM). I also thank Arturo Casasola, Felipe Villegas and Silvia López (Instituto de Biología, UNAM) for slide making and other technical support in the preparation of this paper.

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A NEARCTIC PEST OF PINACEAE ACCIDENTALLY INTRODUCED INTO EUROPE: *LEPTOGLOSSUS OCCIDENTALIS* (HETEROPTERA: COREIDAE) IN NORTHERN ITALY[1]

Steven J. Taylor[2], Giuseppe Tescari[3], Mauro Villa[4]

ABSTRACT: The western conifer-seed bug, *Leptoglossus occidentalis*, an important pest of pines in North America, is reported from urban areas of northern Italy as the first Old World record for this coreid.

Leptoglossus occidentalis Heidemann, the western conifer-seed bug, is a pest of trees, primarily species in the Pinaceae (Mitchell 2000), on which it typically is found at the tips of branches and on cones (Blatt and Borden 1996b, Mitchell 2000). It feeds on seeds of the host tree (Koerber 1963, Krugman and Koerber 1969) and extracts lipids and probably proteins (Bates et al. 2000a), affecting seed production (Blatt and Borden 1996b, Bates et al. 2000b, Mitchell 2000). Hosts include many species of *Pinus*, Douglas fir (*Pseudotsuga menziesii* (Mirbel) Franco), and *Tsuga canadensis* (L.) Carrière (Mitchell 2000). The recent spread of *L. occidentalis* from the western part of North America (Mexico, the United States, and Canada) across the continent to the east is well documented (Katovich and Kulman 1987, McPherson et al. 1990, Marshall 1991, Gall 1992, Mitchell 2000). It may be transported with Christmas trees (Mitchell 2000), in shipments of corn, and, possibly, with landscaping materials or by transcontinental shipping (Gall 1992). It probably is able to move into commercial pine plantations because of its strong flight ability (Gall 1992). The overwintering adults commonly are attracted to buildings in the autumn (Gall 1992) and may form large (Blatt 1994), phermone-mediated (Blatt and Borden 1996a) aggregations.

Two of us (MV and GT) observed specimens of *Leptoglossus* in autumn and early winter of 1999 and 2000 in gardens and in and near houses at various locations (Abbiategrasso, Corbetta, Gessate, Arcugnano) in northern Italy. Specimens were hand collected in Abbiategrasso, Gessate, and Arcugnano and later determined to be *L. occidentalis*. Voucher material is housed in the collections of the Museo Naturalistico Archeologico (Vicenza, Italy), the Museo Civico di Storia Naturale (Venice, Italy), Museo Civico di Storia Naturale (Milan, Italy), the Illinois Natural History Survey Insect Collection (Champaign, Illinois, USA), and the collections of MV and GT.

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ENT. NEWS 112(2): 101-103, March & April, 2001

MATERIAL EXAMINED

ITALY: LOMBARDY: Province of Milan: Abbiategrasso: inside a house: 1♀, 29 Sep 2000 (M. Bertolotti); 2♀♀, 18 Oct 2000 (F. Bellati); 1♂, 21 Oct 2000 (M. Bertolotti); 1♂, 24 Oct 2000 (F. Bellati). Abbiategrasso: outside a house: 1♂, 2 Oct 2000 (M. Bertolotti); 1♂ 1 nymph, 20 Oct 2000 (M. Bertolotti); 2♀♀, 21 Oct 2000 (S. Villa); 1♀, 28 Oct 2000 (M. Scaiola); 1♂, 14 Dec 2000 (M. Villa). Abbiategrasso: in city cemetery: 1♀, 2 Nov 2000 (S.Villa). Abbiategrasso: in city park: 3♀♀, 23 Oct 2000 (S. Villa). Abbiategrasso: near *Picea excelsa* in city garden: 1♀, 29 Sep 2000 (S. Villa). Gessate: in city park: 1♂, 20 Oct 2000 (G. Villa). Gessate: near house: 1♀, 2 Nov 2000 (F. Leoni). VENETO: Province of Vicenza: Arcugnano: Perarolo (Monti Berici, elev. 240 m), outside walls of house associated with gardens and trees (including Pinaceae): 3♀♀, 13 Oct 1999 (G. Tescari); 2♀♀, 23 Oct 1999 (G. Tescari); 1♂, 1♀, 28 Oct 2000 (G. Tescari).

DISCUSSION

The morphologically similar *Leptoglossus gonagra* (F.) [= *Leptoglossus australis* (F.) (Baranowski and Slater 1986)] is known from the tropics and subtropics throughout the world (Packauskas and Schaefer 2001) including northern Africa (Moulet 1995) but has not been reported from Europe. *Leptoglossus gonagra* has scalloped emarginations along the outer border of the metatibial dilation, whereas the margin is entire in *L. occidentalis*. The two species are separated easily in the keys provided by McPherson et al. (1990) and Packauskas and Schaefer (2001). The remaining species of *Leptoglossus* are native only to the Western Hemisphere (Brailovsky and Sánchez 1983). No native Italian coreids (Faraci and Rizzotti Vlach 1995) have metatibial dilations, which allows even the somewhat similar species of *Gonocerus* Latreille to be distinguished easily from *Leptoglossus*.

Based on its well-documented spread across North America, *L. occidentalis* could rapidly become a well-established pest of coniferous trees throughout Italy and other parts of Europe.

ACKNOWLEDGMENTS

We thank Vittorio Bordin, Barb Capocy, Antonio De Angeli, Pierre Moulet, Carl W. Schaefer, Mark J. Wetzel and two anonymous reviewers for their help with earlier versions of this paper.

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THE STONEFLIES (PLECOPTERA) OF SOUTH DAKOTA[1]

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ABSTRACT: Few records exist pertaining to the Plecoptera of South Dakota. We present an updated list of 33 species representing 25 genera and eight families for the state. Five new state records include: *Amphinemura linda*, *Taeniopteryx burksi*, *Pteronarcys pictetii*, *Isoperla bilineata*, and *Perlesta dakota*. Distributional data are included for species not previously reported. The stonefly fauna of South Dakota exhibits mixed affinities, with western, eastern, northern, prairie, and widespread species present.

Very few published records are available pertaining to the Plecoptera (stonefly) fauna of South Dakota. In his catalog of the world's stoneflies, Illies (1966) listed four species from South Dakota. Baumann et al. (1977) included the Black Hills of western South Dakota in their review of the stonefly fauna of the Rocky Mountains. They listed 11 species as occurring in the Black Hills. In Stark et al. (1986), a review of the Neartic stonefly fauna, 14 species were listed from South Dakota. In addition to these surveys, Modde and Drewes (1990) listed the genus *Alloperla* from Slate Creek and South Slate Creek in Pennington County, raising the potential state list to 15 species.

Fifteen species seemed extremely low for a state as large and with as many varied habitats as South Dakota. In comparison, Minnesota contains 51 species (Harden and Mickel 1952), Kansas has 26 species (Stark et al. 1986), and Saskatchewan has 41 species (Dosdall and Lemkuhl 1979). This indicates that our present knowledge of the South Dakota stonefly fauna is limited.

While conducting studies on the stonefly fauna of the Great Plains, the authors collected stoneflies from several locations in South Dakota. In addition, many specimens from other parts of the state were loaned to the authors, most of which had not been previously reported. The authors listed 15 new state records of stonefly species in a survey of the Black Hills area (Huntsman et al. 1999). The purpose of this report is to update our present knowledge of the stonefly fauna from the remainder of South Dakota. Complete collecting data are given for all specimens previously unreported from the state.

METHODS

Five expeditions to South Dakota were made between February, 1995, and July, 1997. Although collecting was conducted primarily in the Black Hills of

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western South Dakota, some collections were made in the central and eastern parts of the state.

In addition to specimens collected in the field, this study was supplemented with specimens housed in the collections of the following institutions: Monte L. Bean Life Science Museum, Brigham Young University, Provo, Utah (BYUC); Canadian National Collection, Ottawa, Ontario, Canada (CNC); C. P. Gillette Museum of Arthropod Diversity, Colorado State University, Fort Collins, Colorado (CSUC); Illinois Natural History Survey, Champaign, Illinois (INHS); North Dakota State University Research Collection, Fargo, North Dakota (NDSU); Purdue Entomological Research Collection, Purdue University, West Lafayette, Indiana (PERC); South Dakota State University Research Collection, Brookings, South Dakota (SDSU); United States National Museum, Smithsonian Institution, Washington, D. C. (USNM); and the University of Nebraska Research Collection, Lincoln, Nebraska (UNSM). Specimens collected during the course of this study are deposited at the Monte L. Bean Life Science Museum and in the C. P. Gillette Museum of Arthropod Diversity.

RESULTS

Thirty-three species from 25 genera and eight families were identified in the material examined. Stoneflies were found to occur in at least 27 counties in the state (Figure 1). One specimen of the genus *Isocapnia* was collected in Lawrence County in 1982. Our subsequent efforts failed to locate any further

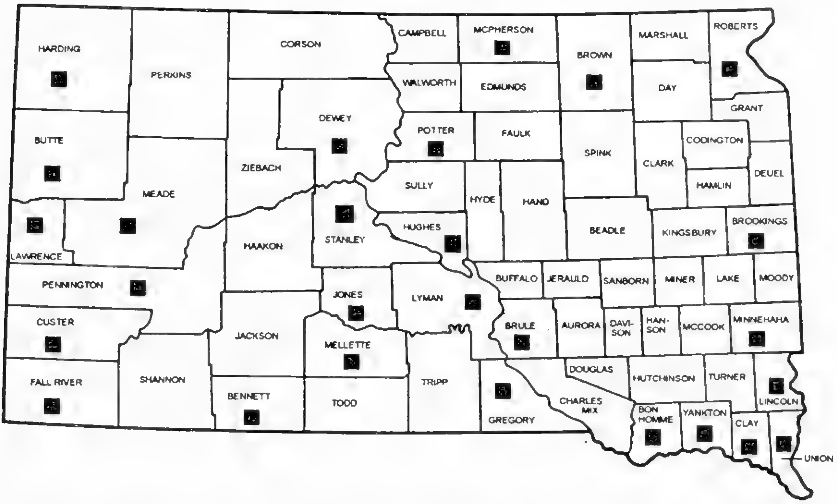

Figure 1. Counties in South Dakota where stoneflies have been collected - solid squares.

specimens. As this lone specimen is a female, a specific determination is impossible at present. We specified this as *Isocapnia* sp. A. Also, several females of the genus *Perlesta* could not be identified to species. These were designated *Perlesta* sp. A. Finally, a single female of the genus *Acroneuria* was collected in Brookings County in 1953. This was designated *Acroneuria* sp. A. Due to the paucity of stonefly records from the state, distributional data for all unidentified specimens are included in the following discussion.

Baumann et al. (1977) and Stark et al. (1986) listed *Nemoura arctica* Esben-Peterson and *Triznaka signata* (Banks) as occurring in South Dakota. However, a recent study by the authors has shown these records to be in error (Huntsman et al. 1999). Also, after extensive collecting, we found no specimens from the genus *Alloperla* in Slate Creek or elsewhere in the Black Hills (Huntsman et al. 1999). It is possible that Modde and Drewes (1990) used obsolete keys to identify nymphs from either the genus *Sweltsa* or *Triznaka*, which would have led to an identification as *Alloperla*. However, the status of *Alloperla* in South Dakota can not be resolved at this time.

ANNOTATED LIST OF STONEFLY SPECIES IN SOUTH DAKOTA

To conserve space, only partial data are given for species previously reported from the Black Hills (Huntsman et al. 1999). Complete data for all species are available from the authors.

Capniidae

Allocapnia sp. - Roberts Co., Sica Hollow State Park, 4-X-1996, 1 N (SDSU)

Capnia confusa Claassen - Custer, Lawrence, Pennington Cos.

Capnia gracilaria Claassen - Custer, Lawrence, Pennington Cos.

Eucapnopsis brevicauda (Claassen) - Custer, Lawrence, Pennington Cos.

Isocapnia sp. A - Lawrence Co.

Paracapnia angulata Hanson - Lawrence, Meade, Pennington Cos.

Utacapnia lemoniana (Nebeker & Gaufin) - Custer, Lawrence, Pennington Cos.

Leuctridae

Paraleuctra vershina Gaufin & Ricker - Custer, Lawrence, Pennington Cos.

Nemouridae

Amphinemura banksi Baumann and Gaufin - Custer, Lawrence, Pennington Cos.

Amphinemura linda (Ricker) - Roberts Co., Sica Hollow State Park, 17-IX-1994, 1♂ (SDSU); 19-IX-1998, 2♀ (SDSU), NEW STATE RECORD.

Malenka coloradensis (Banks) - Custer, Lawrence, Pennington Cos.

Nemoura trispinosa Claassen - Lawrence, Pennington Cos.

Prostoia besametsa (Ricker) - Custer, Lawrence, Pennington Cos.

Zapada cinctipes (Banks) - Custer, Lawrence, Meade, Pennington Cos.

Taeniopterygidae

Taeniopteryx burksi Ricker & Ross - Minnehaha Co., Baltic River, Hwy 114, Baltic, 10-IV-1996, 5♂ 2♀ (BYUC); Big Sioux River, Palisades State Park, 10-IV-1996, 1♀ (BYUC), NEW STATE RECORD.

Taeniopteryx sp. - Roberts Co., Sica Hollow State Park, 4-X-1996, 5 N's (SDSU).

Pteronarcyidae

Pteronarcys pictetii Hagen - Melette Co., Little White River, Hwy 83, N of White River, 9-IV-1996, 1♀ 4N (CSUC, BYUC), NEW STATE RECORD.

Pteronarcys sp.- Lincoln Co., Big Sioux River, Newton Hills State Park, 26-IX-1998, 1N (SDSU).

Chloroperlidae

Paraperla frontalis (Banks) - Custer, Lawrence, Pennington Cos.

Suwallia lineosa (Banks) - Lawrence Co.

Sweltsa borealis (Banks) - Lawrence, Pennington Cos.

Sweltsa coloradensis (Banks) - Custer, Lawrence, Pennington Cos.

Triznaka pintada (Ricker) - Custer, Lawrence, Pennington Cos.

Perlidae

Acroneuria abnormis (Newman) - Butte Co., Belle Fourche River, Belle Fourche, 23-IV-1996, 4N (BYUC). Lincoln Co., Big Sioux River, Newton Hills State Park, 26-IX-1998, 1N (SDSU). Melette Co., Little White River, Hwy 83, N of White River, 9-IV-1996, 1N (BYUC).

Acroneuria sp. A. - Brookings Co., Brookings, 20-VI-1953, 1♀ (SDSU).

Claassenia sabulosa (Banks) - Lawrence Co.

Hesperoperla pacifica (Banks) - Custer, Lawrence, Pennington Cos.

Perlesta dakota Kondratieff & Baumann - Brookings Co., Brookings, date unknown, 8♂ 3♀ (SDSU, INHS); 12-VII-1942, 1♀ (SDSU); 27-VII-1943, 1♀ (SDSU); 1-VIII-1943, 1♂ (SDSU); 17-VII-1945, 9♂ 6♀ (SDSU); 8-VII-1946, 3♂ 2♀ (SDSU); 15-VII-1970, 1♂ (SDSU); 6-15-VII-1998, 1♂ (BYUC), NEW STATE RECORD.

Perlesta decipiens (Walsh) - Bon Homme Co., Sand Creek Recreation Area, 7-VIII-1962, 8♂ 2♀ (USNM). Brookings Co., Brookings, 6-15-VII-1998, 1♂ (SDSU). Butte Co., Belle Fourche River, Belle Fourche, 13-VII-1997, 2♀ (BYUC). Fall River Co., Angostura Dam, 6-VII-1968, 6♂ 22♀ (CNC); Angostura Reservoir, Angostura State Park, 8-VII-1997, 1♂ 2♀ (BYUC); Cheyenne River, Oral, below Angostura Reservoir, 8-VII-1997, 15♂ 9♀ (BYUC). Pennington Co., Rapid City (probably Rapid Creek), 6-VIII-1998, 2♀ (SDSU). Yankton Co., Yankton (probably Missouri River), 30-VI-1960, 2♂ 3♀ (UNSM).

Perlesta sp. A. - Brookings Co., Brookings, 8-VII-1930, 1♀ (INHS); White, 26-VII-1922, 1♀ (INHS). Clay Co., Vermillion (probably Vermillion River), 30-VII-1945, 1♀ (SDSU). Gregory Co., Platte (probably Platte Creek), 31-VII-1942, 1♀ (SDSU). Union Co., Elk Point (probably Missouri River), 30-VII-1945, 3♀ (SDSU).

Perlodidae

Isogenoides elongatus (Hagen) - Lawrence, Pennington Cos.

Isoperla bilineata (Say) - Stanley Co., Fort Pierre (probably Missouri River), 6-VI-2000, 1♀ (PERC), NEW STATE RECORD.

Isoperla longiseta Banks - Bennett Co., Cedor Creek (sic), La Creek National Wildlife Refuge, 16-X-1994, 1N (SDSU). Bon Homme Co., Springfield (probably Missouri River), 15-VI-1928, 1♀ (SDSU). Brookings Co., Brookings, date unknown, 1♂ 1♀ (SDSU); 2-VII-1941, 1♂ 1♀ (SDSU); 21-VI-1943, 3♂ 1♀ (SDSU); 28-VI-1943, 2♂ (SDSU); 15-VI-1944, 1♀ (SDSU); 6-VII-1942, 1♀ (SDSU); 12-VII-1945, 1♀ (SDSU). Brown Co., Hecla (probably James River), 18-VI-1944, 2♀ (SDSU). Brule Co., Chamberlain (probably Missouri River), 21-VI-1944, 1♂ (INHS). Butte Co., Belle Fourche River, Belle Fourche, 7-VI-1995, 2♀ (BYUC); Newell (probably Belle Fourche River), 19-VII-1923, 1♂ (SDSU). Clay Co., Vermillion (probably Vermillion River), 20-VII-1945, 1♀ (SDSU). Dewey Co., Cheyenne Agency (presently inundated by Lake Oahe), 25-VI-1947, 1♂ (SDSU). Fall River Co., Oral (probably Cheyenne River), 4-VII-1953, 1♂ (INHS). Harding Co., Buffalo (probably South Fork Grand River), 28-VI-1947, 2♂ 2♀ (INHS). Hughes Co., Pierre (probably Missouri River), 21-VI-1949, 1♂ (SDSU); 23-VI-1950, 1♂ (SDSU); 21-VII-1950, 1♂ 2♀ (SDSU); 9-VI-1951, 1♂ (SDSU); 26-VI-1951, 3♂ (SDSU); 16-VI-1952, 1♀ (SDSU). Jones Co., Murdo, 10 mi S, on yucca plant (probably White River), 17-VI-1939, 1♂ (SDSU). Meade Co., Cedar Canyon (probably Cedar Creek), 27-VI-1947, 1♂ 1♀ (SDSU); Edson, 27-VI-1947, 1♀ (SDSU). McPherson Co., Eureka, 8-VI-1953, 1♂ (SDSU). Lyman Co., Grass

Rope, N of Lower Brule, 24-VI-1931, 1♂ 1♀ (SDSU). Minnehaha Co., Baltic River, Hwy 114, Baltic, 10-IV-1996, 3N (BYUC). Pennington Co., Badlands, 15-VI-1948, 5♂ 2♀ (SDSU). Potter Co., Gettysburg, 26-VI-1947, 1♀ (SDSU). Yankton Co.,Yankton (probably Missouri River), 18-VI-1930, 1♀ (SDSU); 25-VI-1935, 2♂ (SDSU).

Isoperla phalerata (Smith) - Butte, Custer, Lawrence, Meade, Pennington Cos.
Isoperla quinquepunctata (Banks) - Butte, Custer, Lawrence, Meade, Pennington Cos.
Isoperla transmarina Newman - Pennington Co.
Skwala americana (Klapalek) - Custer, Lawrence, Pennington Cos.

DISCUSSION

The stonefly fauna of South Dakota is an interesting mix of eastern, western, northern, prairie, and widespread species (Table 1). South Dakota is apparently a mixing zone where many of the North American stonefly faunal elements overlap.

The topography of South Dakota has two main features. First, most of the state falls within the Great Plains physiographic province, which is characterized by flat topography and low-gradient, silty streams and rivers. This province can be divided into two areas separated by the Missouri River. Second is the Black Hills, which is an isolated mountain range located on the western border of the state. These two regions contain completely different stonefly faunal elements.

The Black Hills contain the greatest diversity of stonefly species in the state. This is due to the habitats available in the region. In no other area of the state do cold montane streams exist in quantity. Twenty-four of the stonefly species which occur in South Dakota are restricted to disjunct populations in the Black Hills. Most of these (21 species) have western affinities. This suggests a strong relationship between the Black Hills and the Rocky Mountains. Two Black Hills species (*P. angulata* and *I. transmarina*) have eastern affinities, while the final species, *N. trispinosa*, is northern. Their distributions and the implications thereof are discussed in Huntsman et al. (1999).

At least seven species were found to occur in the slow, warm streams and rivers of the plains. Five species [*T. burksi* (Figure 2), *A. abnormis* (Figure 3), *I. bilineata* (Figure 5), *P. decipiens* (Figure 4), and *P. pictetii* (Figure 2)] have widespread affinities and two [*I. longiseta* (Figure 5) and *P. dakota* (Figure 4)] have prairie affinities.

The five widespread species are eastern in origin. They are able to tolerate the waters typical of the Great Plains and thus have been able to use the large rivers of the plains as corridors to expand across the prairies to the foothills of the Rocky Mountains. Their South Dakota populations do not represent disjunctions in their distributions. Although the specimens designated *Acroneuria* sp. A (Figure 3) and *Perlesta* sp. A (Figure 4) could not be identified to species, these two genera are typically eastern. If these specimens are not *A. abnormis* and *P. decipiens*, they are probably members of similar, widespread species.

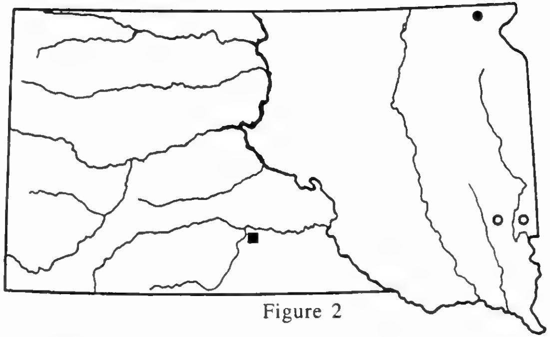

Figure 2

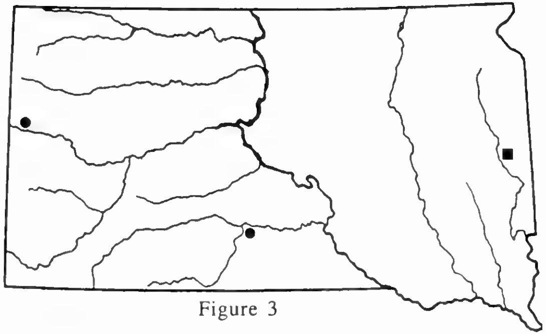

Figure 3

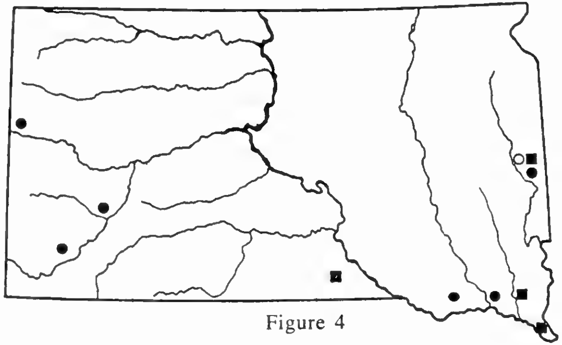

Figure 4

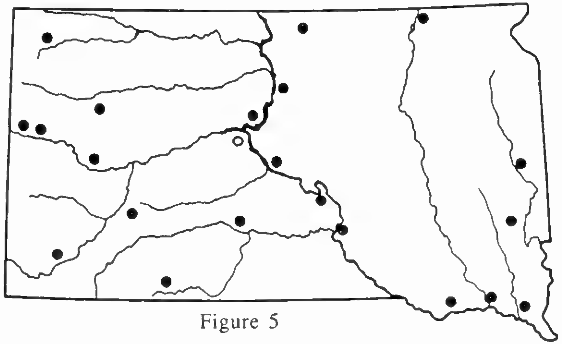

Figure 5

Figure 2. South Dakota distribution of *Amphinemura linda*-solid circle, *Taeniopteryx burksi*-open circles, and *Pteronarcys pictetii*-solid square.

Figure 3. South Dakota distribution of *Acroneuria abnormis* - solid circles and *Acroneuria* sp. A - solid square.

Figure 4. South Dakota distribution of *Perlesta decipiens* - solid circles, *Perlesta dakota* - open circle, and *Perlesta* sp. A - solid squares.

Figure 5. South Dakota distribution of *Isoperla bilineata* - open circle, *Isoperla longiseta* - solid circles.

Two species with affinities for the prairies were collected in the plains of South Dakota. Although the first species, *I. longiseta*, is western in origin, it reaches its greatest abundance in the Great Plains (Ricker 1946, 1964). Not surprisingly, it is the most widespread species in South Dakota, occurring in at least 19 counties. The second, *P. dakota*, is a newly described species, with populations known only from North Dakota (Kondratieff and Baumann 1999) and now South Dakota. However, as previously mentioned, *Perlesta* is an eastern genus (Stark 1989). Further collecting may locate even more *Perlesta* populations.

The final species, *A. linda*, is a northern species (Table 1) with a single population at Sica Hollow State Park, located in the extreme northeast corner of the state (Figure 2). This area is not typical plains habitat, but rather is an isolated pocket of woodlands and springs located in a deep hollow. This disjunct population of *A. linda* is almost certainly a glacial relict.

Table 1. Geographic affinities of the stonefly species of South Dakota.

	Western species	
Amphinemura banksi	*Paraleuctra vershina*	*Paraperla frontalis*
Malenka coloradensis	*Claassenia sabulosa*	*Suwallia lineosa*
Prostoia besametsa	*Hesperoperla pacifica*	*Sweltsa borealis*
Zapada cinctipes	*Perlesta* sp. A	*Sweltsa coloradensis*
Capnia confusa	*Isogenoides elongatus*	*Triznaka pintada*
Capnia gracilaria	*Isoperla phalerata*	*Pteronarcys pictetii*
Eucapnopsis brevicauda	*Isoperla quinquepunctata*	
Isocapnia sp. A	*Skwala americana*	
Utacapnia lemoniana		
	Northern species	
Amphinemura linda		*Nemoura trispinosa*
	Eastern species	
Isoperla bilineata		*Paracapnia angulata*
Isoperla transmarina		
	Plains species	
Isoperla longiseta		*Perlesta dakota*
	Widespread species	
Acroneuria abnormis		*Perlesta decipiens*
Acroneuria sp. A		*Taeniopteryx burksi*

There are other species which should occur in South Dakota but have not been collected. For instance, the perlid *Perlesta xube* Stark & Rhodes has been collected in low-land streams in northern Nebraska (Rhodes and Kondratieff 1996, Stark and Rhodes 1997) and southwest North Dakota (Kondratieff and Baumann 1999), but not in South Dakota. In addition, several more perlid species probably occur in the larger rivers of the eastern part of the state.

Very little is known about the winter stoneflies of the plains region of the state. *Allocapnia* sp. nymphs were collected at Sica Hollow State Park but adult males are needed for species recognition. *Capnura wanica* (Frison) has been collected in the Pine Ridge area of Nebraska (Rhodes and Kondratieff 1996). It is possible that it also occurs in the Black Hills. Additional collecting during the winter months of November-March will likely yield additional winter stonefly species records.

ACKNOWLEDGMENTS

Special thanks go to Edward C. Becker (Canadian National Collection), Oliver S. Flint, Jr. (United States National Museum, Smithsonian Institution), Paul J. Johnson (South Dakota State University), H. Randy Lawson (Chadron State College, Chadron, Nebraska), Arwin V. Provonsha (Purdue University), Brett C. Ratcliffe (University of Nebraska), David A. Rider (North Dakota State University), and Donald W. Webb (Illinois Natural History Survey) for the loan of specimens from South Dakota. We also thank Stanley W. Szczytko, University of Wisconsin, Stevens Point (*Isoperla*) and Kevin Alexander, Wayne State College Wayne, Nebraska (*Suwallia*), for verifying our determinations. We appreciate Mark C. Belk, R. Paul Evans, and Clayton M. White for assistance and suggestions during the course of this project. Finally, it should be noted that a majority of the early records (1940's and 1950's) are the result of intensive collecting throughout the state by H. C. Severin of South Dakota State University.

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BODY SIZE AND SURVIVORSHIP IN OVERWINTERING POPULATIONS OF *PORCELLIO LAEVIS* (ISOPODA: ONISCIDEA)[1]

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ABSTRACT: Because female *Porcellio laevis* (Isopoda: Oniscidea) carry eggs and young manca in a ventral marsupium, fecundity and body size are positively correlated. We examined female body size in November and February, a period in which breeding does not occur and changes in body size are unlikely to be attributed to growth. Our results from two consecutive years revealed several general patterns. First, the sex-ratio of individuals collected with baited traps was extremely female-biased. Second, body size was significantly larger (as indicated by length of antennae and appendages) in samples collected during November than in those collected during February. Third, no same-month differences in body size were found between years, suggesting that differential mortality during the non-breeding season does not result in natural selection on body size. These results suggest that older (presumably senescent) females suffer increased mortality risk over the winter.

Terrestrial isopods (Crustacea: Oniscidea) of several genera are widely distributed throughout North America (Schultz 1982; Jass & Klausmeier 1996). Nearctic Oniscidea appear to be recent European introductions (Vandel 1962), which may account for the relative paucity of recent studies on the natural history of North American populations (but see Miller & Cameron 1983; Jass & Klausmeier 1996) in comparison to populations in Europe (Grundy & Sutton, 1989; Souty-Grosset et al. 1994; Zimmer & Kautz 1997; Jones & Hopkins, 1998) and Africa (Aljetlawi & Nair 1994; Dangerfield & Hassall 1994; Dangerfield & Telford 1995). The present study addresses this gap by investigating aspects of the natural history of *Porcellio laevis* (Latreille) in the northeastern United States.

Reproduction of terrestrial isopods is seasonal in temperate climates (Souty-Grosset et al, 1998), and variation in the onset and waning of reproduction, as well as the number of reproductive episodes, is associated with photoperiod (Juchault et al. 1981; Souty-Grosset et al. 1994) and latitude/temperature (Mocquard et al.1980; Souty-Grosset et al. 1988,1998). For example, long-day photoperiods stimulate the onset of reproduction and extend the length of the reproductive period in *Armadillidium vulgare* (Souty-Grosset et al. 1994), but high ambient temperature only marginally accelerates reproductive onset and does not appear to influence its duration (Mocquard et al. 1980). However, *A. vulgare* females from southern (presumably warmer) latitudes undergo three parturial molts in a season, whereas those from northern latitudes were observed to undergo only a single parturial molt (Souty-Grosset et al. 1998).

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Thus, reproductive strategies appear to be plastic (Dangerfield & Hassall 1992), and variation in reproductive phenology may depend on subtle differences in habitat.

Seasonal variation is also evident in fecundity and egg-mass (e.g. *Ligia oceanica,* Willows 1987). Variation in these factors, as well as quality/quantity of progeny, is also associated with other factors, such as diet and condition. For example, *A. vulgare* reared on dicotyledonous food sources exhibit higher growth rates and fecundity in comparison to those reared on monocotyledonous food (Rushton & Hassall 1983). In addition, competition among individuals for limited resources can result in diminished growth and fecundity (Hassall & Dangerfield 1997). Feminizing *Wolbachia* infections also appear to diminish fecundity (e.g. *Oniscus asellus*, Rigaud et al. 1999). Such factors are therefore predicted to directly impact female reproductive success.

Because female terrestrial isopods retain eggs and young mancas in the marsupium (a fluid-filled brood pouch formed by specialized oostegites on the ventral pereon), body size also places an important constraint on female reproductive success — fecundity is positively correlated with size of the marsupium (Dangerfield & Telford 1995) and body size in general (Tomescu et al. 1992). Although it might be predicted that selection would favor correlations between maternal and egg/manca size, such associations have not been observed (Telford & Dangerfield 1995). Hence, offspring quantity, but not necessarily quality, is governed by maternal body size.

It is unclear, however, how body size and survivorship are associated. Grundy and Sutton (1989) found that adult *Philoscia muscorum* had higher survivorship than smaller-bodied juveniles. Dangerfield (1997), however, found no substantial relationships between birth mass and offspring fitness in *Porcellionides pruinosus* and *Aphiloscia vilis.* In a recent study by Hassall (1996), the relationships between growth and survivorship varied widely depending on habitat structure. Given the importance of body size in reproductive success, there is a need for additional investigation into the role body size plays throughout the life cycle of terrestrial isopods.

In the present study, we examine population-level changes in body size of the terrestrial isopod, *Porcellio laevis* (Latreille) during the non-breeding season. Winter growth rates are expected to be low in temperate climates (Pavese 1987), and we may therefore attribute any differences in average body size primarily to differences in mortality. Because body size and fecundity are associated, selection on body size during the non-breeding season should influence the evolution of terrestrial isopod life histories.

MATERIALS AND METHODS

Porcellio laevis (Latreille) were collected over a two year period (1998-2000) in Essex County, New Jersey, USA using an array of ten ‘potato traps’ during each of four one-week sampling periods. Traps were constructed by bisecting small garden potatoes, carving a cavity of approximately 5 cm^2 into the exposed parenchyma, and placing each potato hollow-side down near a deposit of decaying wood. All traps were spaced approximately 1 m apart and all *P. laevis* in contact with each trap were removed and immediately preserved each day.

One-week sampling periods were conducted on four occasions: twice during winter 1998-99 (11/15/98-11/22/98 and 02/15/99-02/22/99) and twice during winter 1999-2000 (11/15/99-11/22/99 and 02/15/00-02/22/00). Sex of each specimen was determined by visual inspection of the pleon (males possess elongated 1st and 2nd pleopods) and all females were subsequently examined. The following measurements were recorded for each specimen to the nearest 0.1 mm: leng th of left antenna (LA), length of right 7th cephalothoracic appendage (RCTA7), and width of 1st cephalothoracic segment (CTS1). These measurements served as indices of the physical dimensions of female exoskeletons — the factor expected to place absolute limits on marsupium egg capacity during the reproductive season.

Data were statistically analyzed with *Minitab*© v.8.0 following Sokal & Rohlf (1981) with $\alpha = 0.05$.

RESULTS

Sample sizes for each collection period were as follows: 11/98, N = 74; 02/99, N = 38; 11/99, N = 80; 02/00, N = 100. With few exceptions (< 10 males), specimens were phenotypically female. Data collected during winter 1998-99 (Fig. 1) revealed a significant decrease in length of right 7th cephalothoracic appendage between November and February (Two-Sample T-test, T = 1.93, P = 0.05) but no significant differences in length of left antenna or width of 1st cephalothoracic segment (Two-Sample T-test, T = 0.82, P = 0.41 and T = 0.38, P = 0.71, respectively).

Data collected during winter 1999-2000 (Fig. 2) revealed significant decreases in lengths of both the right 7th cephalothoracic appendage and left antenna (Two-Sample T-test, T = 5.88, P<0.01 and T = 2.14, P = 0.03, res pectively) but no significant difference in width of 1st cephalothoracic segment (Two-Sample T-test, T = 0.50, P = 0.62).

The measured characters did not significantly differ between November specimens collected in different years (LA, Two-Sample T-test, T = 0.67, P = 0.51; RCTA7, Two-Sample T-test, T = -1.23, P = 0.22; CTS1, Two-Sample T-test, T = -0.89, P = 0.38), nor were there significant differences between February specimens in different years (LA, Two-Sample T-test, T = 1.20, P = 0.23; RCTA7, Two-Sample T-test, T = 0.09, P = 0.93; CTS1, Two-Sample T-test, T = -1.49, P = 0.14). The detection of within-year but not between-year differences suggests that the phenomenon is a natural component of the annual life history of *P. laevis.*

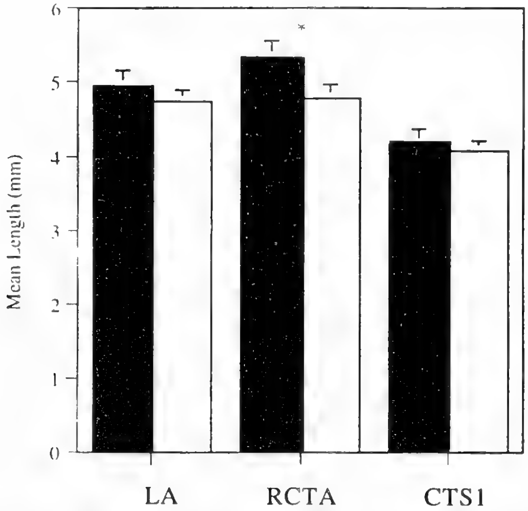

Figure 1. Average length (mm) of left antenna (LA), right 7th cephalothoracic appendage (RCTA7), and width of 1st cephalothoracic segment (CTS1) in November 1998 (black bars) and February 1999 (white bars). Error bars represent standard error on the mean. Asterisk indicates significant difference (P < 0.05).

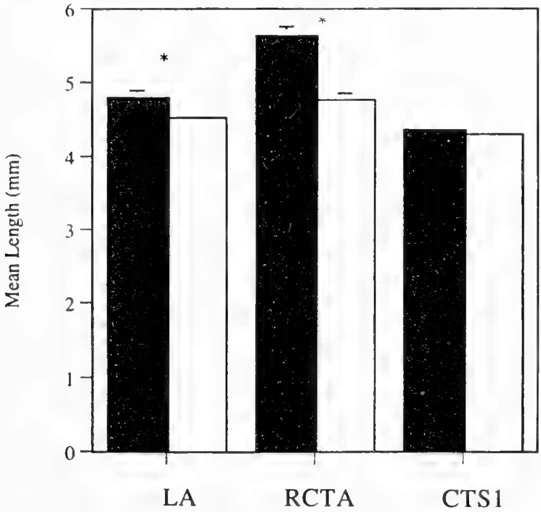

Figure 2. Average length (mm) of left antenna (LA), right 7th cephalothoracic appendage (RCTA7), and width of 1st cephalothoracic segment (CTS1) in November 1999 (black bars) and February 2000 (white bars). Error bars represent standard error on the mean. Asterisk indicates significant difference (P < 0.05).

DISCUSSION

The results of the present study revealed two fundamental life history patterns of *P. laevis* during the non-breeding season in temperate North America. First, the sex-ratio of individuals collected with baited traps was extremely female-biased. Second, body size was significantly larger (as indicated by length of antennae and appendages) in samples collected during the early winter than those collected in the late winter.

In the present study, almost all sampled individuals were phenotypically female. These results are not surprising in light of numerous studies that have addressed female-biased sex ratios in terrestrial isopods (Williams & Franks 1988; Farkas 1998). Recent studies indicate that this phenomenon is associated with microbes of the genus *Wolbachia* (Grandjean et al. 1993; Rigaud, et al. 1999), which drive populations to a female bias through cytoplasmic incompatibility mechanisms and feminization of males. Ambient temperature also appears to influence the direction of this bias in some species (Rigaud et al. 1997). It remains possible, however, that females in the present study were differentially attracted to baited traps, and we are therefore reluctant to speculate further on the actual sex-ratio of the population.

It is also possible that larger females were more attracted to the traps during early winter than in late winter. Large females may have thereby fed more heavily in the early winter and stored fat reserves sufficient to forego late-winter foraging. While we cannot conclusively reject this explanation, it seems unlikely. Winter feeding presumably functions more in maintenance than growth. Larger individuals should have greater maintenance requirements, and we might therefore expect them to be over-represented in late winter feeding activity. Even if winter females undergo vitellogenesis, as suggested by studies in less temperate climates (e.g. Mediterranean populations of *P. ficulneus*, Hornung & Warburg 1993), the metabolic demand on larger females, with corresponding higher fecundities, would be greater.

Alternatively, females in larger size-classes may have suffered differential mortality over the winter months. This interpretation is not consistent with general relationships between organism body size, surface-area:volume ratios and resistance to flux in extreme climates. However, it is consistent with the relationship between body size and age in continuously growing arthropods — larger females are older (and presumably more senescent) organisms. In this case, the largest females in the November samples would have already reproduced through one or more breeding seasons. Such females would be under-represented in February samples if there were a senescence-mediated increase in mortality risk under extreme winter environmental conditions. We are aware of no experimental investigations of Oniscidean senescence and suggest that such studies would yield important insight into the life history of terrestrial isopods. If, as our data suggest, there is differential mortality among larger females during the non-breeding season, it does not necessarily follow that natural selection is acting upon body size per se. Senescent females are expected to have large realized:residual reproductive success ratios – i.e. any natural selection has already acted upon them in previous breeding seasons. This hypothesis is consistent with the results of the present study, in which there was no response to selection between years in female body size. Selection may act indirectly, however, by favoring terminal-investment strategies (Scott & Gladstein 1993; Kight et al. 2000) in aging females unlikely to survive the coming winter. Terminal investment theory pre dicts that older (larger) females should reproductively invest more heavily than younger (smaller) females late in the breeding season. A careful study of body size and late-season reproductive allocation is therefore needed to better understand the life history of *P. laevis* in temperate North America.

ACKNOWLEDGMENTS

The authors thank D. Graziano, E. Katua, M. Patel, K. Priolo, B. Punia and B. Severino for collection and processing of specimens. The manuscript benefited from readings by C. Eadie, J. Smallwood, D. Vanderklein and two anonymous reviewers. This research was supported through SBR and Student-Faculty research grants from Montclair State University.

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NOTES ON THE DISTRIBUTION OF *EPIPOMPILUS PULCHERRIMUS* (HYMENOPTERA: POMPILIDAE)[1]

Howard E. Evans[2], James Wiley[3]

ABSTRACT: The little known species *Epipompilus pulcherrimus*, described many years ago from Dade Co., Florida, is here reported in abundance from Eleuthera, in the Bahamas. Notes are presented on what is known of the biology of members of the genus.

Epipompilus Kohl is an anomalous genus of Pompilidae, largely restricted to the southern hemisphere, with 18 known species in Australia, 5 in New Guinea, 1 in New Zealand, and 10 in the Americas (Evans 1961, 1967, 1972). Only two of the American species range well north of the tropics: *aztecus* (Cresson) (central Mexico) and *pulcherrimus* (Evans) (southern Florida and the Bahamas). Like most species of the genus, these two have been known from very few specimens.

E. pulcherrimus was described from a single female from Everglades National Park, Dade Co., Florida, collected in 1953 (Evans 1955). Several years later several males were collected, also in Everglades National Park, and a description of the male was based on these specimens (Evans 1961). Despite the fact that Malaise traps have been used extensively in several parts of Florida in recent years, the species has not, to our knowledge, been taken again in mainland Florida. However, in 1986, a male was taken in a cactus hammock on Big Pine Key by S. and J. Peck (loaned to us by Albert T. Finnamore, Provincial Museum of Alberta).

That the species occurs in the Bahamas was known from a single female collected on Mangrove Cay, Andros Island (reported by Evans, 1961). It comes as a surprise that *E. pulcherrimus* is actually abundant on at least one other island of the Bahamas. Malaise traps on Eleuthera, maintained by Doris B. and Russell W. Wiley, January-July and October-December 1985-1987, yielded 719 specimens. The traps were located in secondary limestone scrub at Rainbow Bay, approximately 13 km N of Governor's Harbor Airport on Queen's Highway. Specimens have been deposited in the Florida State Collection of Arthropods and the collections of Colorado State University and the U.S. National Museum of Natural History.

The series consisted of 675 males and 44 females, doubtless a reflection of the fact that Malaise traps normally collect far more males than females. Size variation was considerable. Females varied from 5 to 8 mm, fore wing length from 4 to 6 mm. Males varied from 3 to 5 mm, fore wing length from 2.8 to 4.5 mm. Females resembled the type closely except that the thorax was generally

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more extensively rufous. In the males the clypeus varied from light brown to black, the rufous coloration of the thorax was in some specimens suffused with black, and the white tibial spurs were in some cases partially blackened.

The abundance and considerable size variation in the population of *E. pulcherrimus* on Eleuthera suggest that the females are preying upon a diversity of small spiders, or perhaps on a single species of spider at different life stages. The only detailed study of the biology of a species of *Epipompilus* is that of Harris (1987, 1999) concerning the New Zealand *insularis* (Kohl). He found that females hunt in concealed places where retreat-dwelling spiders occur, such as beneath bark, in rolled leaves, or in abandoned galls or beetle burrows. No nest is made; the spiders are stung lightly or not at all, and they resume activities with the wasp larva developing on their body. Harris has described the larva and provided photographs of the larva developing on the spider. Spiders of several families are utilized in New Zealand: Clubionidae, Salticidae, and Desidae. Evans (1972) reported an Australian species preying on a spider of the family Sparassidae. He also cited records that spiders are taken from retreats under bark and elsewhere.

In his recent reevaluation of the classification of the Pompilidae, Shimizu (1994) remarked that *Epipompilus* may represent "one of the most primitive stocks" of the family. He regarded the genus as belonging to an independent subfamily, the Epipompilinae. The occurrence of *E. pulcherrimus* so far north of the largely southern hemisphere range of the genus suggests that the genus may once have had a much wider distribution. The species is uniquely colored and may represent a relict population that has persisted in the Bahamas, where there are few other spider predators that may serve as competitors.

ACKNOWLEDGMENTS

We thank the curators of several museums for checking their holdings for specimens of *Epipompilus pulcherrimus*: Mark Deyrup, Albert Finnamore, Stuart Fullerton, and Karl Krombein. We also thank B.C. Kondratieff and G.B. Edwards for comments on the manuscript.

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SCIENTIFIC NOTE

NOTES ON DISTRIBUTION AND ORTHOGRAPHY ASSOCIATED WITH SOME POORLY KNOWN NORTH AMERICAN MAYFLIES (EPHEMEROPTERA)[1,2,3]

W. P. McCafferty[4]

Caurinella idahoensis Allen was described from a single larva from Idaho County, Idaho by Allen (1984). Both the monobasic genus and the species have been considered rare endemics in Idaho since that time. Additional material of this species from Montana are held in the Purdue Entomological Research Collection as follows: two larvae, Montana, Missoula Co., 0.6 miles below Lolo Pass, 6 June, 1994, D. L. Gustafson.

Baetis rusticans McDunnough was described from adults from Quebec by McDunnough (1925). Subsequently it was reported from New Brunswick, New York, Ohio, Ontario (Walley 1927, Traver 1935, Eidt 1975, Randolph and McCafferty 1998), and questionably from Texas (Baumgardner et al. 1997). The New Brunswick (Eidt 1975) and Ohio (Randolph and McCafferty 1998) records are strictly from misidentified larvae attributable to the common species *B. tricaudatus* Dodds. Although the integrity of *B. rusticans* is somewhat in doubt, larvae have never been correctly associated. Ide's (1937) description of the larva of the *fuscatus* group species *B. rusticans* was actually based on incorrectly associated, non-reared larval variants of the *rhodani* group species *B. tricaudatus*; see also Morhihara and McCafferty (1979), under *B. tricaudatus*. Use of Burks (1953) larval key to species has more than likely been the source of subsequent misidentifications of *B. tricaudatus* as *B. rusticans*.

In the inventory of the Canadian mayfly fauna recently presented by McCafferty and Randolph (1998), one species, *Ephemerella moffatae* Allen, was inadvertently left off the list. That species is known only from a small sample of larvae from the Athabasca River in Alberta at this time (Allen 1977). The species should be added to the Canadian and Alberta checklists.

Cara Flinn (formerly Cara Rowbotham) has kindly informed me that in the original description of the Arkansas species *Paraleptophlebia calcarica*, for which she was the primary author (see Robotham and Allen 1988), her name had been inadvertently misspelled. The species therefore should be emended to *P. calcarica* Rowbotham and Allen. Also, the specific epithet of this species has often been misspelled as *calcarita* in lists of species appearing since its description (e.g., McCafferty 1996). Unfortunately, the misspelling of the author's name must remain as such with respect to the authorship of the publication itself, because of requirements associated with bibliographic tracking.

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[1] Received August 28, 2000; Accepted September 20, 2000.

[2] Research supported in part by NSF grant DEB-9901577.

[3] Purdue ARP Journal No. 16362.

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BOOK RECEIVED AND BRIEFLY NOTED

SOLITARY WASPS. BEHAVIOR AND NATURAL HISTORY. Kevin M. O'Neill. 2001. Comstock Publishing Associates. 406 pp. Cloth $39.95.

A general survey of the natural history and behavior of solitary wasps. Topics covered include: classification of solitary wasps and their relation to other Hymenoptera, foraging and nesting behaviors, mating and parental strategies, thermoregulation, natural enemies, defensive strategies, and directions for future research. Numerous comprehensive tables of quantitative data are provided as resource references for biologists.

SCIENTIFIC NOTE

UNCOMMONLY COLLECTED MOSQUITOES FROM THE FLORIDA KEYS[1]

Lawrence J. Hribar[2]

Monroe County, Florida, includes a large area of the southwestern peninsula of Florida (known to locals as "mainland Monroe") and the Florida Keys southwest of Broad Creek. At least 42 species of mosquitoes have been reported from Monroe County (Darsie and Morris 1998), although it has been years since some species have been collected (Lounibos 1994). The Florida Keys Mosquito Control District is conducting a survey of the mosquitoes of the Florida Keys, the first survey since the 1940s (Pritchard et al. 1949, Thurman et al. 1951). This survey already has revealed that *Anopheles albimanus*, the sole member of the subgenus *Nyssorhynchus* in the United States, is still present in the Florida Keys (Hribar 1999). This note reports the collection of two mosquito species from Monroe County, one infrequently collected in the United States, and the other a new county record.

Psorophora (*Janthinosoma*) *johnstonii* (Grabham): Summerland Key - 2 Sep 1999 (220 ♀♀), 8 Sep 1999 (16 ♀♀); Vaca Key - 16 Sep 1999 (1 ♀); Long Key - 28 Sep 1999 (8 ♂♂). The specimens from Summerland and Long Keys were collected in CO_2-baited light traps. The specimen from Vaca Key was taken as it attempted to bite the author. Summerland Key is a new locality record for this species. *Ps. johnstonii* previously was known from Big Pine Key, Cudjoe Key, Key Largo, Long Key, Lower Matecumbe Key, Plantation Key, and Vaca Key, from specimens collected in April and August (Pritchard et al. 1949, Thurman et al. 1951). Voucher specimens have been placed in the collections of the Florida Keys Mosquito Control District and the Florida Medical Entomology Laboratory.

Culex (*Melanoconion*) *peccator* Dyar and Knab: Big Pine Key - 4 Oct 1999 (1 ♀). The sole specimen known from this county was collected in a CO_2-baited light trap. This species never has been reported from Monroe County, Florida. The closest records are from Manatee and Martin Counties (Darsie and Morris 1998), about 105 miles from Monroe County and about 190 miles from Big Pine Key. The specimen has been deposited in the Florida Medical Entomology Laboratory mosquito collection.

ACKNOWLEDGMENTS

R.F. Darsie, University of Florida, identified the *Cx. peccator* specimen and confirmed identification of *Ps. johnstonii*. E.M. Fussell, Florida Keys Mosquito Control District, and G.L. Miller, United States Department of Agriculture, reviewed the manuscript.

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[1] Received May 22, 2000. Accepted June 12, 2000.

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SCIENTIFIC NOTE

FIRST RECORDS OF THE WATERSCORPION *CURICTA SCORPIO* (HEMIPTERA: NEPIDAE) IN NUEVO LEON, MEXICO[1]

H. Quiroz[2], V. A. Rodríguez[2], R. González[2], C. Solís[2], A. Contreras[3]

Several aquatic insect groups are poorly known in Mexico. In recent years, we have started a research program on the aquatic insect fauna of Nuevo Leon, with several interesting findings as in the case of *Curicta*. Waterscorpions are true bugs bearing a long respiratory tube at the posterior end of the body. The submerged insect uses the tube for atmospheric air intake.

Slater and Baranowski (1978) and Polhemus (1996) listed only two species of *Curicta* as being distributed in the southern United States. *C. scorpio* (as *C. howardi* Mont.) was the more common and was mostly restricted to the southwestern states. According to Wilson (1958), *C. scorpio* (as *C. drakei* Hugenford) was recorded in Louisiana and Texas in 1922. Both *C. howardi* and *C. drakei* have been synonymized with *C. scorpio*, Keffer (1996).

Keffer (1996), listed *C. hugenfordi* Kuitert, *C. pronotata* Kuitert and *C. scorpio* as other nepids present in Mexico, the last having been collected in the states of Tamaulipas, Veracruz, Nayarit, Jalisco, Colima, Michoacan, Guerrero, Morelos, Distrito Federal, Oaxaca, Chiapas and Mexico. The findings reported herein represent the first times that *C. scorpio* has been collected in Nuevo Leon. The specimens of *C. scorpio* are in the Entomological Museum (FCB-UANL).

In the Entomological Museum of the Facultad de Ciencias Biológicas, Universidad Autónoma de Nuevo León (FCB-UANL), specimens of *Ranatra fusca* P & B have been the only representatives of Nepidae in the state but since 1997 some adults and nymphs of *Curicta scorpio* have been collected. In April 1997 an adult of *C. scorpio* was collected in artificial pools at the Campo Agrícola Experimental del Instituto Tecnológico y de Estudios Superiores de Monterrey in Apodaca, Nuevo León. This is a semiarid zone with few permanent surface waters. The Pesquería River is the closest permanent aquatic system to the area (12 km of distance), however it is highly polluted.

We believe the occurrence of *C. scorpio* at the pools was made possible by its dispersal and colonization habits. As with other aquatic hemipterans, the flying dispersal behavior of *C. scorpio* may have been related to an increase in relative air humidity as a short rain period occurred before its presence was noted. The waterscorpion was collected with a plastic dipper in an artificial pool with continuous water supply. Water temperature was 17° C, pH 7.6 and aquatic vegetation was dominated by the green alga *Chara* sp.

A second adult and two nymphs of *C. scorpio* were collected in La Ciudadela Creek in Benito Juárez City, a place with a high density and diversity of trees and grass, located 54 km east of Monterrey. The waterscorpions were collected in June 1999 with a plastic dipper, from a permanent aquatic system with clear water; temperature was 19° C, pH 7.2 and *Chara* sp. was the aquatic vegetation.

In November 1999, a third adult was collected with a plastic dipper in a section of the San Juan River named "Los Canelos", 70 km le. distant from Monterrey, a place with many *Taxodium* sp. trees, a permanent but lightly polluted aquatic system, without riparian vegetation where the waterscorpion was collected; water temperature was 13° C and pH 7.5.

(Continued on page 134)

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[1] Received April 17, 1998. Revision received April 13, 2000. Accepted July 26, 2000.

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THE NAME OF THE TYPE SPECIES OF *SIMULIUM* (DIPTERA: SIMULIIDAE): AN HISTORICAL FOOTNOTE[1]

F. Christian Thompson[2]

ABSTRACT: The proper original description of the type-species of the genus *Simulium*, *S. colombaschense* (Scopoli), is identified and the current spelling of the species name is confirmed.

INTERPRETATIVE SUMMARY: Black flies are among the most impor-tant biting flies, annoying humans and their livestock since the beginning of recorded time. The scientific names associated with the Golubatz fly, a notorious pest of the Danube Basin, are re-evaluated and the valid name confirmed. This will allow historical information on the Golubatz fly to be properly utilized.

Black flies are among the most important biting flies. Black flies have annoyed humans and their livestock since the beginning of recorded time. More than three-quarters of the world's black flies belong to the nominal-typic genus *Simulium*. The type-species of that genus was a notorious pest on the "Bannat," the middle region of the Danube basin. This species was commonly known as the Golubatz fly (or Kolumbatzer mücken). As such, much has been written about this pest. Unfortunately, in the early days of scientific nomenclature this information was associated with different names. Hence, the status and relationships of these names are critical. Crosskey and Howard (1997: 90, also Crosskey 1990: 17-18), in the most recent and comprehensive inventory of the world black flies, have fully and properly analyzed the confusion about these names. They note that this fly was first properly and formally named under the current system of zoological nomenclature by Linnaeus (1771: 541) as *Culex lanio*, but this name was forgotten, perhaps because it was published in an appendix to a botanical work. Crosskey and Howard, therefore, correctly and properly declare that this species should remain known by its Fabrician name, as that is the one most workers have used for the past 200 years. While I agree with this conclusion, this footnote corrects another 200 year old error, that is, Fabricius did not himself name the Golubatz fly, but merely misspelt the name proposed originally by Scopoli.

Linnaeus, in establishing an improved system for naming organisms, wrote a set of guidelines for those who would use his system (Schmidt 1952). These

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[1] Received October 19, 1999. Accepted July 20, 2000.

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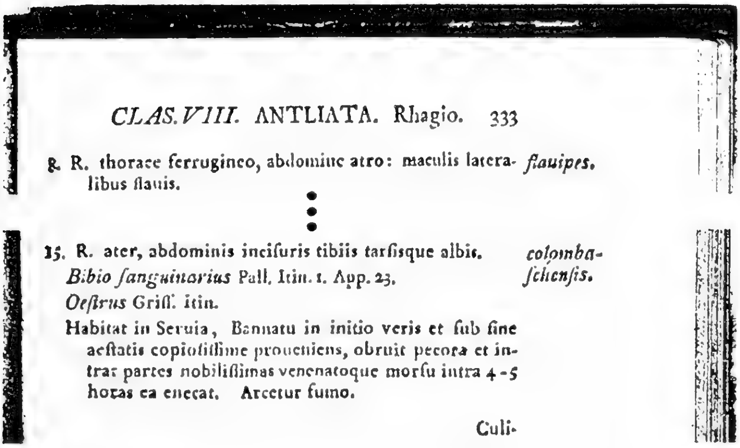
guidelines were published in all the early versions of his *Systema Naturae*, but on reaching the 10th edition, Linnaeus deleted these guidelines, perhaps because he felt by then they were well known to all workers. Unfortunately, in retrospect, the zoological community accepted the 10th Edition of the *Systema Naturae* as the starting date for zoological nomenclature. Hence, modern workers never bother to examine earlier editions and, thereby, the Linnaean guidelines are completely forgotten. For our tale, the important guidelines were 2 & 3, where Linnaeus declared that the synonyms of all prior workers should be given. Fabricius was a student of Linnaeus, and largely followed these guidelines. For *Simulium colombaschense* (which in 1787, Fabricius placed in the genus *Rhagio*), Fabricius (1787: 233) listed two synonyms and references to their source (figure 1). Unfortunately, subsequent workers have largely ignored these references. The first reference was to *Bibio sanguinarius* Pallas (1771). Crosskey and Howard (1997: 93) correctly noted that Pallas's name, *sanguinarius*, was based on a pest from the Russian Volga, rather than the Danube. Hence, the synonymy of this name (*sanguinarius*) with *colombaschense* by Fabricius was incorrect, as *colombaschense* is restricted to the Danube. So, the synonymy of *sanguinarius* by Pallas himself (1776 in an errata page at the end of the volume) under the Linnaean species, *reptans*, is probably correct (Crosskey and Howard cited the later synonymy by Olfers (1816), who also placed sanguinarius as a synonym of *retans*). The second reference is to *Oestrus columbacensis* Scopoli in Griselini (1780). This reference was expanded in the next edition of *Systema Naturae* (Gmelin 1790: 2866 #324 Musca colombaschenis; fig. 2) as "Grisel. hist. temef. *Oestrus columbacensis*." Unfortunately for modern workers, these references are obscure. Although today, one can decipher these citations by using bibliographies of those times, such as Dryander (1796-1800) and Cobres (1782). However, to the workers of those days, these references were clearly understood to refer to Franz Griselini's compendium on the Bannat (Griselini 1780), which includes a "letter" (= chapter) by Scopoli (1780) on the pest insects found in this area.

What are the consequences of the above? Under the current rules of zoological nomenclature, the Fabrician name, *colombaschensis*, is merely a subsequent misspelling of the valid name first proposed by Scopoli, *Oestrus columbacensis*. Hence, the name of the type species should be *Simulium columbacensis* (Scopoli). Or if workers want to maintain the current spelling, given the minor difference in spelling of *columbacensis* ("u" instead of "o" and no "h" or "s") being important enough, then Gmelin's (1790) emendation could be accepted as justified. The justification would be based on the fact that Scopoli used the German spelling of *Kolombashischen Mucken* in his title. However, to change the authorship from Scopoli to Fabricius would require the use of the Plenary Powers of and action by the International Com-



CLAS. VIII. ANTLIATA. Rhagio. 333

8. R. thorace ferrugineo, abdomine atro: maculis lateralibus flauis. *flauipes.*

⋮

15. R. ater, abdominis inciſuris tibiis tarſiſque albis. *colomba-ſchenſis.*

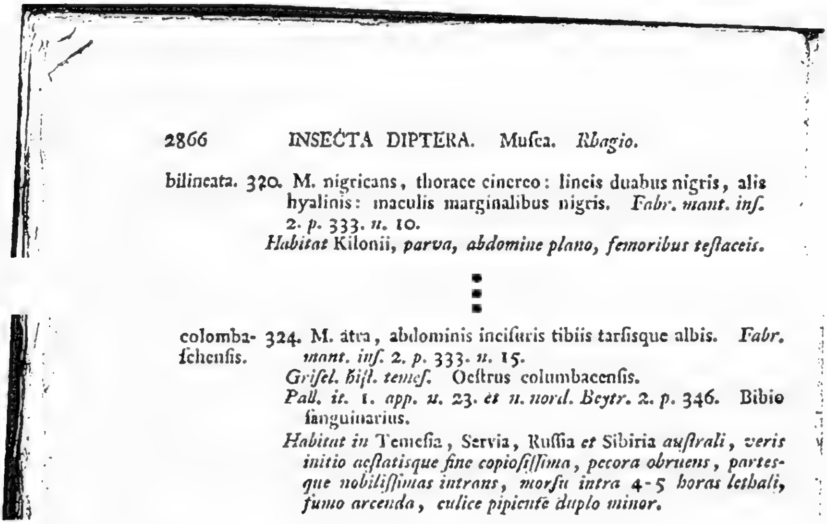
Bibio ſanguinorius Pall. Itin. 1. App. 23.

Oeſtrus Griſſ. itin.

Habitat in Seruia, Bannatu in initio veris et ſub fine aeſtatis copioſiſſime prouenienſ, obruit pecora et intrat partes nobiliſſimas venenatoque morſu intra 4-5 horas ea enecat. Arcetur fumo.

Culi-

1. Fabricus 1787



2866 INSECTA DIPTERA. Muſca. *Rhagio.*

bilineata. 320. M. nigricans, thorace cinereo: lineis duabus nigris, alis hyalinis: maculis marginalibus nigris. *Fabr. mant. inſ.* 2. *p.* 333. *n.* 10.

Habitat Kilonii, *parva, abdomine plano, femoribus teſtaceis.*

⋮

colomba-ſchenſis. 324. M. atra, abdominis inciſuris tibiis tarſiſque albis. *Fabr. mant. inſ.* 2. *p.* 333. *n.* 15.

Griſel. hiſt. temeſ. Oeſtrus columbacenſis.

Pall. it. 1. *app. n.* 23. *et n. nord. Beytr.* 2. *p.* 346. Bibio ſanguinarius.

Habitat in Temeſia, Servia, Ruſſia *et* Sibiria *auſtrali, veris initio aeſtatisque fine copioſiſſima, pecora obruens, partesque nobiliſſimas intrans, morſu intra* 4-5 *horas lethali, fumo arcenda, culice pipiente duplo minor.*

2. Gmelin 1790

Figs. 1-2. Taxonomic descriptions of *Simulium colombaschense* (Scopoli). 1. Page from Fabricius (1878). 2. Page from Gmelin (1790). Note that both pages have been truncated, with the irrelevant material removed.

mission on Zoological Nomenclature. Given that the author is not part of the scientific name and is being used less and less by field workers, such an application to the Commission would serve no useful purpose. The proper synonymy for the Golubatz fly is:

Simulium colombaschense

Culex lanio Linnaeus 1771: 541. *Nomen oblitum.*
Oestrus columbacensis Scopoli 1780: 133.
Rhagio colombaschensis Fabricius 1787: 333. Misspelling of *columbacensis* Scopoli
Musca colombaschensis Gmelin 1790: 2866. Justified emendation of *columbacensis* Scopoli. ... and other more recent synonyms as cited by Crosskey and Howard.

In summary, everyone should be aware that the story of the Golubatz fly is not complete without considering and including Scopoli's 1780 contribution. That contribution has been overlooked because subsequent workers have not taken the time to analyze Fabricius' synonymy of *Rhagio colombaschensis*!

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SOCIETY MEETING OF OCTOBER 25, 2000

THE IMPACT OF IMPORTED PARASITIC MITES ON HONEY BEES AND WHAT IS BEING DONE TO MANAGE MITES AND ADDRESS POLLINATION CONCERNS

Maryann Frazier
Penn State University

Senior extension associate, Maryann Frazier, discussed the recent introduction of two parasitic mites (Varroa and tracheal) and the diseases associated with these mites, which have placed the U.S. beekeeping industry in serious jeopardy. Because state-supported research and extension on honey bees is declining in the northeastern U.S., researchers and extension specialists from several states have banded together to develop a regional program to combat the new problems.

Over ninety crops depend on or benefit from honey bee pollination, and the yields and quality of many fruit and vegetable crops are threatened by the mites and diseases that harm honey bees. Approved chemical treatments for the control of these mites are limited, and Varroa mites are showing widespread resistance to the one approved general use chemical control agent. As an alternative to chemical treatments, entomologists from the Mid-Atlantic Apiculture Research and Extension consortium (MAAREC) are working to develop an IPM (integrated pest management) approach to honeybee mite management. IPM approaches being worked on by MAAREC scientists thus far include the identification of thresholds, control tactics such as the use of screen bottom boards, requeening with queens resistant to mites and diseases, the use of biorational agents such as essential oils, and other mite reducing techniques. Researchers are also investigating the role that viruses are playing in the declining health of honey bees. In addition, the consortium's work includes some research on alternative pollinators such as *Osmia cornifrons* (the hornfaced bee).

In notes of entomological interest, Hal White showed slides of a bolas spider (*Mastophora bisaccata*), taken at Insect Field Day. He reported that some bolas spiders include a female moth pheromone in their lures and catch only male moths. Hat also mentioned a recent article in the Wilmington *News Journal* on dragonfly watching.

President Gelhaus reported that the attendance at Insect Field Day was approximately one hundred.

William J. Cromartie
Corresponding Secretary

ON THE ADULT FEEDING OF SEVERAL EUROPEAN STONEFLIES (PLECOPTERA)[1]

J. M. Tierno de Figueroa[2,3], R. Fochetti[3]

ABSTRACT: This work reports on the gut contents of adults of the genera *Brachyptera*, *Rhabdiopteryx*, *Taeniopteryx* (Taeniopterygidae), *Tyrrhenoleuctra* (Leuctridae), *Besdolus*, *Dictyogenus*, *Perlodes* (Perlodidae), and *Dinocras* and *Perla* (Perlidae). The results seem to support the hypothesis that only large-sized stonefly species may not feed during adult stage and that a size of approximately 1.5 cm is the limit above which an adult stonefly may not feed.

Feeding in adult stoneflies is a poorly known aspect of their biology. The aim of the present study was to determine the gut contents of some species belonging to four genera of Nemouroidea and five of Perloidea. We have tried to expand the knowledge of imaginal feeding in stoneflies by providing information about this aspect of their biology for some genera and by supplementing the data from previous studies (e. g. Hynes, 1942; Rupprecht, 1990; Tierno de Figueroa et al., 1998; Tierno de Figueroa and Sanchez-Ortega, 1999, 2000).

MATERIAL AND METHODS

The transparency method employed to study the digestive contents is the same one used by Tierno de Figueroa et al. (1998) and Tierno de Figueroa and Sanchez-Ortega (1999, 2000) with slight variations: individuals (without legs, wings, antennae and cerci) were placed in vials with Hertwig's liquid (a variation of Hoyer's liquid, composed by 270 g of hydrated chloral, 19 cc of chloridric acid 1N in 150 ml of distillate water and 60 cc of glierine) and kept at 65°C in an oven for 19 to 20 hours. They were then mounted on slides directly with Hertwig's liquid and oven dried. A Carl Zeiss Axioscop microscope (40, 100 and 200x magnification) was used to observe and determine the gut contents.

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ENT. NEWS 112(2): 130-134, March & April, 2001

RESULTS AND DISCUSSION

The studied specimens and the results of their diet analyses are:

Family Taeniopterygidae:
Genus *Brachyptera*. *B. calabrica* Aubert, 1953; Pollino, Italy, 5-VII-1986. G. Carchini leg. 2 females. *B. risi* (Morton, 1896); Fiume Mignone, Canale Monterano, Italy, 6-III-1992. R. Fochetti leg. 2 females and 2 males.

Of all specimens examined, only one female of *Brachyptera calabrica* had appreciable gut contents, more than 95% of which were spores and hyphae of Ascomycetes, occupying most of the gut. The remainder (less than 5%) were plant remains (coarse organic particulate matter) and a small quantity of pollen grains (< 1%), possibly ingested incidentally. The other *Brachyptera calabrica* female did not have any appreciable quantity of food in her gut, only a few Ascomycetes spores. The *Brachyptera risi* females and males did not contain any gut contents.

Genus *Rhabdiopteryx*. *R. neglecta* Albarda, 1889; Fiume Orfento, Parco della Maiella; La Cesa, Italy, 30-VI-1998, Fochetti leg. 6 females.

Four of the six *Rhabdiopteryx neglecta* females had gut contents composed of almost 100% Ascomycete hyphae and spores, with the presence (possibly by incidental ingestion) of some pollen grains of various origin (*Pinus*, Asteraceae and others).

Genus *Taeniopteryx*. *T. kuehtreiberi* Aubert, 1950; Fiume Tenna. Gole Infernaccio; Italy, 30-III-1985, Fochetti leg. 5 females and 5 males.

Two of the five *Taeniopteryx kuehtreiberi* females had gut contents (in one case, a large quantity), principally Ascomycete hyphae and spores, with a small quantity of pollen grains (possibly by incidental ingestion). Two of the males of this species contained a small quantity of gut contents, consisting of Ascospores in one case and Ascospores and pollen grains in the other. However, the very small quantity of food makes it doubtful whether these two males actively ingested it.

Family Leuctridae:
Genus *Tyrrhenoleuctra*. *T. zavattarii* (Consiglio, 1956). Rio di Oschiri; Oschiri (SS), Italy, 11-II-1982. 2 females and 2 males. Rio Terramala, Italy, 11-II-1982, Fochetti leg. 4 males.

The two females of *Tyrrhenoleuctra zavattarii* had no gut contents, but two of the six males had food in the gut. One of them had a large quantity of Ascomycete hyphae and spores (100% of the content). The other had a limited amount of pollen grains, probably by incidental ingestion.

Family Perlodidae & Perlidae:
Genera *Dictyogenus, Besdolus, Perlodes, Dinocras* and *Perla*
Family Perlodidae: *Dictyogenus alpinus* (Pictet, 1842). Riva di Tures (BZ), Rio dei Dossi, Italy, 2-VIII-1998, 2 females. Val'Aosta, Coque Val di Valeille, 1700 m, 8-VII-

1992, M. Mei leg., 1 female. Val'Aosta, Valsavarenche, Eau Rousse, 7-VII-1992, 1700 m, M. Mei leg., 1 female. Piemonte (To) dint Bardonecchia, Vallone Rochenudes, Rifugio Scarfiotti (cascata), 2175 m, 3-VIII-1995, A. Zilli leg., 1 female. *Besdolus ravizzarum* (Pictet, 1841). Rio Fanes, Val di Fanes (BL), 1700 m, 25-VIII-1984, 1 female. App. Emiliano Corniglio t. Parma, 470 m, Ravizza leg., 22-V-1976, 1 female and 1 male. *Perlodes jurassicus* (Aubert, 1946). R. Arno, Prati di Tivo (Te), 21-VII-1985, Fochetti leg. 3 females. *P. microcephalus* (Pictet, 1833). Piemonte (To), valle Argentiera (Alta Valle Susa), 2000-2250 m, 29-VII-1995, A. Zilli leg., 1 female and 1 male.

Family Perlidae: *Dinocras cephalotes* (Curtis, 1827). Marche (Mc), F. Chienti, Tolentino dint, M. Bologna leg., 14-V-1992, 1 female. *Perla grandis* (Rambur, 1841). Appennino Modenese, Parco del riva lago Turchino, 1675 m, Cottarelli leg., 21-VI-1998, 1 female. Alpi Cozie meridionali, Sambuco, 1180 m, 8-VI-1998, A. Vigna leg., 8-VI-1998, 1 male. *P. marginata* (Panzer, 1799). T. Romeano, Poggio Moiano, 30-VI-1980, Fochetti leg. 2 females and 2 males. F. Farfa-Mompeo, 4-VII-1982, 1 female. Picon-Cividale del Friuli, 26-VI-1984, Sbordoni leg. 3 females.

None of the 24 specimens had any substantial amount of gut contents. In fact, only four of them had a very small quantity of food. However, its composition and quantity suggests that it probably was ingested incidentally while the individuals were drinking. Two females of *P. marginata* had a very small quantity of detritus and Ascomycete spores respectively, while one female of *D. alpinus* and one female of *P. microcephalus* had small quantities of detritus. In all these cases, the contents were at the end of the gut and probably ingested while drinking.

CONCLUSIONS

Despite the low number of specimens analysed, the results seem to support the hypothesis that large-sized stonefly species do not feed during their adult stage. This could be a consequence of low metabolic rate and a large accumulation of reserves during the nymphal stage rather than the presence, or not, of mature eggs at the end of the nymphal stage as has previously been suggested (Hynes, 1942; Brinck, 1949; Zwick, 1990). For example, in *Hemimelaena flaviventris*, in which mature eggs have not been found in the mature nymphs, adult feeding seems to be less important than in other Perlodidae, e.g. in two species of the genus *Isoperla* (Tierno de Figueroa et al., 1998; Tierno de Figueroa and Sanchez-Ortega, 1999). Also, *Isoperla nevada*, which has mature eggs in the last nymphal stage (Tierno de Figueroa, 1998) still feeds actively during the adult stage (Tierno de Figueroa and Sanchez-Ortega, 1999).

The present results and the bibliographic data seem to indicate that a size of approximately 1.5 cm may be the limit above which a stonefly does not need food during its adult stage. The existence of some Perlodidae species that feed and others that do not (Table 1) indicates that feeding in adult stoneflies is an adaptative and not a phylogenetic consequence and thus cannot be used as a taxonomic criterion, contrary to what was previously hypothesized by Tierno de Figueroa and Sanchez-Ortega (2000).

Table 1. Importance of adult feeding in European stoneflies. Data Sources (+ = significant feeding demonstrated; – = no significant feeding demonstrated).

Families and Genera	Feeding significance	References
Taeniopterygidae		
Brachyptera	+	Present data
Rhabdiopteryx	+	Present data
Taeniopteryx	+	Present data
Nemouridae		
Amphinemura	+	Tierno de Figueroa & Sanchez-Ortega (2000)
Protonemura	+	Tierno de Figueroa & Sanchez-Ortega (2000)
Nemoura	+	Hynes (1942); Zwick (1990); Tierno de Figueroa & Sanchez-Ortega (2000)
Nemurella	+	Rupprecht (1990)
Capniidae		
Capnia	+	Tierno de Figueroa & Sanchez-Ortega (2000)
Capnioneura	+	Tierno de Figueroa & Sanchez-Ortega (2000)
Leuctridae		
Leuctra	+	Rupprecht (1990); Zwick (1990); Tierno de Figueroa & Sanchez-Ortega (2000)
Tyrrhenoleuctra	+	Present data
Perlodidae		
Dictyogenus	–	Present data
Besdolus	–	Present data
Perlodes	–	Present data
Hemimelaena	+	Tierno de Figueroa et al. (1998)
Isoperla	+	Tierno de Figueroa & Sanchez-Ortega (1999)
Perlidae		
Dinocras	–	Present data
Perla	–	Present data; Tierno de Figueroa & Sanchez-Ortega (1999)
Chloroperlidae		
Chloroperla	+	Zwick (1973); Tierno de Figueroa & Sanchez-Ortega (1999)
Siphonoperla	+	Rupprecht (1990); Zwick (1990)

ACKNOWLEDGMENTS

The stay of JMTF in the Dipartimento di Scienze Ambientali (Università della Tuscia) was supported by a postdoctoral grant from the University of Granada. We thank two referees, Dr. Zwick (Limnologische FlussStation, Schlitz, Germany), Dr. Brittain (Zoological Museum, University of Oslo, Norway) and Dr. Stark (Mississippi College, U.S.A.) for their valuable comments, that notably improved the paper. Dr. Brittain is also thanked for smoothing the English text.

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(Continued from page 124)

ACKNOWLEDGMENTS

We thank Steve L. Keffer for his generosity for providing us with manuscripts of *Curicta* and Miguel Ibarra of Campo Agrícola Experimental del Instituto Tecnológico y de Estudios Superiores de Monterrey for all the facilities used in this field of study.

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TWO NEW SPECIES OF *PARALLAXIS* (HOMOPTERA: CICADELLIDAE) FROM CENTRAL AMERICA[1,2]

Paul H. Freytag[3]

ABSTRACT: Two new species of *Parallaxis, P. maesi,* from Costa Rica and Nicaragua and *P. anisa* from Belize are described for the Central American region. Both species closely resemble *P. colorata* in color, but differ in the form of the male genitalia. The distribution of the five species now known for Mexico and Central America is given.

When the new world genus *Parallaxis* was reviewed by Linnavuori (1954), there were three species known from Central America. Two new species are now added, both of which seem closely related to *P. colorata* Linnavuori. The new species are quite easily distinguished from *P. colorata* on the basis of the male genitalia.

Parallaxis maesi, NEW SPECIES

(Figures 1-3)

External characters similar to *P. colorata.* Length of male 2.5 - 275 mm., female 2.75 - 3 mm.

Male genitalia: Pygofer (Fig. 3) shorter than genital plates, with posterior margin thickened, ventral margin with short nearly closed claw-like process. Genital plates triangular in ventral view, paddle-shaped in lateral view. Aedeagus (Figs. 1-2) slender with shaft gradually narrowing to apex, apex with two pair of fine nearly parallel processes curving ventrolaterally, one third length of shaft.

Holotype male: Costa Rica: Guanacaste, Estación Experimental Enrique Jimenez Nuñez, 25-IX-1992, Frank Parker, blacklight trap. Paratypes: one male, one female same data as holotype. Holotype and female paratype in the collection of the Instituto Nacional de Biodiversidad, Heredia, Costa Rica, and male paratype in the University of Kentucky Collection.

Other specimens examined: Four males, three females, Nicaragua: Masaya, Las Flores, 1-VII-1994, malaise trap, J. M. Maes; one female same data except 1-VIII-1994; one female, same data except 30-VIII-1994; six males, two females, same data except 8-VII-1994; three males, same data except 18-VII-1994; one male, same data except 7-IX-1994; two males, two females, Chinandega, Villa Nueva, 30-X-1989, uv light, S. Valle. Deposited in the Museo Entomológico, León, Nicaragua and two males, two females in the University of Kentucky Collection.

Etymology: this species is named for J. M. Maes who sent the Nicaraguan specimens to me for study.

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[1] Received May 15, 2000, Accepted July 3, 2000.

[2] This paper is published with the approval of the Director of the Kentucky Agricultural Experiment Station as journal article no. 00-08-83.

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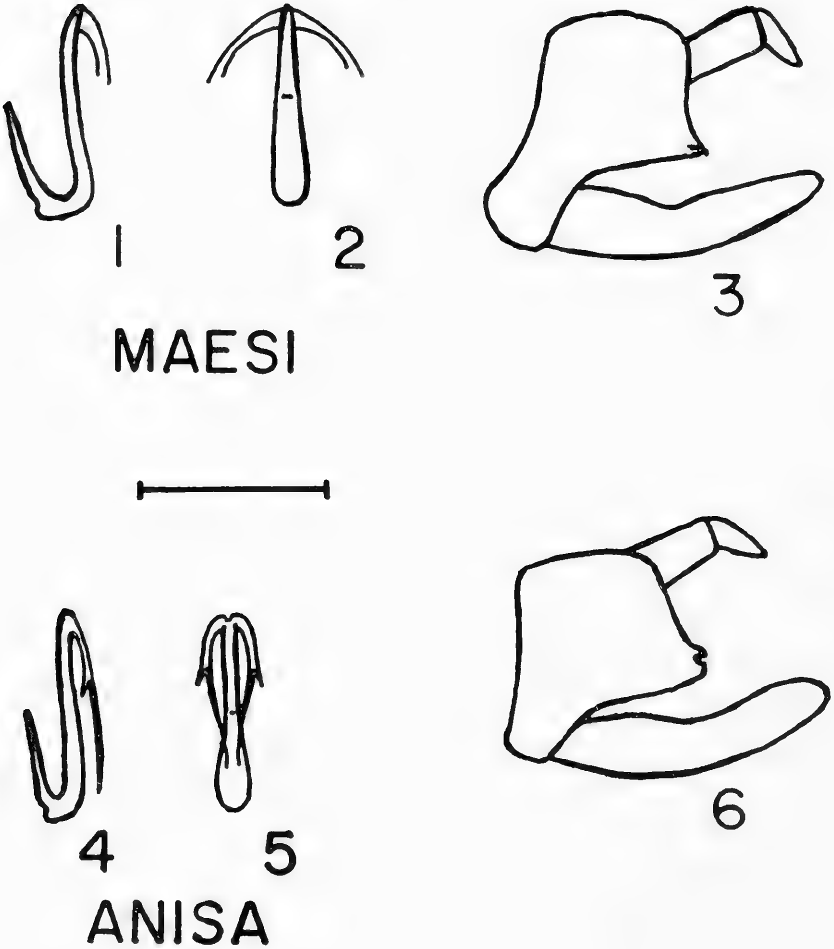

Figures 1-3 *Parallaxis maesi* new species, 4-6 *P. anisa* new species. Fig. 1 and 4 Lateral view of aedeagus. Fig. 2 and 5 Posterior view of aedeagus. Fig. 3 and 6 Lateral view of genital capsule. All drawn to the same scale. Scale equals 0.25 mm.

Parallaxis anisa, NEW SPECIES

(Figures 4-6)

External characters similar to *P. colorata*. Length of male 2.5-2.75 mm., female 2.8-3 mm.

Male genitalia: Pygofer (Fig. 6) similar to *P. colorata*, except ventral margin longer than dorsal margin, and posteroventral claw-like process small. Genital plates longer than pygofer. Aedeagus (Figs. 4-5) with shaft nearly uniform width from small bulbous base, one pair of apical processes nearly same length as shaft, extending ventrally very close to shaft with short lateral spur at midlength.

Holotype male: Belize: Orange Walk Dist., Rio Bravo Cons. Area, Well trail near "Texas Camp", 10-18-VII-1996, P. W. Kovarik, yellow pan traps, Well trail transect. Paratypes: nine males, ten females same data as holotype. Holotype and one female paratype in the British Museum of Natural History, London, England; two male, two female paratypes in each of the following collections, Florida Collection of Arthropods, Gainesville, Florida, The California Academy of Sciences, San Francisco, California and The Ohio State University Collection, Columbus, Ohio; and the remainder in the University of Kentucky Collection.

Etymology: this species is named for its unequal aedeagal processes.

The known distribution of the species of *Parallaxis* for Mexico and Central America is now as follows:

1. *P. anisa* Freytag, new species	Belize
2. *P. colorata* Linnavuori 1954	Costa Rica, Panama
3. *P. donaldsoni* (Baker) 1903 (*Erythria*)	Belize, Costa Rica, Honduras, Mexico, Nicaragua, Panama
4. *P. guzmani* (Baker) 1903 (*Erythria*)	Costa Rica, Honduras, Mexico, Nicaragua, Panama
5. *P. maesi* Freytag, new species	Costa Rica, Nicaragua

ACKNOWLEDGMENTS

Thanks to Frank Parker, USDA retired, for collecting many leafhopper specimens from Costa Rica, and J. M. Maes for doing the same in Nicaragua. Both sent many specimens to me for study.

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Linnavuori, R. 1954. Contributions to the Neotropical leafhopper fauna of the family Cicadellidae III. A revision of the genus *Parallaxis* McAtee. Suomen Hyönteistieteellinen Aikakauskirja 20 (4):153-164.

A STUDY ON GENUS *AGIOMMATUS* (HYMENOPTERA: PTEROMALIDAE) FROM CHINA, WITH DESCRIPTION OF ONE NEW SPECIES[1,2]

Xiao Hui, Huang Da-Wei[3]

ABSTRACT: The two Chinese species of *Agiommatus* are treated and keyed. *A. pantanus* n. sp. is described from the south of China. *Agiommatus jiahuanae* is synonymized with *A. erionotus*. Both Chinese *Agiommatus* species were reared from the eggs of Lepidoptera.

Agiommatus has been placed in Pteromalinae (Pteromalidae) since its description by Crawford in1911. *Agiommatus* can be easily recognized within the Pteromalinae by the following characters: head with inner eye orbits converging upwards (fig. 1); eye large, eye height 1.2-1.7 times frons width; female with 3 anelli; mesopleuron ventrally with distinct transverse carina separating from mid coxae. Some species of Cleonyminae (Pteromalidae) have converging inner eye orbits, but they can be easily separated from *Agiommatus* by the following characters: antenna with 1 anellus; thoracic dorsum with dense setiferous punctures, notauli complete, pronotum usually large and subconical, collar not delimited by an edge.

Eight valid species of *Agiommatus* are now known. They are distributed mainly in the Oriental region (Noyes, 1998). In this paper we describe a new species, *A. pantanus* Xiao and Huang, from the Oriental part of China and synonymize *A. jiahuanae* Yang 1992 with *A. erionotus* Huang 1986, n. syn. The four remaining Oriental *Agiommatus* species include *A. attaci* Ferrière, *A. geethae* Sureshan & Narendran, *A. paria* (Motschulsky) and *A. sumatraensis* Crawfold. *A. viridis* (Girault) is known from Australia and *A. bekiliensis* (Risbec) was recorded from African Region.

Agiommatus Crawford, 1911

Agiommatus Crawford, 1911:278. Type-species: *A. sumatraensis* Crawford; by original designation. Huang, 1993:182-184.

Pterosemella Girault, 1913:317. Type-species: *P. viridis* Girault; by original designation. Synonymized with *Agiommatus* by Bouček, 1976: 18.

Polycystella Girault, 1913:325. Type-species: *P. fasciativentris* Girault; by original designation. Synonymized with *Agiommatus* by Bouček, 1988: 458.

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[1] Received Januray 31, 2000. Accepted August 27, 2000.

[2] Supported partly by NNSFC (No. 39900014) and Young Scientist Grants of CAS (C2999081).

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Generic diagnosis: Body metallic green; head distinctly wider than mesoscutum; inner orbits converging upwards; clypeal margin produced and deeply emarginate in the middle; antenna shorter than head width, 13-segmented, formula 11353; occiput not margined; thorax convex, notauli incomplete; propodeum with complete median carina and plica, nucha distinct; fore wing densely hairy outside speculum; gaster on distinct petiole, gaster narrower than head and thorax.

Biology: *Agiommatus* species are parasites of the eggs of various large Lepidoptera including *Acherontia styx* (Westwood) (Sphingidae), *Opodiphthera astrophel* (Walker) (= *Antheraea simplex*) and *Attacus atlas* (L.) (Saturniidae), *Erionota thrax* (L.) (Hesperiidae), *Pantana* sp. (Lymantriidae), *Spodoptera litura* (F.) (Noctuidae), and *Mimathyma chevana* (Moore) (Nymphalidae) (Bouček 1988, Bouček et al. 1979, Huang 1986, Thomson 1958, and Yang, 1992).

Distribution: South and north of China, India, Indonesia, Malaysia, Australia, Madagascar.

Key To Female Species of *Agiommatus* from China

1. Clypeal margin deeply excided in the middle (fig. 1), with two sharp teeth; head width about 1.1-1.17x as long as height; scapula and frenal area smooth or with very shallow reticulation (fig. 2, 3); marginal vein about 2.4 times as long as stigmal vein (fig. 4); . . . . ***Agiommatus pantanus* n. sp.**
Clypeal margin shallowly emarginate (fig.5), without distinct sharp tooth; head width about 1.25-1.3x as long as height; scapula and frenal area densely reticulate (fig. 6); marginal vein about 3 times as long as stigmal vein; . . . . ***Agiommatus erionotus* Huang**

Agiommatus pantanus Xiao and Huang, NEW SPECIES

Figs. 1-4

Description. Holotype Female: Length 2 mm. Head and mesosoma metallic dark green, gaster brown; antenna dark yellow; leg yellowish except coxa pale brown. **Head** large, wider than high (1.17x) in front view (fig. 1); eye height 3.2x malar space; clypeal margin slightly produced, deeply emarginate in the middle, distance between two teeth as long as tooth length. In dorsal view, eye length 5x temple, POL 2.5x OOL. Antennal insertion at middle of face; antenna short, nearly 0.57x head width, scape 0.5x eye height, each anellus transverse, first funicular segment slightly longer than broad, other funicular segments square, clava slightly longer than last two funicular segments combined. **Thorax** (fig. 2) compact and convex; pronotum with indistinct margin, collar length medially about 0.13x mesoscutum length, mid lobe and frontal part of scutellum (in front of frenal line) distinctly reticulate; scapula, axilla and frenal area smooth or with shallow reticulation; scutellum length 1.26x mesoscutum, 1.5x propodeum length; propodeum (fig. 3) with median carina, plica and cross carina. Fore wing (fig. 4) with upper surface of costal cell bare, basal cell bare, basal vein with 5 hairs; marginal vein longer than postmarginal vein and stigmal vein, marginal vein 1.58x postmarginal vein, and 2.4x stigmal. **Gaster** with petiole 2x as long as wide, and with one little seta on each side; gaster length 2.9x width, slightly shorter than thorax. **Male:** Length1.6-1.7 mm. Gaster triangle and a yellow ribbon on the middle; antenna longer than that of female, 0.75x length of head width; gaster length 1.5-1.6x width, distinctly shorter than thorax (0.8x length of thorax).

Variation. Body length of females examined varied from 1.8 to 2.0 mm; the metallic body color varies from dark green to bluish green. The ratio of head width to height for 12 measured females varied from 1.1 to 1.17. The ratio of gaster length to width for 12 measured females varied from 2.8 to 2.93.

Diagnosis. This species resembles *A. erionotus* Huang and can be separated from it by the key above. This species differs from *A. geethae* Sureshan & Narendran by the combination of the following characters: the clypeal margin deeply excided in the middle (in *geethae*, emarginated); head width 1.1-1.17x as long as height (in *geethae*, head width 1.3x height); antennal insertion at middle of face (in *geethae*, antennal insertion below middle of face); scapula and frenal area smooth or with very shallow reticulation (in *geethae*, with finer reticulation). *A. erionotus* Huang differs from *A. geethae* Sureshan & Narendran at least by the following characters: antennal insertion at middle of face; more transverse head in front view.

Specimens Examined. Holotype: CHINA: ♀ Longyanshi Suangche (25.1°N, 117.0°E), FUJIAN, Sep.13.1996, ex. Pantana sp., Coll. Xiao Hui. Paratypes: 13♀ 4♂, Same date as holotype. The type specimens are deposited in Institute of Zoology, the Chinese Academy of Sciences.

Distribution. This species is currently known only from Fujian, southern China.

Biological and collection information. All specimens were reared on 17 September 1996 from eggs of *Pantana* sp. (Lepidoptera: Lymantriidae), which were collected on the under surface of leaves of bamboo on 13 September 1996 in Fujian, China.

Etymology. This species is named from the host, *Pantana* sp.

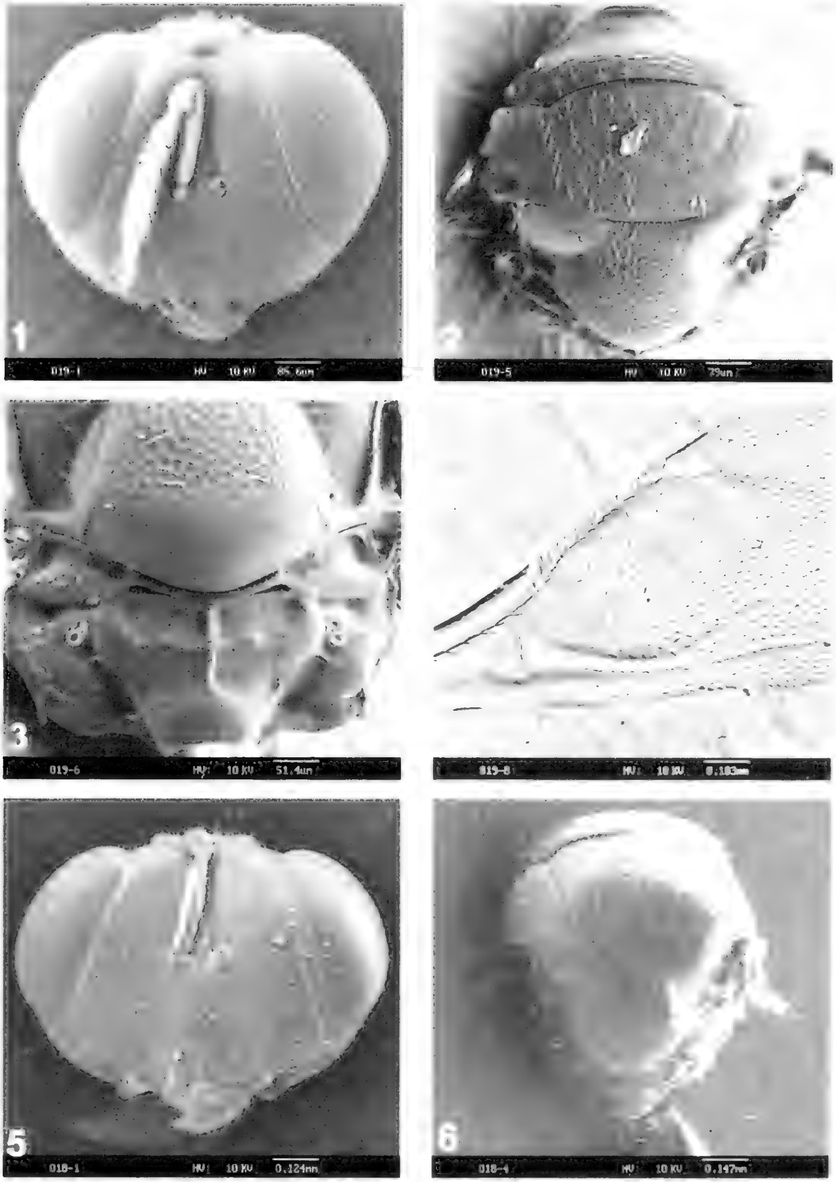
Agiommatus erionotus Huang

Figs. 5-6

Agiommatus erionotus Huang, 1986:103-105.
Agiommatus jiahuanae Yang, 1992: 72-75. NEW SYNONYMY.
Agiommatus erionotus Huang, 1993:182-184.

Diagnosis. Body length 2-2.2 mm. Clypeal margin shallowly emarginate (fig.5); head width 1.25-1.3x as long as height; first funicular segment 1.5 times as broad as long, F2 to F5 about quadrate respectively; clava about as long as the last three funicular segments combined; thorax with dense reticulation (fig. 6); marginal vein 3 times as long as stigmal vein; basal cell bare, basal vein complete; both sides of petiole without a small spine.

This species differs from *A. pantanus* n. sp. by the characters given in the key. *A. attaci* Ferrière is closely related to *A. erionotus* Huang, from which it differs in its F1 two times as long as broad, basal cell setose, body size 3-3.5mm (Specimen examined: Paraleototype ♀, MALAYA: Kuala, 16.April 1925, ex. eggs of *Attacus atlas* L., coll. G. H. Corbett., det. Ferrière).



Figs. 1-6. 1-4. *Agiommatus pantanas* sp. n. ♀: 1. head in front view; 2. thorax in dorsal view; 3. propodeum in dorsal view; 4. fore wing. 5-6. *Aggiomatus erionotus* Huang ♀: 5. head in front view; 6. thorax in dorsal view.

Specimens Examined. Holotype and Paratypes: CHINA: 14♀ 4♂ Jinshan, Fuzhou, FUJIAN, Oct. 23.1986, ex. *Erionota thrax* L., Coll. Huang Jian-hua. **Other specimens:** 1♀ Yangjiang, GUANGDONG, Sep. 1980, ex. *Dasychira axutha* Collenette, Coll. Su Xing; 4♀ GUANGXI, May, 1974, ex. *Dendrolimus* sp., Coll. Wei Lin; 4♀ Anning, YUNNAN, Aug. 1980, Coll. Li Chang-Fang. All the examined specimens are deposited in Institute of Zoology, the Chinese Academy of Sciences.

Distribution. This species is currently known from southern China: Fujian, Guangdong, Guangxi, Yunnan.

Biological and collection information. Reared from eggs of *Erionota thrax* L. (Hesperiidae) (Huang, 1986), *Dasychira axutha* Collenette (Lymantriidae), *Dendrolimus* sp. (Lasiocampidae) (Huang, 1993) and *Mimathyma chevana* (Moore) (Nymphalidae) (Yang, 1992).

ACKNOWLEDGMENTS

Thanks are due especially to Zdenek Bouèek (British Natural History Museum) for kindly providing specimen of *Agiommatus*, to Yang Zhong-Qi for loaning specimens, and to Wang Lin-Yao for identifying the host.

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DRAGONFLIES OF NORTH AMERICA. James G. Needham, Minter J. Westfall, Jr., and Michael L. May, 2000. Gainesville. 940 pp. Hard. $125.00.

Few current students of the Odonata ever met James C. Needham. He died in 1957. However, virtually everyone in the past 70 years who has attempted to key out a dragonfly (Anisoptera) has encountered Needham as the first author on the only available comprehensive keys to the dragonflies of North America. A Handbook of the Dragonflies of North America by Needham and Heywood, published in 1929, was followed in 1955 by A Manual of the Dragonflies of North America by Needham and Westfall. Now Needham's name will live on well into the 21st century with this considerably revised "Manual." Michael L. May, who with Minter J. Westfall, Jr. recently co-authored another Odonate book, Damselflies of North America[1], considerable credit for bringing this revised Dragonflies of North America to fruition.

Given the explosion of information on North American Odonata during the past several decades, the 1955 volume had become seriously out of date. Many new species (54) had been described and nomenclatural changes affecting 34 species published. Incorporation of these developments in revised keys along with the flood of distributional data is reflected in a doubling of the content (and weight) compared to the former volume.

Several new features make this more than a revision. Notable is the inclusion of many more illustrations reproduced or modified from the taxonomic literature. These are especially helpful to those of us who in the past have labored with the meaning of couplets in some of the former keys. Among the new illustrations are color drawings by Dr. Lawrence W. Zettler. As someone who is familiar with many of the species in the field, my initial reaction to these drawings was negative. They seemed stylized with the colors too bold and bright and the patterns too sharp. While this may be true in a number of instances, the color illustrations will greatly assist identification. In fact, the illustrations are potentially more helpful than the small photographs in a field guide to the dragonflies of North America also published last year[2]. Apparently, the drawings by ZettLer were originally intended for a field guide. A comparison of the two types of presentation highlights the different merits of photographs versus artistic rendering. Both have their place and can complement each other.

Because adult Odonata are often large and colorful, they attract attention. The larvae, on the other hand, escape notice except by fishermen. While a definitive guide on the dragonfly larvae of North America is yet to be written, this book is substantially enhanced over its predecessor and provides a wonderful resource. Anyone with dragonfly larvae from macroinvertebrate surveys has a reasonable chance of identifying specimens to species with this book.

This book is neither a field guide to compete with Dunkle's book[2] nor a treatise on Odonate behavior and ecology like Corbet's recent book[3]. However, it fills an important niche that will appeal to both amateurs and specialists. The authors have yielded to the popularization of dragonfly study among amateurs by including English names with each species description. This feature should make the study of these beautiful insects more generally accessible despite the need to learn technical terminology. There is no doubt that this book is also more user-friendly to specialists than its predecessor. This is evident in the keys, the illustrations, the extensive glossary, the index, and the bibliography. Needham, Westfall, and May will be the reference of choice for North American Dragonflies for some years to come.

1. **Westfall, M.J., Jr. and May, M.L.** 1996. Damselflies of North America Scientific Publishers, Gainesville.
2. **Dunkle, S.W.** 2000. Dragonflies Through Binoculars: A Field Guide to Dragonflies of North America. Oxford University Press, Oxford.
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SCIENTIFIC NOTE

NEW EPHEMEROPTERA RECORDS FROM PENNSYLVANIA[1]

Luke M. Jacobus, W. P. McCafferty[2]

We report the following eleven species of mayflies for the first time from Pennsylvania. All material is deposited in the Purdue Entomological Research Collection, West Lafayette, Indiana, unless otherwise indicated.

The new state records include *Acentrella turbida* (McDunnough): male adults, Chester Co, E Br White Clay Cr at Stroud Estate, Rt 926, 4-V-1967, 25-VII-1966, J. W. Richardson, Jr.; *Acerpenna pygmaea* (Hagen): larvae, Bradford Co, Cayuta Cr, 41°59'54"N, 76°31'24"W, 15-VII-1992 [deposited with New York State Department of Environmental Conservation, Stream Biomonitoring Unit, Albany, New York]; *Baetisca carolina* Traver: female adult, Columbia Co, Fishing Cr, 41°14'30"N, 76°22'04"W, 25-VI-1998, R. E. Moase; *Callibaetis fluctuans* (Walsh): male and female adults, Chester Co, E Br White Clay Cr at Stroud Estate, Rt. 926, lab pond, 17/24-IV-1968, J. W. Richardson, Jr.; *Centroptilum semirufum* McDunnough: male and female adults, Chester Co, E Fk E Br White Clay Cr at SWRC, 0.9 mi SW London Grove, elev 325', 39°51'32"N, 75°42'02'W, lab 3, 22-V-1985, D. I. Reback; *Centroptilum triangulifer* (McDunnough): female adults (reared), Chester Co, E Fk E Br White Clay Cr at SWRC, 0.9 mi SW London Grove, elev 325', 39°51'32"N, 75°42'02'W, lab 3, 28-V-1985, D. I. Reback, larvae, same data but 13-VIII-1985; *Heptagenia diabasia* Burks: larvae, Cambria Co, Salt Lick Cr, 2 mi N Mineral Point, 14-VI-1975, M. Minno; *Leucrocuta hebe* (McDunnough): larva, Centre Co, Bald Eagle Cr at Julian, 15-VII-1978, C. R. Meck; *Procloeon rivulare* (Traver): Chester Co, E Fk E Br White Clay Cr at SWRC, 0.9 mi SW London Grove, elev. 325', 39°51'32"N, 75°42'02'W, lab 3, 6-IX-1993, D. H. Funk; *Serratella serratoides* (McDunnough): male and female adults, Chester Co, E Br White Clay Cr at Stroud Estate, Rt 926, 23/29-VI-1966, J. W. Richardson, Jr.; *Stenonema pulchellum* (Walsh): male and female adults, Chester Co, E Br White Clay Cr at Stroud Estate, Rt 926, 8/15-VI-1966, 11-VII-1966, 23-VIII-1966, J. W. Richardson, Jr.

ACKNOWLEDGMENTS

We thank M. Novak (New York State Department of Environmental Conservation, Stream Biomonitoring Unit) for sharing data. This study has been funded in part by NSF grant DEB-9901577 to WPM.

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[1] Received January 20, 2001. Accepted January 25, 2001.

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ENT. NEWS 112(2): 144, March & April, 2001

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

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

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l. 112 MAY & JUNE, 2001 U.S. ISSN 0013-872X
NO. 3

ENTOMOLOGICAL NEWS

SCIENTIFIC NOTE

THE AMERICAN ENTOMOLOGICAL SOCIETY

ENTOMOLOGICAL NEWS is published bi-monthly except July-August by The American Entomological Society at the Academy of Natural Sciences, 1900 Benjamin Franklin Parkway, Philadelphia, Pa., 19103-1195, U.S.A. AES office phone: 215-561-3978; e-mail: aes@ansp.org; website: http://www.ansp.org/aes.

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STUDIES IN AQUATIC INSECTS, XVIII: NEW SPECIES AND NEW RECORD OF CADDISFLIES (TRICHOPTERA) FROM MEXICO[1]

J. Bueno-Soria, S. Santiago-Fragoso, R. Barba-Alvarez[2]

ABSTRACT: Seven new species of caddisflies collected in Mexico are described and the male genitalia are figured. The species *Leucotrichia extraordinaria* n. sp. and *Byrsopteryx tabasquensis* n. sp. belong to the family Hydroptilidae, *Chimarra chimalapa* n. sp. to the family Philopotamidae, *Smicridea pochutla* n. sp. and *Leptonema pinotepa* n. sp. to Hydropsychidae, and *Lepidostoma ixtlahuaca* n. sp. and *Lepidostoma pinotepa* n. sp. to Lepidostomatidae. The genus *Byrsopteryx* is recorded from Mexico for the first time.

During the past years, we have been collecting specimens in different areas of Mexico. As a result, we now know that more collecting in the numerous streams of the tropical rain forest of Mexico will be necessary in this region since a great diversity of still unknown caddisflies species exists (Bueno and Flint, 1978). Also more collecting needs to be done in the mountain forests at altitudes between 1000 to 3,500 m above sea level, where most of the Nearctic fauna of Mexican caddisflies can be found.

Morphological terminology for the family Philopotamidae follows Blahnik (1998); for Hydroptilidae, Marshall (1979); and for the families Lepidostomatidae and Hydropsychidae, Weaver (1988) and Flint, et al. (1987), respectively. Length was measured from the insertion of the forewing to the wing tip in all the species here described. Type material is deposited in the Colección Nacional de Insectos, Universidad Nacional Autónoma de México (CNIN, formerly IBUNAM).

Family Hydroptilidae

The Family Hydroptilidae is well represented in Mexico. However, the genus *Leucotrichia* is rarely attracted to light traps. At present, only five species have been recorded from Mexico by Mosely (1934), Ross (1944), and Flint (1967, 1970, Flint et al. 1999).

Leucotrichia extraordinaria Bueno, Santiago, Barba, NEW SPECIES

Fig. 1A-D

Because of the presence of three ocelli, spurs with formula 1-3-4, mesoscutellum with a transverse suture, metascutellum pentagonal, and phallus with the typical midventral complex, this species is a natural member of the *L. melleopicta* species group. However, *Leucotrichia extraordinaria,* new species, can be distinguished from the other species of the group by the elongate

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[1] Received June 28, 2000. Accepted October 25, 2000.

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ventrolateral processes of the eighth segment in ventral view.

Adult ♂.- Length of forewing, 2 mm. Color in alcohol, dark brown.

Male genitalia: Seventh sternum with long, spatulate apicomesal process, which in lateral aspect appears with the apex extremely acute. Eight sternum with elongate apicolateral processes with two or three black peg-like setae apically; with deep, U-shaped notch medially. Ninth segment slightly longer than broad in ventral aspect, with ventral surface more deeply divided than dorsal; posterolateral margin bordered by row of long setae; open ventrally; in lateral aspect, anterodorsal margin nearly straight; posteroventral angle slightly prolonged, with a long setae row. Subgenital plate narrow in ventral aspect, with basal tubular angles produced in short rounded lobes; U-shaped in lateral aspect with dorsal arm subequal to ventral arm, with small, ovoid basal opening in ventral aspect. Tenth tergite and lateral penis sheaths triangular. Inferior appendages fused basally; in ventral aspect, narrow with pair of preapical short, hooklike spines; apical portion with tips directed mesad; in lateral aspect, with dorsal margin straight. Phallus with apex bearing a lightly sclerotized apical tubule and small, membranous lateral processes, midlength complex with a long basal tubule, with two elongate, membranous loops.

Female: Unknown.

Type Material.- Holotype, ♂: MEXICO: TABASCO: Municipio de Huimanguillo, Arroyo las Flores, Villa de Guadalupe 2ª sección Los Chimalapas, km 5 Ruta Malpasito-Carlos A. Madrazo, 17° 22' 05" N; 93° 36' 25" W, 26-vi-1999, J. Bueno and R. Barba (CNIN). PARATYPES: 2 ♂ with the same data as the holotype (CNIN).

Etymology: The epithet of the species indicates uncommon, in allusion to the shape of the eighth sternum.

Byrsopteryx tabasquensis Bueno, Santiago, Barba, NEW SPECIES

Fig. 2A-D

This description establishes the first record of this genus from Mexico (Harris and Holzenthal, 1994). The bifurcate apical region of phallus in lateral and dorsal view distantly relates *Byrsopteryx tabasquensis*, new species, to *B. chaconi* Harris and Holzenthal from Costa Rica. However, *B. tabasquensis* can be separated from the above mentioned species by the very different size and shape of the subgenital plate in lateral view and by the rectangular shape of the inferior appendages in ventral view.

Adult ♂.- Length of forewing 2 mm. Color in alcohol, dark. Forewings centrally with thickened membrane, a distinct weak line separating the posterobasal area.

Male genitalia: Eighth tergum transversely rectangular; in lateral aspect with the anterior margin lobate; in ventral view, anterior margin produced in a midventral round lobe. Ninth segment in lateral view, with anterior margin produced; in ventral view with anterior margin tapering to a slightly emarginated and rounded apex; in dorsal view with a pair of sclerotized, parenthesis-like rods. Tenth tergum membranous, with a short basal dentiform process on the left side; in lateral view, a wide plate with a long basolateral seta, with two processes, the dorsalmost presents a sclerotized rodlike process, the ventral one appears wide at base, its ventral margin sinuous with series of black peglike setae at base, with apical portion produced into narrow neck with apex hooked ventrad. Subgenital plate in lateral and ventral view slender, terete, rodlike sclerite; in lateral view, produced preapically into narrow neck, the apical portion with tip hooked ventrad, with a long, membranous ventral rod with the apex obtuse. Inferior appendages, in lateral aspect,

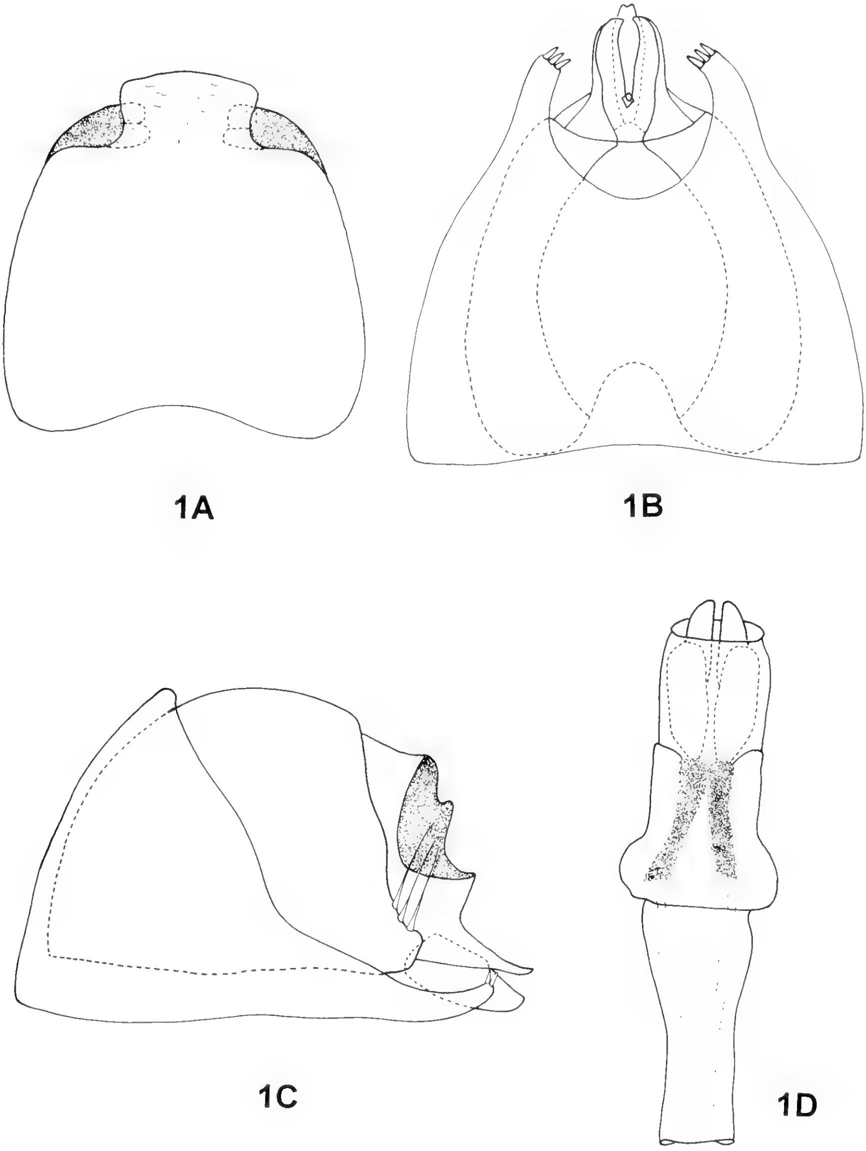

Fig. 1. *Leucotrichia extraordinaria* n. sp., male genitalia: A, Dorsal view. B, Ventral view. C, Lateral view. D, Phallus dorsal view.

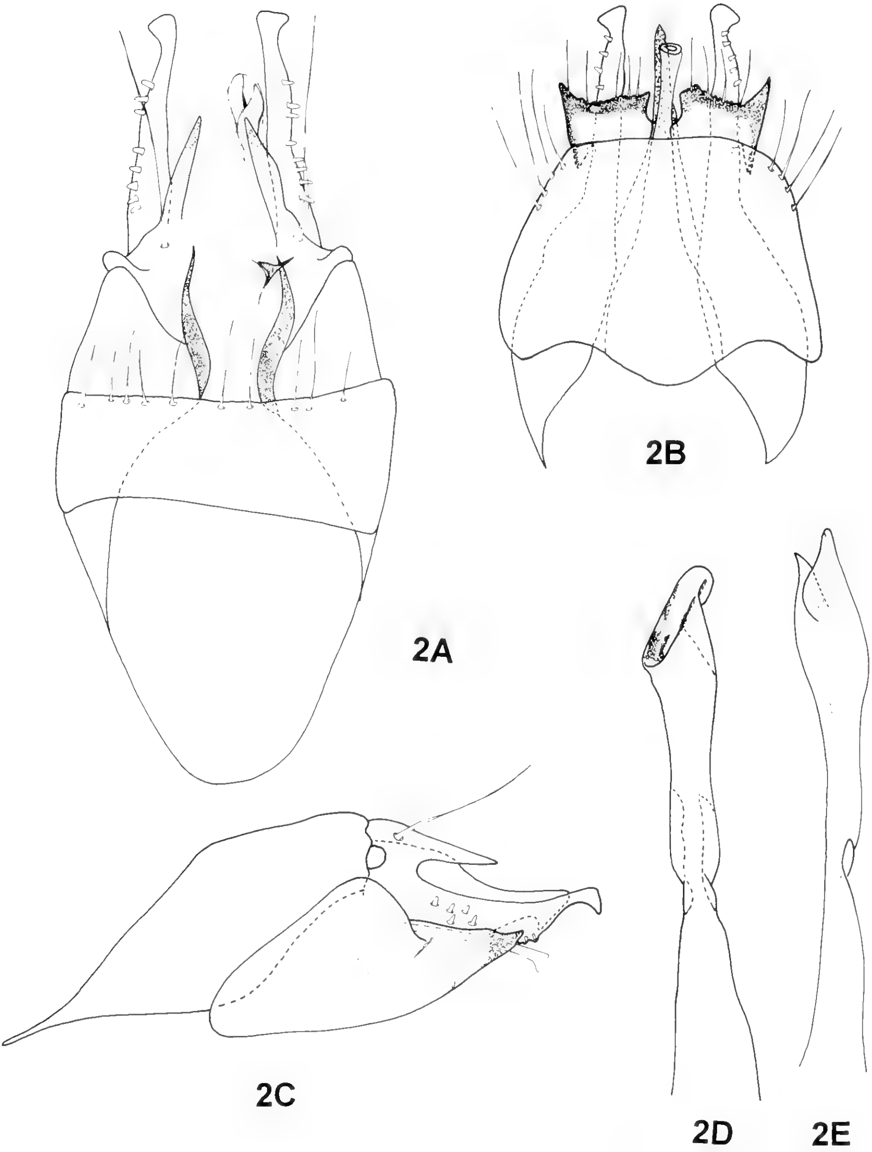

Fig. 2. *Byrsopteryx tabasquensis* n. sp., male genitalia: A, Dorsal view. B, Ventral view. C, Lateral view. D, Phallus dorsal view. E, Phallus in lateral view.

triangular with acute apex; in ventral view, rectangular with posterior margin darkened, dentate, with inner apex bifurcated into two short dentiform processes, external apices elongate horn-like processes slightly curved midventrally. Phallus with base conically flared; from midsection to apex with a long, membranous, tube; apex bifurcated in two membranous processes.

Female: Unknown.

Type Material.- Holotype, ♂; MÉXICO: TABASCO: Municipio de Huimanguillo, Arroyo Las Flores, Villa de Guadalupe 2ª Sección Los Chimalapas, km 5 Ruta Malpasito-Carlos A. Madrazo, 17° 22' 05" N; 93° 36' 25" W, 25-iii-1998, J. Bueno and R. Barba (CNIN). PARATYPES: with the same data as the holotype, 5♂ (CNIN). Same but 12-xi-98, 1♂ (CNIN).

Etymology: The species epithet, refers to Tabasco, the state where the species was collected.

Family Philopotamidae

This family is well represented in Mexico by a large number of species. Blahnik (1998), in his revision of the genus *Chimarra*, recorded 33 species for Mexico, we here describe an additional species from southeastern Mexico. The new species belongs to the *Chimarra primula* species group, on the basis of the ellipsoidal shape of the inferior appendages in lateral view and features of the tenth tergum.

Chimarra (*Chimarra*) *chimalapa* Bueno, Santiago, Barba, NEW SPECIES

Fig. 3A-E

This species is closely related to *Chimarra guatemalensis* Blahnik, differing only in minor aspects of the structure of the tenth tergum, the inferior appendages, and the phallic apparatus of the male. It differs from *C. guatemalensis* by the more expanded sensillae-bearing projections of the tenth tergum in dorsal aspect and by the presence on the phallus of two long endothecal spines, one longer by one third than the other.

Adult ♂.- Length of forewings 4.5 mm. Color in alcohol, nearly fuscous. Head flattened, postocular parietal sclerite elongate. Maxillary palp with third segment nearly twice as long as second, first segment very short, fourth segment slightly shorter than second, fifth segment slightly longer than third.

Male genitalia: Ninth abdominal segment with pair of distinct apodemes from anterolateral margin; anteroventral margin moderately and somewhat sinuously expanded from dorsal apodemes, with obtusely angular bend near ventral margin, as viewed laterally; posteroventral process short, broadly subtriangular, very wide basally, apex scarcely projecting, obtuse. Tenth tergum membranous mesally, sclerotized lateral lobes, each with two sensillae on elongated stalks, mounted on a rather broadly rounded, flattened, widely expanded, lateral process; apex of lateral lobe indistinctly sclerotized, large and triangular. Preanal appendages short, globose, slightly flattened. Inferior appendages ovate, convex, longer than in *guatemalensis*, with stout setae along the apicodorsal margin; each with short, broad, hooked, sclerotized, dorsomesal appendage; mesal surface with flattened, setose projection. Phallotheca with apicoventral projection, two endothecal spines, with the longest one third longer than the shorter, asymmetrically arranged on endotheca; apex of endotheca with minute, echinate spines. Phallotremal sclerite complex composed of rod and ring structure, rod of moderate length and ring with slight dorsal projection; apically with indistinct, troughlike, membranous structure.

Female: Unknown.

Type Material.- Holotype, ♂: MEXICO: TABASCO: Municipio de Huimanguillo, Arroyo las Flores, Villa de Guadalupe 2ª Sección Los Chimalapas, km 5 Ruta Malpasito-Carlos A. Madrazo, 17° 22' 05" N;93° 36' 25" W, 16-iii-2000, J. Bueno, R. Barba and A. Rojas (CNIN). PARATYPES: with the same data as the holotype, 5♂ (CNIN).

Etymology: The species epithet refers to the name of the area in the state of Tabasco where the species was collected.

Remarks: The main differences encountered in the new species with respect to *C. guatemalensis* are the wider and triangular shape of the apical region of the lateral lobes of the tenth tergum in dorsal view, as well as the longer size of the endothecal spines.

Family Hydropsychidae

The genus *Smicridea* has been studied in Mexico and Central America by Flint (1974) and Flint and Denning (1989). Because this genus has a high diversity in the Neotropics, it is not surprising to find a new species in the tropical forest of Oaxaca and Guerrero.

Smicridea (S.) pochutla Bueno, Santiago, Barba, NEW SPECIES

Fig. 4A-E

This species appears to be closely related to *S. mirama* Flint & Denning (Flint & Denning, 1989, figs. 40-43) because of the long, slender, ventrolateral processes of the phallus. However, *Smicridea pochutla*, new species, is easily distinguished from *S. mirama* by the presence of two short spines on each side of the ventrolateral processes.

Adult ♂.- Length of forewing, 4 mm. Color in alcohol, dark brown; forewing denuded, membrane without the pale band on stigma.

Male genitalia: Ninth segment in lateral aspect slightly rectangular with anterior margin rounded; tapering to a dorsal margin. Tenth tergite narrow, apex slightly upturned in lateral aspect; in dorsal view expanded laterally, apex broadly rounded. Inferior appendages with long basal segment, expanded distally; apical segment elongate, apex acute. Phallus, in lateral aspect, slightly elongate basally, anterolateral corner rounded, open apically; ventrolateral processes long and slender, with the apex slightly upturned; in ventral aspect with two short spines basally on each exterior side of the ventrolateral processes.

Female: Unknown.

Type Material.- Holotype, ♂: MÉXICO: OAXACA: Pochutla, Finca Progreso, 2-vi-1987, E. Barrera (CNIN). Paratype: GUERRERO: Ruta 130, 80 km N W of Zihuatanejo, 8-v-1988, el. 1200 m, J. Bueno 1 ♂ (CNIN).

Etymology: The species epithet refers to Pochutla, the region in the state of Oaxaca where the holotype was collected.

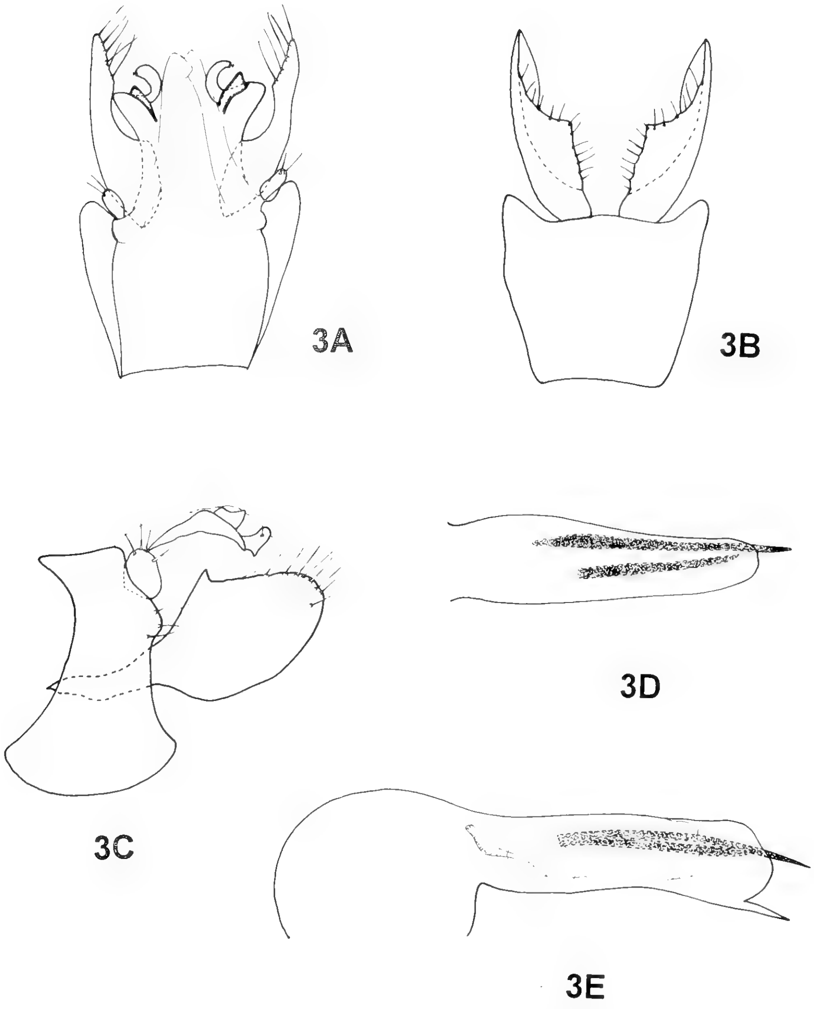

Fig. 3. *Chimarra C. chimalapa* n. sp., male genitalia: A, Dorsal view. B, Ventral view. C, Lateral view. D, Apical section of phallus in dorsal view. E, Phallus in lateral view.

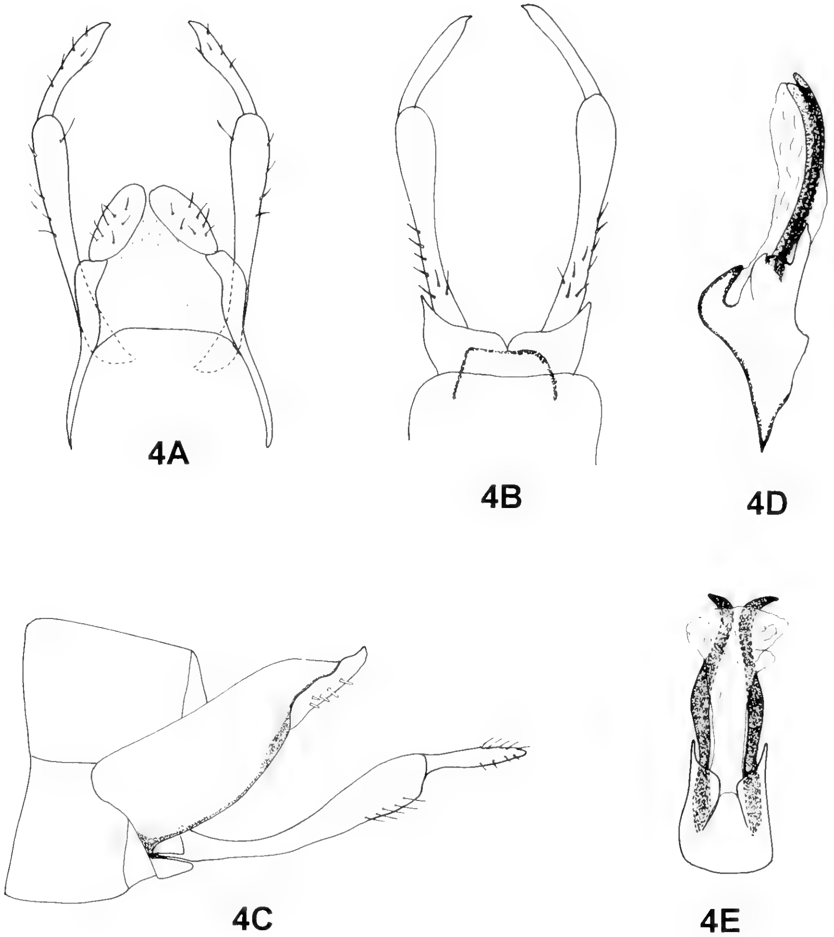

Fig. 4. *Smicridea S. pochutla* n. sp., male genitalia: A, Dorsal view. B, Ventral view. C, Lateral view. D, Phallus in lateral view. E, Phallus dorsal view.

Leptonema pinotepa Bueno, Santiago, Barba, NEW SPECIES

Fig. 5A-D

Leptonema pinotepa, new species, appears closely related to *L. michoacanense* Flint, McAlpine, Ross and *L. plicatum* Mosely by the general structure of the processes on the apical portion of the phallus. However, the new species can be separated from these two species because the phallus in lateral view has a long, curved, bifurcate process, as well as by the wide and triangular apicolateral processes "b" of the phallus.

Adult ♂.- Length of forewing,16 mm. Color, light brown; forewing almost transparent over thyridial cell. Malar space narrow, about 1/3 height of eye. Parafacial and postocular areas almost as wide as malar; postocular area with a row of 5 stout setae. Maxillary palpus with fifth segment as long as 2/3 the length of basal four segments together. Processes of fifth sternum large, ovoid.

Male genitalia: Tenth tergum with warts a, and b, on short stalks; lateral lobe rounded apically, ventral margin slightly sinuate. Inferior appendages with apical segment short, terete; basal segment 5 times as long as apical, base unmodified. Phallus in lateral view, with phallobase elongate, slightly angled; apical section, with long, curved, bifurcate processes, which are sclerotized; in dorsal view the processes appear dark and parallel to apical section; processes b wide and triangular; phallotremal sclerites *f* dark and rhomboidal.

Female: Unknown

Type Material.- Holotype, ♂; MEXICO: OAXACA: Metates, Sierra de Juárez, el. 1600 m, 16-ix-1982, A. Ibarra (CNIN). Paratype: OAXACA: Pinotepa Nacional, 20-vi-1982, M. García 1 ♂ (CNIN).

Etymology: The species epithet refers to the Pinotepa Nacional region in the state of Oaxaca where the holotype was collected.

Family Lepidostomatidae

This family is represented in the streams of the highlands of Mexico by the genus *Lepidostoma.* This genus has been studied by Flint & Bueno (1977), Bueno and Padilla (1981), Bueno and Contreras (1986), Weaver (1988), and Holzenthal and Strand (1992). In Mexico, the genus *Lepidostoma* is represented by 15 species.

Lepidostoma (Nosopus) catarina Bueno, Santiago, Barba, NEW SPECIES

Fig. 6A-D

Lepidostoma catarina, new species, is a member of the *Mexicanum* Group. It is closely related to *Lepidostoma aztecum* Flint & Bueno, as evidenced by the presence of two processes on the tenth tergum in lateral view and a basodorsal semierect process on the inferior appendages in lateral view. However, the new species can be distinguished from *L. aztecum* because the tenth tergum in dorsal aspect appears with a small notch middorsally with two long lateral processes, and the inferior appendages, in dorsal view, possess a gob-

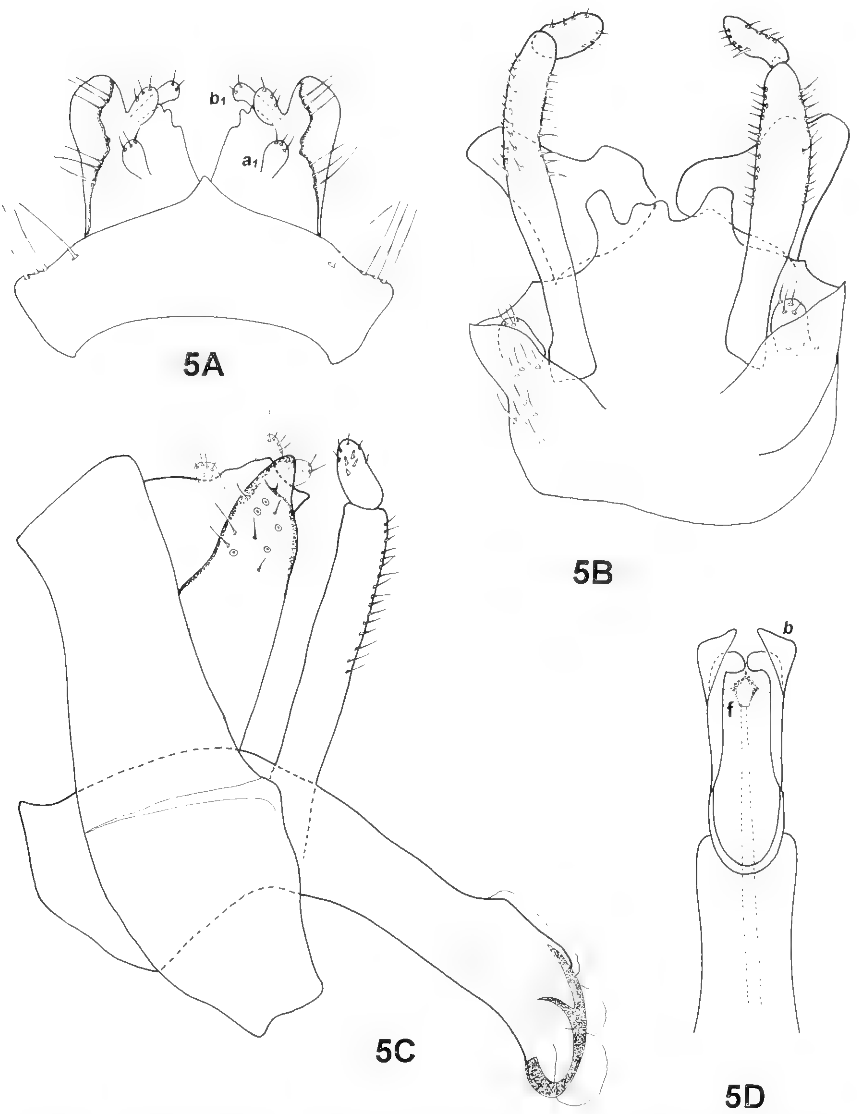

Fig. 5. *Leptonema pinotepa* n. sp., male genitalia: A, Dorsal view, tenth tergum with warts a_1 and b_1 on short stalks. B, Ventral view. C, Lateral view. D, Apical section of phallus in dorsal view, with phallic processes ***b*** and phallotremal sclerites

let-shaped apex with a mesal flap-like bifurcate lobe.

Adult ♂.- Length of forewing, 9 mm. Color in alcohol, brown. Antenna stramineous. Maxillary palpus 1-segmented, spatulate. Antenna with basal seg-ment terete, as long as head, unmodified; legs and wings without modification.

Male genitalia: Tenth tergum in lateral view divided into two processes, the dorsalmost appears strong erect spine-like, the ventralmost process elongate ending in a bifurcate apex; in dorsal view, with small notch middorsally, with two long, dorsolateral processes, the ventralmost processes elongate, wider, ending in dentate apex. Inferior appendages in lateral view, with basodorsal process, extending slightly beyond midlength of inferior appendages; ventral arm of process appressed to inferior appendages tapering to apex; in dorsal view, with small tooth-like process, apex with blunt lateral lobe; in dorsal aspect with bifurcate lateral lobe; a strong, digitiform central lobe, and a mesal lobe with apex

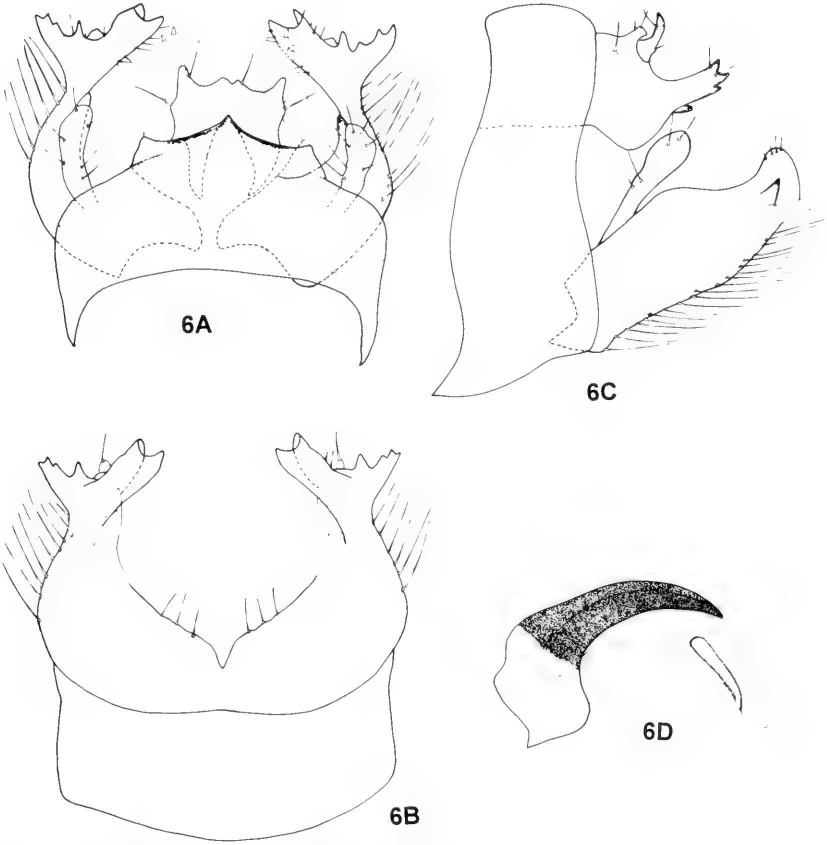

Fig. 6. *Lepidostoma* (*Nosopus*) *catarina* n. sp., male genitalia: A, Dorsal view. B, Ventral view. C, Lateral view. D, Phallus lateral view.

bifurcated and flap-like; with sinuous basal connection to base of phallus. Phallus, in lateral view, with enlarged base, central curved tubular portion, and pair of short, dorsolateral, spine-like sclerites.

Female: Unknown.

Type Material – Holotype: ♂; MEXICO: OAXACA: Sta Catarina La Chatao, 17° 15' 58" N, 96° 28' 15" W, el. 2160 m, 5-6-xii-1999, A. Rojas (CNIN). Paratypes, with the same data as the holotype, 6♂ (CNIN); Puerto Angel, km 156, Ruta 175, el. 2100 m, 21 xii 1982, J. Bueno, 1♂ (CNIN); GUERRERO: Mpio. de Chilpancingo, Parque Ecológico Estatal Omiltemi, Zona La Perra, 23-x-1998, Martínez and Casasola, 1♂ (CNIN)

Etymology: The specific epithet refers to Santa Catarina, Oaxaca, where the holotype was collected.

Lepidostoma (*Nosopus*) *ixtlahuaca* Bueno, Santiago, Barba, NEW SPECIES

Fig. 7A-D

Lepidostoma (*Nosopus*) *ixtlahuaca*, new species, is another member of the *Mexicanum* Group due to the cylindrical shape of the scape and the modified maxillary palps with dark scales. It seems related to *L. oaxacensis* Bueno and Contreras, because of the bifid apex of the inferior appendages in lateral view. However, the new species is easily distinguished by the more elongate basodorsal process of the inferior appendages in lateral view, as well as by the terete lobes of the tenth tergum in dorsal view.

Adult ♂.- Length of forewing, 9 mm. Color in alcohol, pale brown, antennae stramineous; forewings with a group of broad scale-like setae on the radial veins. Maxillary palpus 1-segmented, slightly cylindrical, both palpi contiguous, mesal face concave and filled with broad scale-like setae. Antenna with basal segment terete, as long as head, unmodified. Legs without modification.

Male genitalia: Tenth tergum in lateral aspect divided in two plates; dorsalmost with group of apicodorsal, spinelike processes produced ventrally; ventralmost with pair of strong spinelike processes; in dorsal view, with central area membranous with short processes with setae at apex, and group of black peglike setae at base; with pair of lateral, terete processes, and two ventrolateral plates, the left one with pair of strong spinelike processes. Inferior appendages, in lateral view, with long, curved, basodorsal process, extending slightly beyond midlength of the inferior appendages, ventral arm of process wider preapically with acute bifurcate apex; apex with two flat lobes situated apicodorsally; in dorsal view, apex with pair of compressed broad rounded lobes with darkened, short, spinelike process; at midlength with long, thin, spinelike process; in ventral view symmetrical, apical portion with two short, lateral processes. Phallus in lateral view with enlarged membranous tube ventrally situated, with a pair of dorsolateral swordlike processes, strongly darkened at apex.

Female: Unknown.

Type Material.- Holotype, ♂; MEXICO: HIDALGO: Ixtlahuaco, el. 1320 m, 27 xi 1998, H. Brailovky and E. Barrera (CNIN). Paratype, HIDALGO: Ixtlahuaco, Rta. 105, Hotel Campestre Conchita, 20° 53'45" N 98° 41' 47" W, 1420 m, 2-v-2000, J. Bueno and R. Barba, 1♂ (CNIN).

Etymology: The species epithet is the feminine termination for the place where the holotype was collected, Ixtlahuaco.

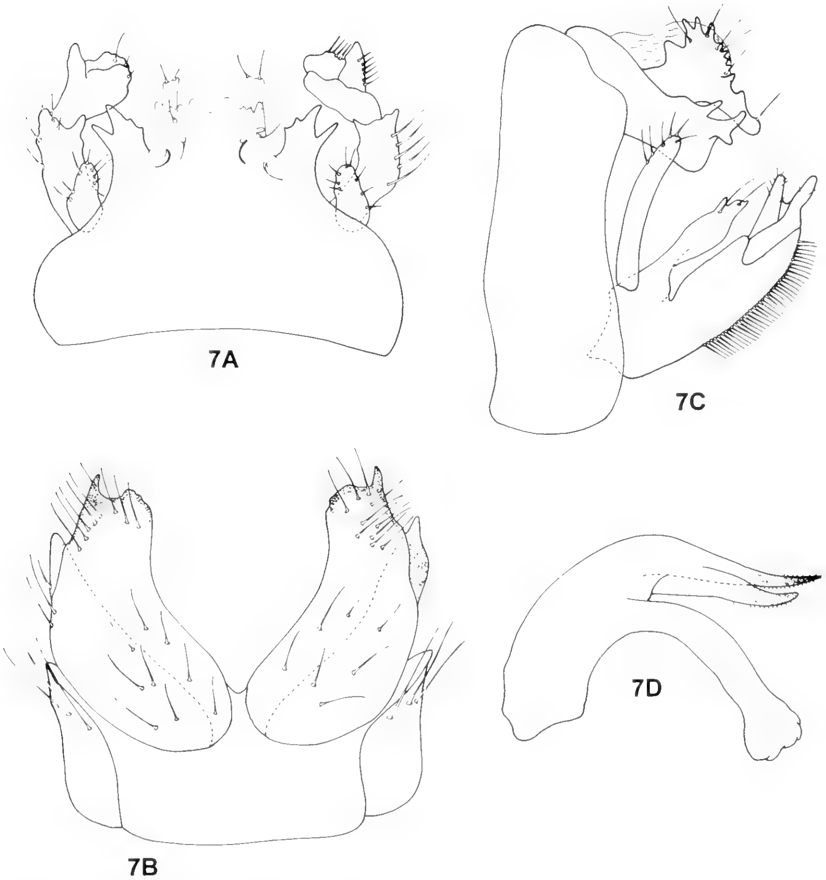

Fig. 7. *Lepidostoma* (*Nosopus*) *ixtlahuaca* n. sp., male genitalia: A, Dorsal view. B, Ventral view. C, Lateral view. D, Phallus lateral view.

ACKNOWLEDGMENTS

We are in debt with to. Atilano Contreras-Ramos, for reading and suggesting changes in the manuscript, with Alicia Rojas-Ascencio for collecting part of the *Lepidostoma* material, with Martha Gabriela Espinosa-Farrera for the male genitalia drawings, and finally to the anonymous reviewers for the effort and time used to improve the manuscript.

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DESCRIPTIONS OF THE MALE OF *MONTEZUMINA INCA* (ORTHOPTERA: TETTIGONIIDAE) AND ANOTHER NEW SPECIES FROM CENTRAL AMERICA[1]

David A. Nickle[2]

ABSTRACT: The male of *Montezumina inca* is described for the first time, substantiating the hypothesis that this northern South American species in a predominantly Central American genus is related to members of the *bradleyi* group, based on color patterns of the forefemora and morphological similarities of the male tenth tergum and cercus to members of that group. A newly discovered Central American species—*Montezumina maya*, new species—is also described herein. Based on the presence of styles on the male subgenital plate, it is a cryptic species closely related to *M. longistyle*.

When Hebard (1925) erected the bush katydid genus *Montezumina*, he included in it the species *Turpilia oblongoculata* Brunner von Wattenwyl 1878, *T. ocularis* Saussure and Pictet 1897, and *T. oridiops* Saussure and Pictet 1897. He later described (1927) the species *M. bradleyi*, based solely on the female, and the subspecies *oblongoculata mesembrina* (elevated to species by Nickle (1984)). Hebard (1934) later added *Symmetropleura modesta* Brunner von Wattenwyl, the only species found in the United States. Marquez (1965) described *M. longistyle*, an unusual species because of the presence of true articulating styles on the male subgenital plate, and Nickle (1966) described another species *M. granti*, as well as the male of *M. bradleyi*.

Nickle (1984) revised the genus *Montezumina*, presenting information on a total of 25 species, 16 of them previously undescribed. These species range geographically from the United States (VA to IL, south to FL, AL, MS, and TX) into northern South America (*M. guyana* Nickle from Guyana, *M. walkeri* Nickle from Colombia, and *M. inca* Nickle from Peru). Although most species were described on the basis of males only or both sexes, one species—*M. inca*—was described from a single female collected in Madre de Dios, Peru. This species is atypical in that the forefemur is expanded, with broader ventral spines, the color patterns are present on other parts of the body (unique for the genus), and the range is well south of the normal distribution of other members of this genus (88% of the species are distributed from northern Mexico to Costa Rica [only *M. modesta*, *M. walkeri*, *M. inca*, and *M. guyana* are found beyond this range]. Nickle suggested that *M. inca* is related to *M. bradleyi*, based solely on the presence of color patterns on the mesial face of the forefemur. The markings of the *bradleyi* group consist of some variation of a blackened

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[1] Received May 31, 2000. Accepted July 5, 2000.

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ENT. NEWS 112(2): 159-166, May & June, 2001

"E" on the mesial face of the forefemur and a simple black horizontal line on the external face. Although the markings on *M. inca* (consisting of a blackened irregular pattern on the mesial face but only reddish blotches on the dorsal and ventral margins of the outer face) only superficially resemble the patterns defining the *bradleyi* group, the presence of color patterns on the forefemur suggested a relationship to the *bradleyi* group.

Characters of the male genitalia are more important in establishing species affinities, and it was hoped that the discovery of the male of *M. inca* would resolve the question of group affinity. After nine years of collecting orthopteroid insects in northern Peru as part of an Earthwatch project (Amazon Katydids) (1986-1995), only three additional specimens of this species have been collected, including the first male, described herein. Based on the more reliable characters of the male genitalia, rather than on color patterns on the forefemur alone, *M. inca* is most closely related to *M. guyana* and, as previously speculated by Nickle (1984), is associated with members of the *bradleyi* group.

In a collection of Orthoptera sent to me from Dr. Richard Brown, Mississippi State University, a male of a heretofore undescribed species of *Montezumina* from Panama was discovered. Additional specimens from Costa Rica in the orthopteroid collection at the Instituto Nacional de Biodiversidad de Costa Rica (INBio), Heredia, Costa Rica, have added to our knowledge of this species, described herein as *Montezumina maya*, new species.

Specimens from the study are deposited in the U.S. National Museum of Natural History, Washington, DC [USNM] and at the Instituto Nacional de Biodiversidad de Costa Rica [INBio].

Montezumina maya Nickle, NEW SPECIES

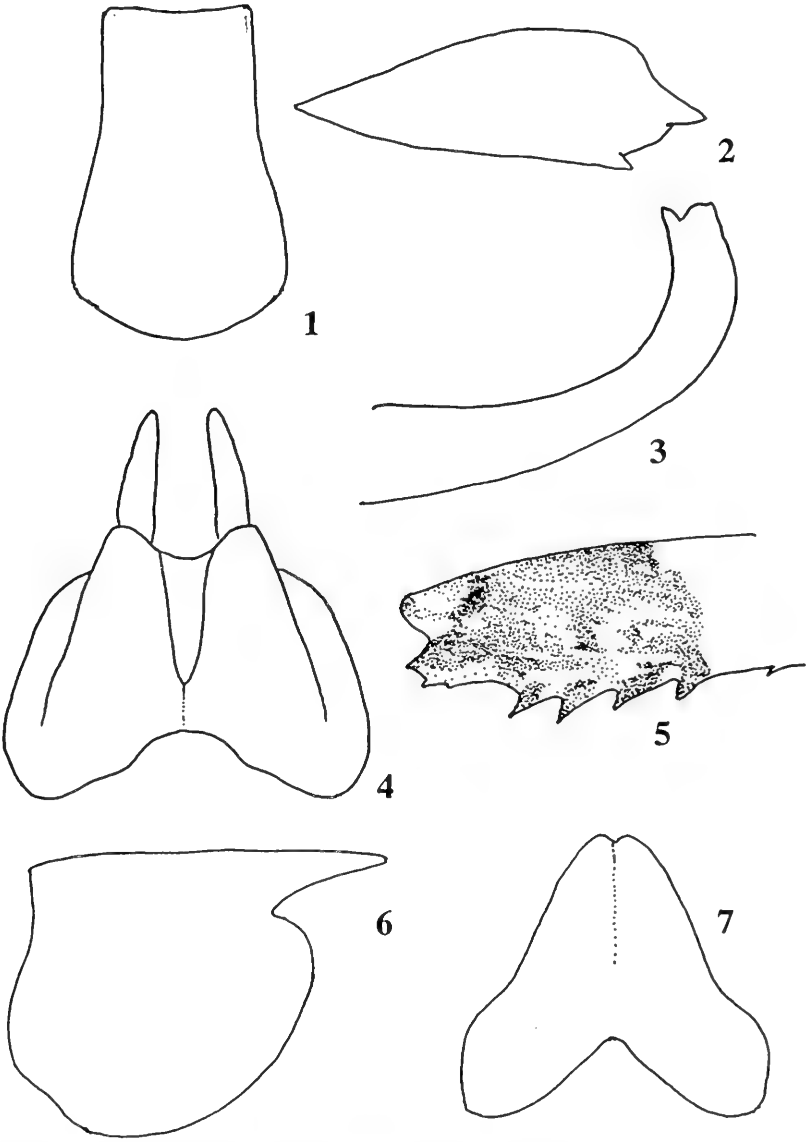
(FIGS. 1-7, 13)

Diagnosis. Dark spots are absent on all corners of the pronotal disc [present on the posterior corners only in *bradleyi bradleyi*, the other Panamanian species of this group]. Articulating styles are present on the apex of the subgenital plate, and the cerci are apically armed with a well developed dorsal tooth and a broader ventral blade. Differing from *longistyle* on the basis of the darker maculation on the mesial face of the forefemur and the more gracile, apically toothed ♂ cercus.

Holotype. Male. PANAMA: Cerro Campaña, 800 m. Jan. 2-3, 1987. (coll. J. R. MacDonald) [USNM]. Allotype. Female. COSTA RICA: Heredia. [INBio].

Description. Head. Eyes elongate, oval, 1.8x subocular genal length. Occipital rise >0.33x eye length. From above, interocular width equivalent to slightly less than one eye width. Fastigium nearly twice as wide as frons, both narrow, convergent, and attingent.

Thorax. Pronotal disc elongate, 1.47x longer than posterior width; posterior width 1.7x broader than anterior width. Dark maculations on all four corners of disc. lateral lobe of pronotum as in Fig. 6.



Figures 1-7. Morphological features of the holotype of *Montezumina maya*. 1. pronotal disc; 2. lateral genicular lobe of hindfemur, left lateral view; 3. left cercus, lateral view; 4. subgenital plate, ventral view; 5. color pattern on inner face of forefemur; 6. latral lobe of pronotum; 7. subgenital plate of allotype, ventral view.

Wings. Tegmen 5.6x longer than wide. Hindwings extending 4.9 mm beyond tegmina in repose. Stridulatory vein 1.99 mm.

Legs. Hindfemur 8.1x longer than wide. Inner face of forefemur ornamented with a dark brown mottled pattern. Ventral margin of forefemur bearing 4 large broad spines beneath mottled pattern and two smaller spines near midpoint. Posterior margins of hindtibia each armed with 25-26 spines. Lateral genicular lobe of hindfemur as in Fig. 2.

Abdomen. Male: Tenth tergum produced, medially depressed, and apically deflexed between cerci. Cercus long, cylindrical, gradually curving medially to apical third of its length, then more acutely dorsomedially to apex; apex armed with a sharp dorsal tooth and an adjoining broader cutting blade (Fig. 3). Subgenital plate spatulate, apically with a U-shaped median emargination, and armed with two well developed articulating styles (Fig. 4). Female: Subgenital plate as in Fig. 7.

Coloration. A narrow band extending from dorsal rim of compound eye toward anterolateral corner of pronotal disc; small brown maculations absent at each of four corners of pronotal disc (Fig. 1). Apical third of mesial face of forefemur mottled brown (Fig. 5); foretibia with dark markings, especially on leading edge and in areas surrounding spines, beneath tympanum, and along apical fifth. Apical fifth of midtibia mottled dark brown. Penultimate tarsal segments of all legs black, others brown or green.

Paratypes. 10 males, 8 females. COSTA RICA: Prov. Ajal. Fca. San Gabriel, 2 km SW Dos Rios, 600 m. VII-1988. 1 male [INBio]; Guanacaste Prov. Est. Pitilla, 9 km S Santa Cecilia, P.N. Guancaste , 700 m. various dates and collectors 9 males, 8 females [INBio].

Distribution. The range of this species extends from Heredia Province, Costa Rica, to Cerro Campaña, Panama.

Measurements (n = 5 specimens, each sex; mm; $\bar{x}$; R). Total length: male 35.59, 34.94-36.41; female 35.75, 34.10-38.10; length pronotal disc: male 4.24, 4.09-4.39; female 4.29, 4.11-4.71; posterior width pronotal disc: male 2.90, 2.86-2.93; female 2.95, 2.85-3.17; length hindfemur: male 17.47, 16.63-17.94; female 18.39, 17.87-19.10; width hindfemur: male 2.32, 2.24-2.39; female 2.50, 2.41-2.70; length tegmen: male 27.33, 25.44-32.07; female 28.02, 27.24-30.20; width tegmen: male 6.07, 5.38-6.45; female 6.23, 5.57-6.84; ovipositor: female 5.59, 5.29-6.05.

Etymology. This species is named after the Mayan Indians.

Discussion. *Montezumina maya* possesses characters that link it with several species in the *bradleyi* group and is most closely related to *M. longistyle.* Both species differ from other species by the presence of articulating styles on the male subgenital plate. Though the shape of the male cercus is similar for these species (Fig. 13), the apex is more heavily armed in *M. maya.* One distinctive color pattern differs as well; the mesial face of the forefemur is deeply mottled (more similar to that of *M. inca* or *M. guyana,* two related South American species), while in *M. longistyle* it is very lightly patterned in the shape of the letter "E" (Fig. 13).

Montezumina inca Nickle

(Figs. 8-12)

Montezumina inca Nickle 1984: Trans. Amer. Entomol. Soc. 110: 592.

Diagnosis. Male. Tenth abdominal tergum medially declivent, its lateral margins acutely arcuate over bases of cerci. Cercus short, cylindrical, with a median inflated ridge arising along midportion of body of cercus, apically upcurved, and terminating as a broad blunt tooth. Mesial face of forefemur inflated and marked with a mottled irregular blackened patch.

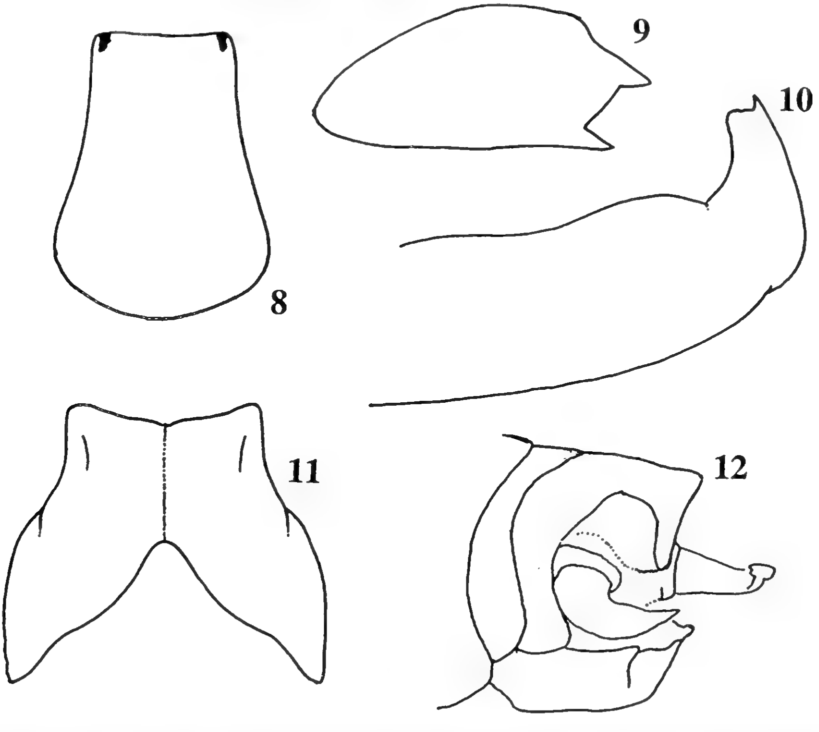
Head. Eyes elongate, oval, subocular genal length equal to about 0.8x length of eye. Occipital rise about 0.33x eye length frons distinctly bilobed; fastigium and frons convergent and attingent.

Thorax. Pronotal disc short, 3.4 mm in length; 1.33x longer than posterior width (Fig. 8).

Wings. Tegmen 5.0x longer than wide. Hindwings extending 4.0 mm beyond tegmina in repose.

Legs. Hindfemur 6.0x longer than wide. Ventromesial face of forefemur inflated, bearing 3 broad spines. Midtibia moderately inflated, gradually tapering apically from distal third of its length. Posterior margins of hindtibia each armed with 27 median and 25 lateral spines. Lateral genicular lobe of hindfemur as in Fig. 9.

Abdomen. Tenth abdominal tergum medially declivent, its lateral margins acutely arcuate over bases of cerci (Fig. 12). Cercus short, cylindrical, with a median inflated ridge arising along midportion of body of cercus, apically upcurved, and terminating as a broad blunt tooth (Fig. 10). Subgenital plate spatulate (Fig. 11).



Figures 8-12. Morphological features of the male sex of *Montezumina inca*. 8. pronotal disc; 9. lateral genicular lobe of hindfemur, left lateral view; 10. left cercus, lateral view; 11. subgenital plate, ventral view; 12. tip of abdomen, posterolateral aspect.

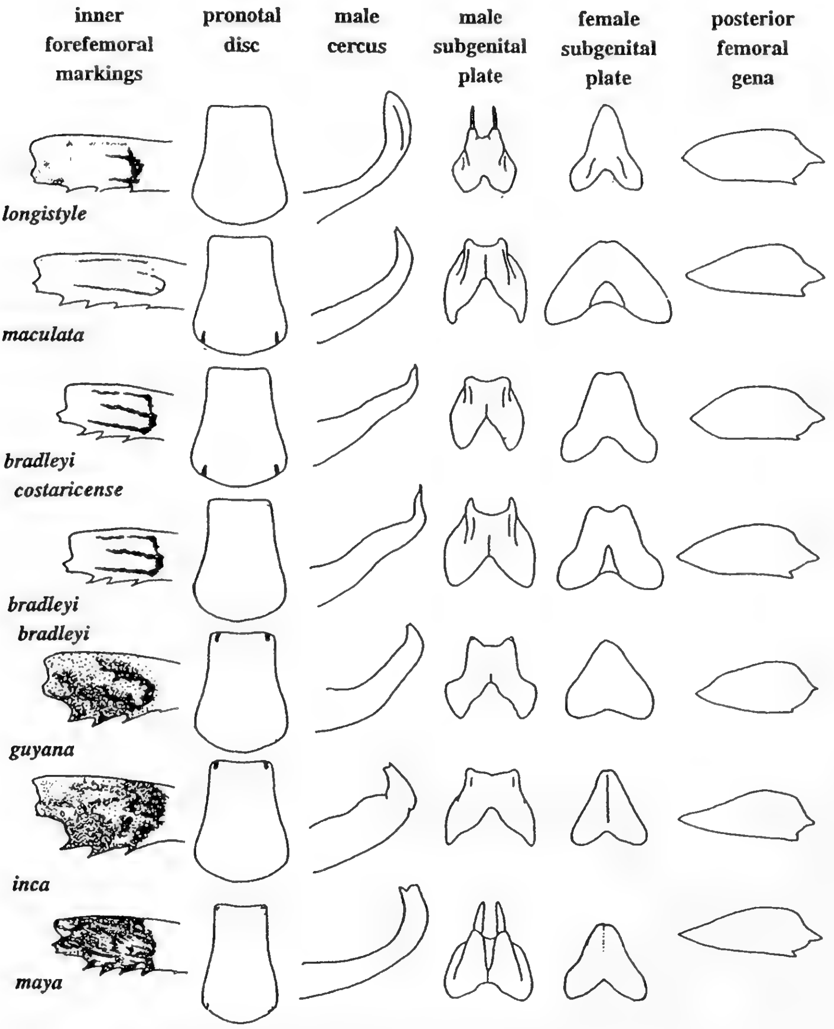


Figure 13. A comparison of key morphological features of *Montezumina* species of the *bradleyi* group. Features are the left lateral hindgenicular lobe, lateral view; mesial face of forefemur, median view; male and female subgenital plates, ventral view; left male cercus dorsolateral view; and pronotal disc [diagramatic], dorsal view.

Coloration. The color patterns on this sex are essentially the same as those described in Nickle (1984: 592) on the female holotype.

Distribution. The range of this species is extended into Loreto Province, 40 km NE of Iquitos, at the Explorama Inn (3°26'S, 73°02'W), but it is probably found throughout rainforests extending from Madre de Dios to the Peruvian Amazon River basin.

Measurements (♂; mm; $\bar{x}$). Total length: 28.97; length pronotal disc: 3.60; posterior width pronotal disc: 2.70; length hindfemur: 14.92; width hindfemur: 2.38; length tegmen: 21.10; width tegmen: 4.41.

DISCUSSION

Nickle (1984) divided the 25 species of *Montezumina* into six species groups, based primarily on shared male genital characters. Development of the tenth tergum displays a variety of character states, including: "not produced, truncate" (*ocularis* and *granti* groups), "produced and strongly declivent" (*oblongoculata*, *sinaloae*, and *oridiops* groups). Cercus shape also displays discordant character states, including: "short and robust, with large apical teeth" (*ocularis* group), "long and sinuate, round in cross section to the apex, and terminating in a gracile apical tooth" (*oblongoculata* and *bradleyi* groups), "very long and sinuate, round in cross section to the apex, and terminally blunt with a small apical tooth" (*sinaloae* group), and "long, round in cross section at basal portion but distally upcurving and becoming laterally flattened" (*oridiops* group). *Montezumina inca* differs from other species in the *bradleyi* group in the degree of deflexion of the tenth tergum between the cercal bases: from weakly produced (*bradleyi bradleyi*), to moderately produced and weakly deflexed (*bradleyi costaricense*), to both strongly produced and deflexed (*guyana*), to weakly declivent (*longistyle*), and finally, to strongly declivent (*inca*). There is a similar trend among these species in the shape of the cercus: from elongate and sinuate to the apex (*bradleyi bradleyi*, *b. costaricense*, and *maculata*) to compressed and apically blunt (*longistyle*) to apically blunt with a tooth (*guyana* and *inca*). *Montezumina inca* appears to be most closely related to *M. guyana* on the basis of forefemoral and pronotal disc color patterns and shape of the male cercus. Other characters useful in separating these species are presented in Fig. 13.

Montezumina maya is recognized as a sibling species of *M. longistyle*, based primarily on the unusual stylated subgenital plates of the males.

ACKNOWLEDGMENTS

I express my sincere thanks to Earthwatch Foundation (Watertown, MA) for providing funds to James L. Castner (University of Florida) and me to support research on katydids of the Peruvian Amazon region (Project Nos. 87-008, 89-163, 90-010, 91-174, 91-015, 92-032). I am indebted to Peter Jensen for his assistance since the beginning of our project for use of his facilities in Peru (Explorama), for providing us with additional space as a field laboratory, and for continued support in the logistics of getting our volunteers into and out of Iquitos. I extend my appreciation also to the staff at Explorama facilities for their hospitality and interest in our project. I am indebted to the volunteers of the project for their help and enthusiasm. One of them was responsible for collecting the specimen of *M. inca*, upon which this study is based; I wish I knew who it was, but I thank all of them for their collecting time and energy. Thanks are extended also to the following individuals for reviewing the manuscript: Natalia Vandenberg and E. E. Grissell, Systematic Entomology Laboratory, USDA, J. L. Castner, Gainesville, FL, and O. S. Flint, U. S. National Museum of Natural History, Washington, DC. Specimens upon which this paper is based were provided by Richard Brown (Mississippi State University) and Angel Solis (InBio).

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MORPHOLOGY OF THE SECOND INSTARS OF *POLEA MARTINI* AND *POLEA SELANGORAE* (COCCOIDEA: ASTEROLECANIIDAE)[1]

Paris L. Lambdin[2]

ABSTRACT: The second instars of the pit scales (Asterolecaniidae) *Polea martini* and *P. selangorae* are described and illustrated with measurements included for the various morphological structures. Both species were collected on species of *Calophyllum* sp. from Borneo and Singapore, respectively. These species are morphologically similar to immatures of *Grammococcus* in the New World. *Polea martini* is distinguished from *P. selangorae* by the presence of an anal ring with 6 setae, more multilocular pores in the dorsal pore clusters, and differences in the tubular ducts.

Identification of scale insect species is based primarily on the adult female. Immature stages have been described and illustrated infrequently. Because of their cryptic appearance, small size, and limited period of development, comparatively few immatures have been collected and prepared in a manner suitable for description. Specimens representative of *Polea* are rarely encountered, and presently are known only from southeast Asia. Species in this genus are reported to feed on *Calophyllum* spp. (Guttiferae). Since Green's (1909) original description and subsequent review (1922) of *Polea*, the genus has been mentioned only in major generic revisions. The genus *Polea* was revised to include the species, *P. ceylonica* (Green), *P. selangorae* (Lambdin 1977), and later, the species *P. martini* Lambdin was described and illustrated (Lambdin 1999). The objective of this study was to describe the second instar stage of *Polea martini* and *P. selangorae* to better understand the development of these taxa and to be able to distinguish them from similar other species encountered. Second instars of *Polea selangorae* and *P. martini* were collected and provided by Jon Martin (Natural History Museum, London). Because of the morphological similarities exhibited by the specimens studied, it was not possible to determine with absolute certainty the sex of each species. However, based on the shape of the body, lack of medial setae on the venter, and reduced pore numbers on the dorsum, they appear to be females, Measurements (in micrometers) were obtained from 10 structures, when available, and are presented as averages followed by ranges in parentheses.

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[1] Received June 16, 2000. Accepted December 10, 2001.

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ENT. NEWS 112(2): 167-172, May & June, 2001

Polea martini Lambdin

(Fig. 1a-j)

Material studied (type series): (slide b), on *Calophyllum inophyllum*, 1 second ♀, 4 adult ♀♀ (1 slide), Borneo, Brunei, 23 Mar. 1989, Coll. J.H. Martin, coll. no. 5475. (Deposited in Natural History Museum, London).

Description of slide-mounted second instars: Body (Fig. 1a) elongated, 750 long, 455 wide, with minute, distinct anal lobes.

Dorsal Surface (left half): Large 8-shaped pores absent. Anal lobes (Fig. 1a,b) rounded, with apical setae (broken setae 30 and 31 long, respectively); a minute inner and outer tacklike seta on each lobe. Anal ring (Fig. 1a,b) minute, subcircular, ca. 17 long, 14 wide, with 6 fleshy setae, each seta 22 (18-26) long. Bilocular pores (Fig.1c) subcircular, sparse, appearing in segmental rows over derm, each 1.2 (1-2) long. Two pairs of pore clusters on submargin, each cluster with 20 (15-26) 7-10 locular pores (Fig. 1d), each pore 4.5 (4-6) diam. Simple disc pores (Fig. 1e) rare, few in marginal and submarginal area, each 1 in diam. Setae sparsely spaced, a pair of tacklike setae on margin of anal area. Tubular ducts (Fig. 1f) asteroform, inner ductule reduced, outer ductule becoming progressively larger apically, most numerous in submarginal and submedial areas, each 22 (20-25) long and 2.5 (2-3) wide.

Ventral Surface (right half): Antennae (Fig. 1g) one-segmented, ca. 5 wide at base and 3 long; with 4 fleshy setae, each 5-11 long. Bilocular pores (Fig. 1c) arranged in marginal row with occasional associated tacklike setae (Fig. 1k), few pores scattered throughout cephalothoracic region, one associated with the antennae and one laterad of mouthparts, each pore 1.2 (1-2) long. Clypeolabral shield ca. 56 long, 50 wide. Labium slightly deltoid, ca. 23 long and 34 wide, with 2 pairs of minute setae. Legs (Fig.1h) reduced to minute sclerotized points ca. 4-5 wide. Spiracles (Fig.1i) on submargin, 19.5 (18 -20) long, 8 (8) wide at peritreme, with atrium 4 (4) in diam. With 2-3 quinquelocular pores (Fig. 1j) located near margin of spiracular furrows. Setae (Fig.1k) rare, few associated with marginal row of bilocular pores, absent on remainder of derm.

Polea selangorae Lambdin

(Fig. 2a-j)

Material studied: (slide a), 1 second instar ♀, 3 adult ♀♀, right label: *Polea selangorae* Lambdin, JHM 6391; left label: on *Calophyllum* sp. Bukit Timah Forest Reserve, Singapore, 1 March 1994, Coll. J.H. Martin, coll. no. 639, (slide b), 1 second instar and 3♀♀, same data, (slide c), 1 second instar, 3 adult ♀ and one parasitized ♀♀, same data. (Deposited in Natural History Museum, London).

Description slide-mounted second instars: Body (Fig. 2a) elongate, 467 (422-500) long, 362 (349-377) wide, with minute, distinct protruding anal area.

Dorsal Surface (left half): Large 8-shaped pores absent on dorsum. Anal lobes (Fig. 2 a-b) slightly extended and rounded; each lobe with an apical seta, broken seta 36 (32-40) long, and one minute tacklike seta on inner and one outer margin between apical setae, each seta ca.1 long. Anal ring (Fig. 2a-b) reduced to minute, subcircular opening, without setae, anal ring 4-5 in diam. Bilocular pores (Fig. 2c) irregularly spaced on segments over derm, each 1.5 (1-2) diam. Two pairs of pore clusters on submargin consisting of 7-10 locular pores (Fig. 2d), each cluster with 5-12 pores, each pore 4.5 (4-6) diam. Simple disc pores (Fig. 2e) rare, few in marginal area, each 1.5 (1-2) in diam. Tubular ducts (Fig. 2f) asteroform, irregularly spaced, more numerous in marginal to submedial area, inner ductule reduced, with strong sclerotization on shoulder, flared at end, outer ductule becoming progressively larger apically, each 22 (20-26) long, 2 (1.5-3.0) wide.

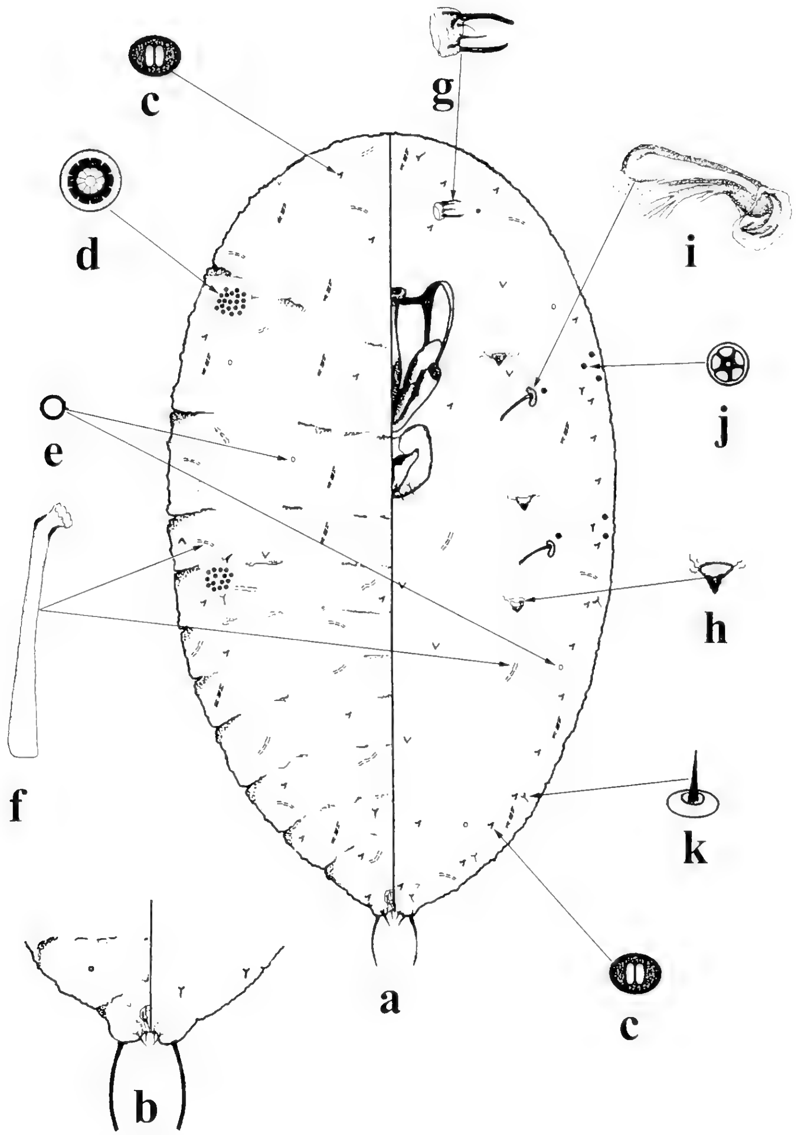

Fig. 1. *Polea martini,* second instar: a, dorsoventral view (left, dorsal; right, ventral); b, anal ring; c, bilocular pore; d, multilocular pore; e, simple pore; f, tubular duct; g, antenna; h, leg stub; i, spiracle; j, quinquelocular pore; k, seta.

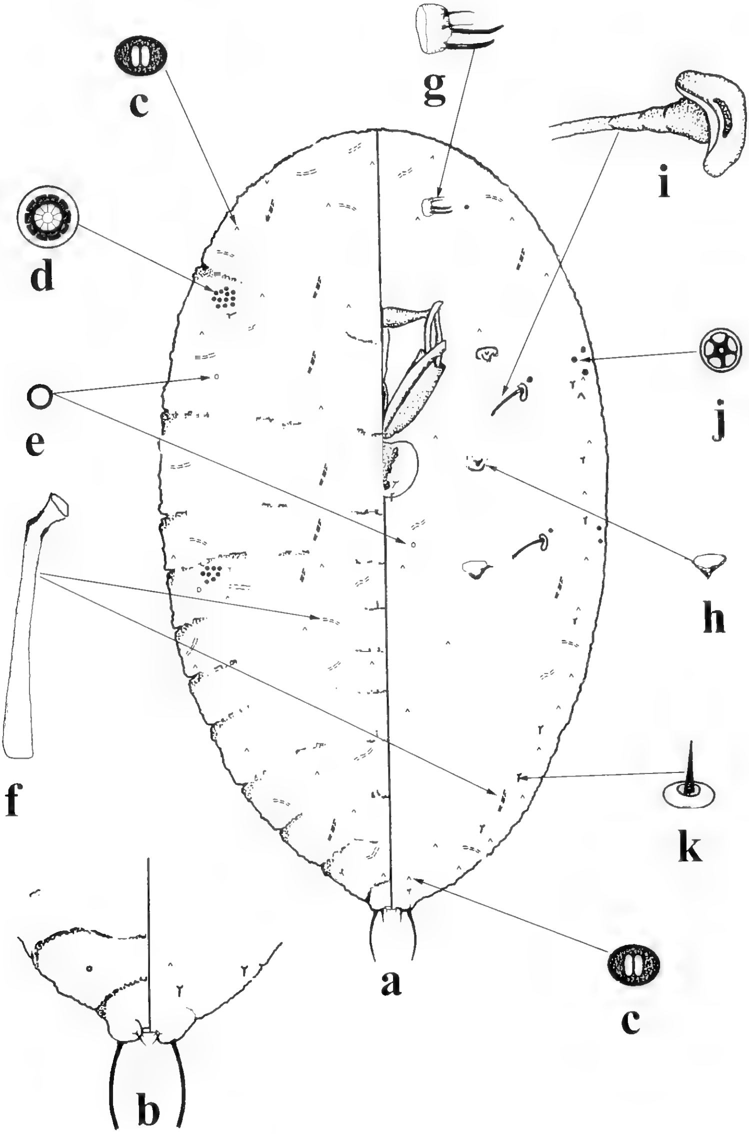

Fig. 2. *Polea sengalorae*, second instar: a, dorsoventral view (left, dorsal; right, ventral); b, anal ring; c, bilocular pore; d, multilocular pore; e, simple pore; f, tubular duct; g, antenna; h, leg stub; i, spiracle; j, quinquelocular pore; k, seta.

Ventral Surface (right half): Antennae (Fig. 2g) one-segmented, 5-6 long; with 2 fleshy (8-9 long) and 2 slender (4-5 long) setae, and with one associated bilocular pore at base of each antenna. Bilocular pores (Fig.2c) in submarginal row extending from the antennae to anal lobes (ca. 26 pores), and irregularly spaced over derm, each 1.5 (1-2) long. Clypeolabral shield 60 (57-62) long, 51 (50-52) wide. Labium triangular, 23 (21-25) long, 26 (23-30) wide, with two pairs of minute setae. Legs (Fig. 2h) reduced to minute sclerotic points ca. 4-7 wide. Microspines common on posterior abdominal segments. Simple disc pores (Fig. 2e) sparse, irregularly distributed in marginal area, shape and size similar to those on dorsum. Spiracles (Fig. 2i): on submargin, (20-25) long, 7 (7-8) wide at peritreme, with atrium 4 (3-5) in diam.; with 5-(4-5) locular pores (Fig. 2j), one at spiracle and 2-3 near margin, each 2 (1.0-2.5) diam. Setae (Fig. 2k) rare, minute, a few in transverse row on abdomen and associated with the marginal row of bilocular pores, setae,

DISCUSSION

These two species are very similar and exhibit a reduction in the number and type of pores compared with other species of asterolecaniids. The structures present have a similar arrangement on the derm in both species. Species of these taxa lack large 8-shaped pores, possess multilocular pore clusters, and lack significant setae on the dorsum. Minute bilocular pores are arranged in a marginal row with associated setae, leg remnants are visible on both species, the antennae are 1-segmented, and the submarginal spiracles have only a few associated quinquelocular pores on the venter. *Polea martini* is distinguished from *P. selangorae* by the presence of a complete anal ring with 6 setae, and more numerous pores in the dorsal pore clusters.

The second instars may be distinguished from the first instars by the presence of one-segmented antennae and minute leg remnants, and from adult females by the number of multilocular pore clusters on dorsum, lack of partial row of quinquelocular pores on margin, and absence of multilocular pores in transverse rows on the venter.

The second instars of *Polea* are similar to those of *Grammococcus*. Immatures of both taxa have sparsely scattered tubular ducts and minute bilocular pores, and possess pore clusters on the dorsal in the marginal area. On the venter, bilocular pores with associated setae are arranged in a submarginal row and irregularly scattered on the derm. Except for *P. martini*, the anal ring is greatly reduced to a minute sclerotized ring. However, second instars of *Polea* have 7-10 locular pores arranged in two pair of pore clusters and possess minute leg remnants, while those of *Grammococcus* have 5-locular pores in four pairs of pore clusters and lack any sign of leg remnants. In addition, the immatures of *Polea* lack large 8-shaped pores, while a few are present, especially in the medial area on the dorsum, on both *G. adetocorymbus* and *G. corymbus* (Miller and Lambdin 1978).

ACKNOWLEDGMENTS

I am deeply grateful to Ernest Bernard (University of Tennessee, Knoxville) for reviewing this manuscript before publication, and to Jon Martin (Natural History Museum, London) for the loan of material for this study.

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DISTRIBUTION AND STATUS OF *MEROPE TUBER* (MECOPTERA: MEROPEIDAE) IN PENNSYLVANIA[1]

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ABSTRACT: A review of the status and distribution of *Merope tuber* within Pennsylvania indicates that the species is more common than previously believed. Two published records exist for the species in Pennsylvania – one from Philadelphia County and the second from Lancaster County. This paper reports twenty new locality records and extends the known distribution of *M. tuber* into western Pennsylvania. The use of black lights and flight intercept traps in wooded areas near fresh water sources were found to be productive collecting techniques.

My interest in *Merope tuber* Newman began with the collection in September 1999 of an unusual insect that I did not recognize. The collection was made at an ultraviolet light near Messiah College's campus, Grantham, Pennsylvania. After returning to the laboratory, I identified the adult female as a member of the order Mecoptera, family Meropeidae. The family is represented in North America by the single species, *M. tuber*. The only other species in the family is found in Australia (Byers 1973).

Two published records exist for the species in Pennsylvania – a male was caught in Fairmont Park, Philadelphia County, Philadelphia, PA in the late 1800s by Philip Nell (Johnson 1904). A second specimen was collected at a molasses trap set for cave crickets in Lancaster County in Sept. 1930 (Byers 1954, Scarbrough 1980). Essentially nothing is known of the biology of *Merope tuber* and its immature stages remain undescribed (Johnson 1995, Webb et al., 1975).

The distribution of *M. tuber* is widespread within the eastern U.S. It has been collected from southern Canada (Ontario) to northern Georgia in the east and from Kansas to Minnesota in the west (Byers 1973, Byers 1999 personal communication, Webb et al., 1975). Within this range, *M. tuber* has been considered, until recently, to be rare. The rarity, however, appears to be more an artifact of collection technique than of few individuals. *M. tuber* is reported to be nocturnal (Sanborne 1982). Collectors employing ultraviolet lights and especially flight intercept traps such as the Malaise trap have obtained sizable numbers of individuals (Byers 1973, Carpenter 1932, Thornhill and Johnson 1974). Indeed two years of collecting at a single Malaise trap in Ohio yielded 163 specimens (Johnson 1995). Others (Maier 1984, Scarborough 1980) have reported similar success with Malaise traps.

Merope has been most commonly collected in forested areas of dense undergrowth (Coffman 1982) and often near a water source (Johnson 1995).

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Collections from Ohio (Johnson 1995), Connecticut (Maier 1984), Maryland (Scarbrough 1980), Delaware (Newark, Delaware, Charles Bartlett, 1999 personal communication), West Virginia (Coffman 1982) and New Jersey (George Byers 1999 personal communication) suggest that Pennsylvania should have a sizable population.

When I announced at the October 1999 meeting of the American Entomological Society in Philadelphia that I had collected a specimen of *Merope tuber* in Pennsylvania, others in the audience reported that they too were aware of recent collections. Evaluation of these and other reports has resulted in the documentation of the following new distribution records for Pennsylvania as described below and as shown in Figure 1. Specimens in major collections are designated ANSP (Academy of Natural Sciences of Philadelphia), CMNH (Carnegie Museum of Natural History), and SWRC (Stroud Water Research Center).

- Earliest record: Fairmont Park, Philadelphia, Philadelphia Co. Late 1800s. Collected by Philip Nell. One male. In Wagner Free Institute Insect Collection. See note regarding the specimen by Johnson (1904).
- Second published record: Lancaster Co., caught at molasses trap set for cave crickets by T. H. Hubbell. Between 6 and 30 Sept. 1930 (Byers 1954, Scarbrough 1980).
- Roxborough, Philadelphia Co. One female. 29 August 1915. Collected by Frank Lyons. In ANSP.
- 1.25 mi. NW of London Grove, Chester Co. Along Ledyard's Spring Branch, East Fork of White Clay Creek. Elev. 390'. 39°52'44"N, 75°47'29"W. 21 August 1983. Malaise Trap. One female. In SWRC.
- 1.9 mi. SE of Mortonville, Bog Hollow Creek: West Branch of Brandywine Creek, Chester Co. Elev. 330'. 39°55'25"N, 75°45'27"W. 19 July 1978. Malaise Trap. One male. In SWRC.
- 0.6 mi. West of London Grove, Chester Co. East Branch of White Clay Creek. Elev. 370'. 39°51'54"N, 75°46'54"W. 17 September 1980. Malaise Trap. One female. In SWRC.
- 1 mi. E of Grantham, York Co. At Confluence of Stony Run with Yellow Breeches Creek. Elev. 400'. 40°09'12"N, 76°58'57"W. 3 September 1999. Coll. By J. K. Sheldon. At black light, 5 meters from stream. Mesic flood plain forest dominated by sycamore, box elder, and silver maple; with a dense shrub understory of privet, smooth blackhaw and multiflora rose. One female. In ANSP.
- Messiah College Campus, Cumberland Co. Elev. 500'. 40°09'30"N, 76°59'03"W. 11 August 1998. Coll. by Chris Ridge. Malaise Trap. Upland site in 50-year-old oak (red, chestnut, and white), hickory (mockernut and shagbark) and black cherry forest with privet, spicebush, and honeysuckle shrub understory. Approximately 400 meters from Yellow Breeches Creek. Two males. In ANSP.
- Fort Indiantown Gap training area A3, Lebanon Co., 10 Meters SE of road, in upper level of Vesle Run Floodplain, 25 meters from stream. 15 July 1999. Coll. by Betsy Ray. At blacklight. White ash, pignut hickory, white oak, and black walnut dominant trees; red maple, dense spicebush, blackhaw, multiflora rose, and blackberry in understory. Four females; one male. In ANSP.
- Swatera State Park, south side Swatera Creek, north of Appalachian Trail and 1-81, Lebanon Co. 40°30'31"N, 76°29'45"W. 5 August to 3 September 1997. Coll. by J. Weintraub. Malaise trap. Mixed deciduous forest along creek, with Rhododendron and

Locopodium common in understory. One male, eight females. In ANSP.

- Coyne Farm, Wilkinson Rd., Rushland, Bucks Co. 40°15'01"N, 75°02'30"W. 16 to 20 August 1998. Coll. by Heather O'Connor. Malaise trap. Near vernal wetland on wooded hilltop. One male. In ANSP.
- Bowman's Hill Wildflower Reserve, Washington's Crossing, Pidock Creek, Bucks Co. 40°19'03"N, 74°56'33"W. 25 September to 2 October 1997. Coll. by J. Weintraub. Malaise trap. One male. In ANSP.
- 3 km NE Lower Burrell, Westmoreland Co. 21 August 1987. Coll. By Walter Zanol. One male. CMNH #240306.
- Ohio Pyle, Fayette Co. 4 August 1907. One female. CMNH # 217624.
- Husband, Somerset Co. 13 August 1994. Coll. by Walter Zanol. One female. CMNH #237536.
- 1 km SW Clarington, Jefferson Co., 390m. 30 August 1993. Coll. by Walter Zanol and M. Klingler. One female. CMNH #237634.
- Darlington, Beaver Co. 15 September 1962. Coll. by R. E. Carter. One female (CMNH #214914).
- Darlington, Beaver Co. 2 October 1962. Coll. by R. E. Carter. One female (CMNH #208655); One male (CMNH #169315).
- Darlington, Beaver Co. 18 September 1963. Coll. by M. A. Carter. Sex unknown (CMNH #238960).
- Darlington, Beaver Co. 22 September 1963. Coll. by M. A. Carter. One female (CMNH #238969).
- Darlington, Beaver Co. 27 September 1963. Coll. by M. A. Carter. One female (CMNH #238896).
- Darlington, Beaver Co. 3 October 1963. Coll. by M. A. Carter. One female (CMNH #219556); one female (CMNH #239370).
- Shawville, Clearfield Co. 6 September 1940. Coll. by John Bauer. One female (CMNH 218347).

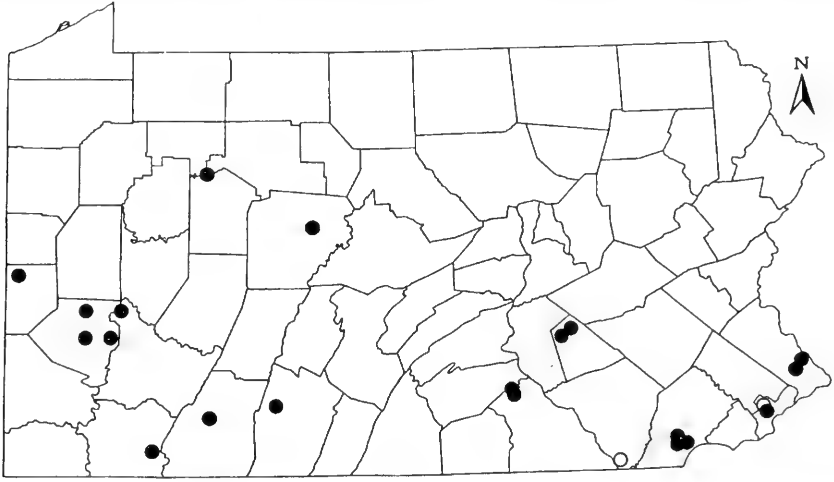

Fig. 1. Current known distribution of *Merope tuber* Newman in Pennsylvania. The open circles represent the published records for the species. Darkened circles report new distribution records that are described in detail in this paper.

- Monroeville, Allegheny Co. 2 July 1960. Coll. by R. Raff. One male (CMNH #239291).
- Pittsburgh, Allegheny Co. 29 August 1917. One female (CMNH #209026).
- Gibsonia, Allegheny Co. 19 June 1951. Coll. by G. E. Wallace. One male (CMNH #240529).
- New Paris, Bedford Co. 19 August 1991. Coll. by N. D. Richmond. One female (CMNH #240302).

What then is the current status of *M. tuber* in Pennsylvania? The new records presented in this paper confirm that *M. tuber* occurs throughout much of the southern and central portions of Pennsylvania. It has not been recorded from the northern tier counties or from northeastern Pennsylvania. This includes the Pocono Plateau and the Allegheny High Plateau. There also are no records from uplands of the Appalachian Mountain Section. The two records in this geographic region from Bedford and Somerset Counties are both from low elevation valley sites. Coffman (1982) reports specimens from West Virginia near the south-central and south-western Pennsylvania border. Chen Young of the Carnegie Museum of Natural History has told me (personal communication) that their largest collection of *M. tuber* is from West Virginia. The collection of more than 150 specimens near Lancaster, Ohio, during the summer of 1992 and 1993 indicates a significant Ohio population (Johnson, 1995). There are no published records from New York, which is consistent with its absence from northern Pennsylvania. The Nature Conservancy has given *M. tuber* a rank of G3G5 that expresses the range of uncertainty (Dale Schweitzer of The Nature Conservancy, personal communication). The rank of G3 is given to vulnerable species that are known from five or fewer counties in a single state while G5 refers to demonstrably secure species typically known from four or more states. *M. tuber*, thus appears not to be rare, but until now, has been seldom collected.

The new records for *M. tuber* in Pennsylvania that are reported here do not appear to represent a recent range expansion of the species. They derive from previous records that had not been reported (most of the "new" western Pennsylvania records) and to more efficient collecting techniques. The continued use of flight-intercept traps and ultraviolet lights in mesic habitats, which has accounted for the majority of the recent eastern Pennsylvania records, will undoubtedly provide additional records of this species in Pennsylvania. The next major task in the study of *M. tuber* will be the elucidation of its natural history including the discovery of its larval form.

ACKNOWLEDGMENTS

I thank The Academy of Natural Sciences of Philadelphia for their support in this project. My recent appointment as Research Associate of the Academy has provided many opportunities. Special thanks go to Dr. Jon Gelhaus of the Academy for his assistance in this project, to two anonymous reviewers and their helpful suggestion, and to my friend Howard Boyd who has served as editor of Entomological News since 1974. All individuals who read and publish in Ent News benefit from Howard's concern for quality and detail.

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A CLEARWING MOTH HOST (LEPIDOPTERA: SESIIDAE) FOR THE BEE FLY, *GERON ARGUTUS* (DIPTERA: BOMBYLIIDAE)[1]

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ABSTRACT: The Nearctic bee fly, *Geron argutus*, is a larval-pupal endoparasitoid of the clearwing moth, *Synanthedon polygoni*. This is the first Sesiidae host record for *Geron*, and the first reported host for *G. argutus*, of which we illustrate the pupa.

The parasitic bee flies (Diptera: Bombyliidae) comprise one of the largest families within the Brachycera, with over 5000 species described since 1758 (Evenhuis 1991). They have a cosmopolitan distribution, predominantly in Mediterranean climate zone arid environments (Hull 1973). While the vast majority are ectoparasitoids of arthropods in seven insect orders (principally the Hymenoptera) and spiders, species in *Geron* Meigen (Toxophorinae: Gerontini), with about 25 species in the United States, are endoparasitic (Yeates and Greathead 1997), mostly as primary parasitoids of Lepidoptera. Reported moth hosts are in Psychidae (Bowden 1974; Donahue 1968; Mik 1896), Tortricidae (Pinto et al. 1987), Pyralidae (Mik 1896; Johnson and Smith 1981; Möhr 1990), and Noctuidae (Bowden 1974).

Several *Geron* species appear to be facultatively hyperparasitic. *Geron turneri* Hesse parasitizes not only a pyralid moth but also two braconids (Hymenoptera: Braconidae) and an ichneumon (Hymenoptera: Ichneumonidae) (Möhr 1990). Johnson and Smith (1981) reported *G. aridus* from a pyralid moth as well as from an ichneumon. *Geron nomadicus* Hesse may be an obligate hyperparasitoid; to date it is recorded exclusively from a braconid, and tachina flies (Diptera: Tachinidae) in at least four genera (Annecke and Moran 1977).

Here we report *G. argutus* Painter (1932) from pupae of the clearwing moth, *Synanthedon polygoni* (Henry Edwards) (Lepidoptera: Sesiidae). This is the first record of a *Geron* species reared from a clearwing moth, and the first host reported for *G. argutus* .

Host Plant and Collection Site. In June 1999 we obtained several *S. polygoni* larvae and pupae at Mayfield Pond in Deschutes County, central Oregon (44°05'07"N, 121°07'39"W; elev. 1020 m). They were extracted from granite gilia, *Leptodactylon pungens* (Torr.) Nutt. (Polemoniaceae), a low growing, perennial woody shrub widely distributed in North American aridlands

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ENT. NEWS 112(3): 178-182, May & June, 2001

west of the Rocky Mountains from British Columbia to lower California and New Mexico (Cronquist et al. 1994). Other plants at the collection site include a scattered overstory of western juniper, *Juniperus occidentalis* Hook., a shrub layer of mountain big sagebrush, *Artemisia tridentata vaseyana* (Rydb.) B. Boivin, bitterbrush, *Purshia tridentata* (Pursh), green rabbitbrush, *Chrysothamnus viscidiflorus* (Hook.) Nutt., gray rabbitbrush, *C. nauseosus* (Pall.) Britt., bluebunch wheatgrass, *Agropyron spicatum* (Pursh) Scribn. & Smith, and cheatgrass, *Bromus tectorum* L. (Teal MacKenzie Purrington, *in litt.*).

The collection area is characterized by exposed lava flows and blister cones, with rocky outcrops and swales dispersed across lava plains. Thin sandy eolian soils are developed on a shallow basalt bedrock. Average annual precipitation (1965-1994) is 28.8 cm (Garwood 1996).

Clearwing moth host. *Synanthedon polygoni* is the most polymorphic species of North American clearwing moths (Eichlin and Duckworth 1988). It ranges from Alaska to Baja California and Chihuahua, Mexico, and east to the Rocky Mountains. Host plants are xerophytes in Polygonaceae (Engelhardt 1946) and Polemoniaceae (Duckworth and Eichlin 1978).

By the time of our June collections, host moth larvae had tunneled in stems and root crowns at and below the ground-line, and in preparation for eclosion had constructed silk- "sawdust" escape tubes from below-ground egress ports to above-ground exits.

DISCUSSION

Insect parasitism of clearwing moths has occasionally been reported but remains anecdotal (Engelhardt 1946) or fragmentary (e.g. Krombein et al. 1979; Purrington and Nielsen 1987; Solomon 1995; Georgiev 2000). Until this report no insect parasitism of *S. polygoni* has been reported.

Geron argutus was reported from Kansas (holotype from Medora, Reno County), Texas, New Mexico, and Oregon by Painter (1932).

Leptodactylon pungens plant material containing *S. polygoni* immatures was taken to Ohio State University in Columbus where one *G. argutus* pupa (Figure 1) developed from a host moth pupa. An adult female bee fly eclosed from this pupa on 4 July 1999. Yeates and Greathead (1997) claim that species in Gerontini consume the larval host before it can pupate. This conflicts with our observation of a *G. argutus* larva exiting a host clearwing pupa.

A second bombyliid pupa that developed from a *S. polygoni* pupa but failed to eclose can not be determined to species, lacking the adult. We can confirm it is not a species of *Geron*; it may be in the Villini, perhaps in *Villa, Chrysanthrax*, or *Thyridanthrax.*

Description of *Geron argutus* pupa (Fig. 1): Overall length:8.2 mm. Head and thorax 3.5 mm in length, generally devoid of hairs; cephalic spine with tip not prominently bilobed, darkly sclerotized. Caudal spines very short, stump-like, with darkly sclerotized apices. Abdominal tergites with numbers of spines as follows: II (61), III (57), IV (49), V (49), VI (41), VII (31), VIII (11). Lateral abdominal setae as follows I (2), II (0), III (1), IV (1), V (2), VI (0), VII (3), VIII (4). This pupa and the one we could not determine are deposited in the U.S. National Museum.

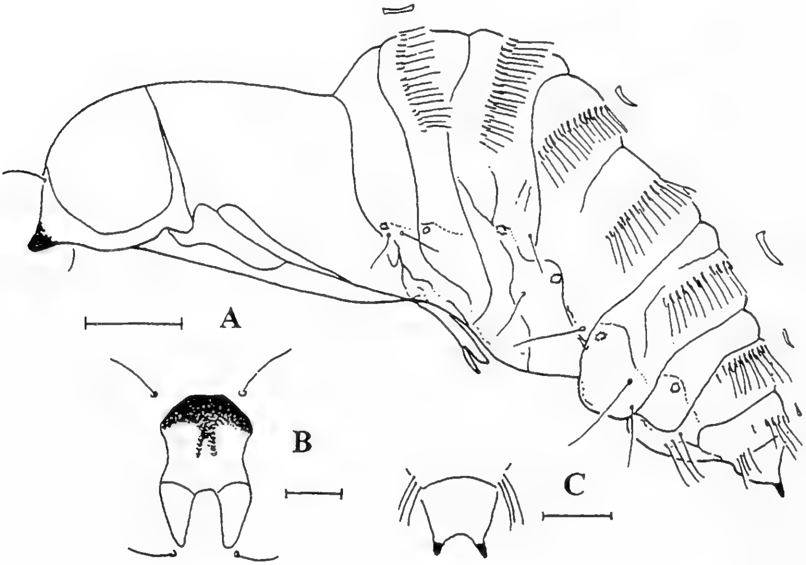

Figure 1. Pupa of *Geron argutus* Painter, female; A: habitus (showing abdominal spines enlarged X4); B: cephalic spine; C: caudal spines. Scale bars = 1 mm.

The pupa of *G. argutus* is similar in some respects to those of the African bee flies, *G. exemptus* Bowden and *G. hesperidium* Frey, i.e., short abdominal hairs, short cephalic spine, short caudal spines [both pupae are described and illustrated by Bowden (1974)]. Whereas all three are members of the nominate subgenus, *G. argutus* is separated from these other two species by the less prominent cephalic spine that lacks a prominent bilobed tip (this armature, or "snout"[in Bowden (1974)], is more distinctly bilobed with rounded or pointed tips in the African species) and the less numerous spines and hairs on the tergum of ABII (these spines and hairs more numerous in the African species).

Lacking sufficient pupal material, published illustrations, and descriptions, it may be premature to make comparisons and deductions of differences found among pupae of known *Geron* species. However, representatives of the two *Geron* subgenera we examined (*Geron* Meigen and *Empidigeron* Painter) show differences in structure of the cephalic armature. The junior author examined the sole pupal specimen of *G. (Empidigeron) calvus* Loew housed in the U.S. National Museum [discussed but not illustrated by Donahue (1968)]; its cephalic spine is vestigial and lightly sclerotized (the remainder of the specimen could not be examined because it is still inside the lepidopteran host cocoon - only the head and thorax are emerged). More pupal material of bee flies in these subgenera and the subgenera *Pseudoammictus* Bigot and *Plichtamyia* Evenhuis are needed to help resolve salient morphological, phylogenetic, and host relationship issues among these taxa.

From the standpoint of evolution and functional convergence of bee flies with parasitic Hymenoptera, it would be interesting to resolve more details of *G. argutus* parasitism of its clearwing host, in particular how moth larvae are acquired by bombyliid planidia and how the second instar parasitoid contends with conspecifics it encounters (superparasitism) on and inside a host moth larva. Parasitic Hymenoptera that acquire hosts via planidial first instars eventually must deal with conspecific competitors in mortal combat as early second instars (Purrington 1979) because only a single such parasite normally can develop on one host. Planidia of *G. argutus* surely also superparasitize hosts and larval bee flies must ultimately eliminate conspecifics.

ACKNOWLEDGMENTS

We thank Teal MacKenzie Purrington (BLM Prineville, OR) for locating a productive collecting area and providing incisive floristic and geologic site analyses. Cathy Drake and Robert Marheine provided field logistics support. David J. Horn and Adrienne E. Smith kindly commented on early drafts of the manuscript.

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FIRST BACKSWIMMER RECORDS (HEMIPTERA: NOTONECTIDAE) FROM DELAWARE[1]

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ABSTRACT: While the family Notonectidae is considered cosmopolitan throughout North America, no published records exist for its presence in two of the United States: Delaware and New Hampshire. We newly report this family for Delaware. It is represented by seven species in two genera; *Buenoa margaritacea, B. scimitra, Notonecta insulata, N. irrorata, N. raleighi lunata, N. uhleri* and *N. undulata.* A list of additional species likely to occur in Delaware is also provided.

The predaceous bug family Notonectidae Latreille, 1802 (the backswimmers) has been reported from every Canadian province and territory and all but two of the 48 conterminous United States (Chordas et al., 1999). We newly report this family for Delaware, leaving only New Hampshire without published records of backswimmers (Chordas et al., 1999; Hungerford, 1934; Polhemus and Polhemus, 1988; Truxal, 1953). This paper documents the Notonectidae from Delaware and provides a list of species likely to be encountered in this state. We report for the first time two species of *Buenoa* Kirkaldy, 1908, and five species of *Notonecta* Linnaeus, 1758, as new records for Delaware.

METHODS

Adult backswimmers were collected during the summer of 1998 with dip nets and preserved in 70% ethanol. Museum specimens from the University of Delaware were also examined. Identifications were made using keys by Hungerford (1934) and Truxal (1953). Chordas et al. (1999), Chordas and Harp (1991), Hilsenhoff (1984), Hungerford (1934), Polhemus and Polhemus (1988), Polhemus (1997), Truxal (1953) and Yeakel and Larsen (1997) were used as distribution references. Voucher specimens are deposited in the University of Delaware Insect Collection (Newark, Delaware) (UDC) and in the first author's personal collection (SWACC).

RESULTS AND DISCUSSION

Seven backswimmer species, two belonging to the genus *Buenoa* and five to the genus *Notonecta*, were identified from Delaware. These species, *Buenoa margaritacea* Torre-Bueno, 1908; *Buenoa scimitra* Bare, 1925; *Notonecta*

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[1] Received October 10, 2000. Accepted December 16, 2000.

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ENT. NEWS 112(3): 183-186, May & June, 2001

insulata Kirby, 1837; *Notonecta irrorata* Uhler, 1879; *Notonecta raleighi lunata* Hungerford, 1926; *Notonecta uhleri* Kirkaldy, 1897 and *Notonecta undulata* Say, 1832, are the first backswimmer species reported for Delaware. Two species, *N. irrorata* and *N. undulata*, are known from all three Delaware counties. All seven species reported here were found in New Castle County collections. The other five species reported here are currently known in Delaware from a limited number of specimens and localities. However, they generally occur throughout the northeast United States and probably also occur throughout Delaware.

Buenoa margaritacea: We collected a single specimen of this species during our 1998 survey and identified two specimens in the University of Delaware collection. Although most *Buenoa* species normally occur in fishless habitats, we encountered our specimen in a well-vegetated run-off pond that contained mosquito fish (*Gambusia* sp.). This species is most common throughout the eastern half of the United States and Canada and likely occurs throughout Delaware.

NEW RECORDS: **New Castle County,** Newark (University of Delaware, Agriculture pools) R.W. Lake, 28 September 1976 (UDC) 2 males; Crofton (pond, near junction of U.S. Route 40 and State Route 7 [N39.63 : W-75.65]) R.L. Stewart Jr., 25 July 1998 (SWACC) 1 male.

Buenoa scimitra: The University of Delaware collection contained three specimens of this species. We did not find this species during our 1998 survey. Typically known as a southern species, these Delaware records are at the northern edge of its range.

NEW RECORDS: **New Castle County,** Newark (University of Delaware, pond; Townsend Hall) D. Hulbert , 6 September 1996 (UDC) 1 male; Kirkwood (pond near C&D Canal) C. Bartlett, 26 September 1997 (UDC) 2 males.

Notonecta insulata: A single specimen was identified from the University of Delaware collection. No additional specimens were found during our 1998 survey. This species is distributed throughout the northeast United States and was expected for Delaware.

NEW RECORD: **New Castle County,** Newark (label gave no specific site information) 21 April 1969, W.J. Williams (UDC) 1 male.

Notonecta irrorata: Although we did not find this species during our 1998 survey, the University of Delaware collection held 14 specimens taken from all three Delaware counties. In the United States this species has now been reported for every state east of the Mississippi River except Georgia, New Hampshire, and Vermont.

NEW RECORDS: **Kent County,** Petersburg (label gave no specific site information or collector) 17 August 1961, 1 female; Rising Sun (at beach), D. MacCreary, 18 April 1962, 1 male; Viola (label gave no specific site information), W.A. Connell, 17 August 1964, 1 female. **New Castle County**, Newark (University of Delaware, Agriculture pools) R.W. Lake, 28 September 1976, 1 female; Newark (labels gave no specific site information), C. Bartlett, 2 September 1988, 2 males & 2 females and W.J. Williams, 21 April 1969, 1 female; Newark, Whiteclay Creek, M. D. Phipps, 17 November 1997, 2 males. **Sussex County,** Dewey Beach (at beach), W.A. Connell, 21 May 1960, 1 male & 1 female; Millsboro (tributary north of junction of 113 & 334) R.W.Lake, 19 July 1979, 1 female (all above in UDC).

Notonecta raleighi lunata: Twelve specimens of this species were identified from the University of Delaware collection. This species is fairly common throughout most of its range and is one of the few backswimmers that often occurs in habitats containing fish (Steve W. Chordas III, personal observations). No additional specimens of this species were discovered during our 1998 survey.

NEW RECORDS: **New Castle County**, Newark (label gave no specific site information), W.A. Connell, 27 August 1955, 1 male; Delaware City, Dragon Run, 21 October 1977, R. W. Lake & R. Weber, 4 males & 3 females; Lum's pond, C. Bartlett, 5 April 1990, 1 male & 1 female; Kirkwood (pond near C&D Canal) C. Bartlett, 26 September 1997, 1 female. **Sussex County,** Rehoboth Beach (label gave no specific site information or collector) 11 May 1968, 1 female (all above in UDC).

Notonecta uhleri: This species appears to be uncommon throughout its range and was the least anticipated backswimmer for Delaware. Two specimens were identified from the University of Delaware collection. We did not encounter this species during our 1998 survey and suspect that it is rare in the state.

NEW RECORDS: **New Castle County**, Delaware City, Dragon Run, 21 October 1977 R. W. Lake & R. Weber (UDC) 1 male; same site, 25 March 1982, F.C. Elia (UDC) 1 female.

Notonecta undulata: This species appears to be the most abundant and widespread backswimmer in Delaware and was collected in all three Delaware counties. The University of Delaware collection contained 29 specimens and we collected 22 specimens during our 1998 survey. This species was expected as it occurs in almost any lentic habitat and is common and widespread in the United States and Canada. Including Delaware, it has been reported from 39 of the 48 conterminous United States and from every province and territory in Canada except the Yukon.

NEW RECORDS: **Kent County,** Viola (label gave no specific site information), W.A. Connell, 17 August 1964 (UDC) 3 males & 6 females; Clayton (Twin Eagle), R. Mitchell, 31 July 1997 (UDC) 1 male; pond (near Symnera River/State Route 9 [N39.34 : W-75.54]) R.L. Stewart Jr., 25 July 1998 (SWACC) 3 males & 5 females. **New Castle County**, Newark (label gave no specific site information) R. Back, 25 April 1943, 3 males & 3 females and W.J. Williams, 21 April 1969, 1 female and W.A. Connell, 26 September 1968, 1 male (all UDC); Newark (University of Delaware, Agriculture pools) R.W. Lake, 28 September 1976 (UDC) 2 males & 3 females, and (U of D, pond; Townsend Hall) D. Hulbert , 6 September 1996, 1 female and (C&D canal) J. Fredericks, 26 September 1997, 1 male (both UDC); Delaware City (MEZulfle?), 15 July 1997 (UDC) 1 female; Crofton (pond, near junction of U.S. Route 40 and State Route 7 [N39.63 : W-75.65]) 1 male & 5 females and pond (junction of Limestone and Brackenville roads, E of State Route 41 [N39.76 : W-75.70]) 3 males & 5 females, R.L. Stewart Jr., 25 July 1998 (both SWACC). **Sussex County,** Selbyville (label gave no specific site information) W.A. Connell, July

1960 (UDC) 1 female; Redden (at Redden State Forest headquarters), T.A.R., 30 August 1994 (UDC) 1 male & 1 female.

In addition to these seven newly reported species, two additional *Buenoa* and two additional *Notonecta* species may occur in Delaware (Table 1). *Buenoa confusa* is a widespread species and is expected for Delaware; the other three species are either uncommon or southern, but eventually may be encountered in the State.

Table 1. Backswimmer species known or likely to occur in Delaware.

Genus	*Notonecta*	*Buenoa*
Species	*N. indica* Linnaeus, 1771 —	*B. confusa* Truxal, 1953
	N. insulata Kirby, 1837 **	
	N. irrorata Uhler, 1879 **	*B. limnocastoris* Hungerford, 1923
	N. petrunkevitchi Hutchinson, 1945 —	
	N. raleighi lunata Hungerford, 1926 **	*B. margaritacea* ** Torre-Bueno, 1908
	N. uhleri Kirkaldy, 1897 **	
	N. undulata Say, 1832 **	*B. scimitra* Bare, 1925 **

— = Species likely to occur in Delaware.
** = Species newly reported for Delaware.

ACKNOWLEDGMENTS

We thank Larry R. Fisher for collection assistance and the University of Delaware for providing museum specimens. We also thank David J. Horn and Foster F. Purrington (of the Department of Entomology at The Ohio State University, Columbus, Ohio) and two additional individuals for reviewing this manuscript.

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NEW TENNESSEE RECORDS FOR *WORMALDIA SHAWNEE*, *OLIGOSTOMIS OCELLIGERA*, *OLIGOSTOMIS PARDALIS*, AND *PYCNOPSYCHE ROSSI* (TRICHOPTERA)[1]

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ABSTRACT: Adults of the caddisflies *Pycnopsyche rossi* and *Wormaldia shawnee* were collected for the first time in Tennessee. Four adults of *Oligostomis ocelligera* were collected for the first time in Tennessee since April 1973. *Oligostomis* larvae, known from several cool streams in eastern Tennessee, represent *O. pardalis* based on a single female reared from a larva collected in Monroe County.

During an insect diversity survey (Lambdin et al. 2001) conducted from September 1997 to November 1998 on Arnold Air Force Base (AFB), a military reservation on the Barrens Plateau in middle Tennessee, adults of *Pycnopsyche rossi* Betten (Trichoptera: Limnephilidae) and *Wormaldia shawnee* (Ross) (Trichoptera: Philopotamidae) were collected for the first time in Tennessee. Also, *Oligostomis ocelligera* (Walker) (Trichoptera: Phryganeidae) was collected for the first time since 1973. *Oligostomis pardalis* (Walker), a species found primarily in the northeastern U. S., is recorded from Tennessee for the first time.

Pycnopsyche rossi Betten

One adult male *P. rossi* was collected from a light trap placed in a naturally-occurring grove of water tupelo, *Nyssa aquatica* L., in Coffee County, Tennessee, on 17 September 1998 (Lambdin et al. 2001). This collection represents a new state record. For decades *P. rossi* was known only from the type locality, McCann Spring, Wolf Lake, Union County, Illinois (Betten 1950). It recently was recorded from Indiana (Wojtowicz 1982) and from Arkansas and Missouri (Moulton and Stewart 1996). Records from Indiana and Illinois are associated with spring habitats (Betten 1950, Wojtowicz 1982). Moulton and Stewart (1996) indicated that *P. rossi* collected in the Ozark Mountains of Arkansas and Missouri were from similar habitats. The grove of water tupelo from which *P. rossi* was collected in Tennessee occurs in a topographic depression where standing water is found throughout most of the year. Although numerous seeps occur within or near other habitats sampled during our survey, conditions in the water tupelo grove may be the most conducive to

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the development of *P. rossi* larvae.

Of the 17 nominal species of *Pycnopsyche* (Wojtowicz 1982), all but *P. aglona* Ross and *P. scabripennis* (Rambur) are now recorded from Tennessee (Etnier et al. 1998).

Wormaldia shawnee (Ross)

One adult male *W. shawnee* was collected from a light trap placed on the banks of Sinking Pond in Coffee County, Tennessee, on 18 June 1998 (Vlach 1999). Sinking Pond is a large compound limestone sink and contains water, at varying levels, most of the year. The dominant plant species in the 155-hectare wetland, overcup oak (*Quercus lyrata* Walt.), is a major component of a plant community currently classified by the Tennessee Chapter of the Nature Conservancy as "G1", or critically globally imperiled (Grossman et al. 1998, The Nature Conservancy 1998). Records of habitat types of *W. shawnee* larvae include small springs and swift temporary streams (Ross 1944, Mathis and Bowles 1992). Thus, immatures of *W. shawnee* probably occur in shallow springs that feed Sinking Pond, or along seeps and drainages flowing into Sinking Pond.

This report is the first record of an adult *W. shawnee* collected in Tennessee. Subsequently, a single male was reared from a pupa collected in upper Wet Mill Creek, Clay County, 13 May 2000, that emerged on 21 May (J. D. Baxter and D. A. Etnier, unpublished data). The only other report of *W. shawnee* in Tennessee is from Edwards (1966), who listed it as a new state record based on two larval specimens collected in 1953, one from Davidson County and one from Macon County. Etnier and Schuster (1979) and Etnier et al. (1998) designated this record as "dubious" noting the larvae in question could represent *W. thyria* Denning.

Wormaldia shawnee was initially collected in Illinois and Kentucky, but since has been collected in ten states in the eastern U.S., including Alabama, Missouri, North Carolina, and Virginia (Ross 1938, 1944, Moulton and Stewart 1996). Two other species, *W. moesta* (Banks) and *W. thyria*, are reported from Tennessee (Etnier and Schuster 1979, Etnier et al. 1998).

Oligostomis ocelligera (Walker) and *O. pardalis* (Walker)

Four adult male *O. ocelligera* were collected on 7 April 1998. Two specimens were collected in flight, with an aerial net, in a drainage ditch bordering a managed pine stand in Franklin County, Tennessee. Two additional specimens were collected from a light trap placed in a riparian forest bordering Bradley Creek, Coffee County, Tennessee (Lambdin et al. 2001). The only previous record of *O. ocelligera* in Tennessee was a single male collected in Coffee County on 1 April 1973 (Etnier and Schuster 1979). Before its discovery in Tennessee, the southern-most known distribution of *O. ocelligera* was New Jersey. The only other North American species, *O. pardalis* (Walker), is primarily found in the northeastern U. S. (Wiggins 1996), with additional records from North Carolina (Brigham et al. 1982). Larvae believed to represent *O. pardalis* from large, cool streams in eastern Tennessee (Etnier et al. 1998) and western North Carolina have been confirmed as that species based on a female that emerged 1 June 2000 from one larva collected in Tellico River, Monroe County (C. R. Parker, personal communication).

All specimens of *P. rossi*, *W. shawnee*, *O. pardalis*, and two specimens of *O. ocelligera* are held in the Trichoptera collection of the Department of Ecology and Evolutionary Biology, The University of Tennessee. Two specimens of *O. ocelligera* are held in The University of Tennessee Insect Museum.

ACKNOWLEDGMENTS

Special thanks to Josh Vlach for collecting and processing material from Sinking Pond and to Ashley Morris, Derek Puckett, and Damon Bartley for assisting with collecting and processing specimens from other diversity survey sites. Many thanks to John Lamb and Geoff Call (ACS Conservation, Arnold AFB) for assistance with survey site selection and plant identification within those sites. We thank Steve Layman and Dale Jones (CHM2HILL) for assistance with development of the diversity survey. The survey was partially funded by a grant from The United States Air Force at Arnold Air Force Base through CH2MHILL. Larvae of *Oligostomis pardalis* were provided by Rick Bivens, Bart Carter, and Carl Williams of the Tennessee Wildlife Resources Agency and reared by Charles Parker.

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DYNAMICS OF THE MATING SYSTEM, SPERM TRANSFER, MIXING AND FERTILIZATION IN THE DUNG BEETLE, *APHODIUS ILLIGER* (COLEOPTERA: SCARABAEIDAE) IN KENYA[1]

Tohko Kaufmann[2]

ABSTRACT: The male of the dung beetle, *Aphodius illiger* (Illiger) produces a single spermatophore in its life and mates only once. The future of each male's sperm is secured, since they are transferred to the female's spermatheca during the very act of copulation. During this process, the male reproductive system becomes permanently damaged so that the male dies soon after mating,

The female of the species is not monogamous but mates with a few (2-5) different males whose sperm are thoroughly mixed in the spermatheca. The mixed spermatozoa then swim back from the spermatheca, via a long convoluted seminal duct, to fertilize a single egg in the vagina.

The entire development of this dung beetle takes place within cow dung. The incubation, larval, and pupal periods average 2, 21, and 7 days respectively. The beetles are nocturnal. Fifty-two percent of the population were males.

The dung beetle, *Aphodius illiger* was selected for this study because it was abundant and readily available. Two years of investigation revealed the complex but highly specialized nonpriority reproductive system of this species. The evolutionary history of this system is discussed.

MATERIALS AND METHODS

For the biological study, some 50 beetles were housed in an aquarium 30x50x25 cm, containing a pad of cow dung placed on a sandy soil which occupied the bottom of the aquarium. The dung was examined from time to time to study the developing egg, larvae and pupae. The nocturnal activities of the beetles were also observed in this setting.

The specimens were collected in the field where a herd of cattle fed and roamed near a bubbling well. This same site was used throughout the study. The collected specimens were immediately dissected under a stereo microscope to extract gonads which were then examined with a compound microscope. A total of 1,492 beetles (782 males and 710 females) were thus investigated from June 1995 to May, 1997.

RESULTS

Biology

The dung beetle, *Aphodius illiger* lays eggs in cow dung and the entire devel-

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ENT. NEWS 112(3): 191-199, May & June, 2001

opment from egg to adult takes place within the dung. The incubation period lasts 2-3 days; larval period, 20-22 days; and the pupal period, 6-8 days making a total of about a month. With frequent rain, a cow pad may keep moist for 30-40 days. Adults live for about one month.

The beetles use cow dung for feeding only. They dig small round holes beneath the dung and hide in them during the day when not feeding or sensing danger. Between 6 and 7 p.m. the insects appear from their hiding places to crawl, fly, and mate. Such activities continue throughout the night, and in cloudy and cool weather they may be active until 9 a.m. of the following day. In the field, the beetles were found in moist but not in fresh droppings. None was observed in sheep and goat feces in the same field. In the laboratory, they readily fed on cooked chicken, beef, and fish by burrowing into them as they do into the dung. Consequently, what they actually feed on in the wild may be bacteria, and fungi that occur abundantly in the cattle feces.

No periodicity was found either in male fecundity or in oviposition. This is probably due to the equable climate with rain occuring throughout the year in the equatorial region of Kenya. At least this was the case during the 2 years of this research. With a few exceptions, the percentages of ovipositing females were considerably greater than those of fecund males (Table 1).

Table 1: Numerical relationship between fecund males (males with sperm-filled spermatophores) and ovipositing females, in percentages.

Year	Month	% Fecund males ( ) no. examined	% Ovipositing females ( ) no. examined
1995	June	6 (17)	78 (11)
	July	20 (35)	43 (32)
	August	20 (25)	35 (23)
	September	13 (38)	15 (40)
	October	21 (33)	4 (50)
	November	3 (33)	13 (31)
	December	2 (43)	18 (34)
1996	January	4 (52)	8 (39)
	February	21 (42)	4 (41)
	March	29 (49)	46 (37)
	April	10 (42)	27 (35)
	May	8 (50)	6 (32)
	June	4 (23)	5 (22)
	July	14 (22)	19 (27)
	August	0 (30)	12 (25)
	September	0 (31)	44 (16)
	October	7 (30)	30 (33)
	November	17 (43)	42 (19)
	December	0 (28)	41 (22)
1997	January	6 (34)	63 (32)
	February	0 (20)	42 (26)
	March	15 (20)	42 (26)
	April	38 (24)	75 (12)
	May	50 (24)	46 (39)

Sex ratio differed monthly, but the overall ratio was 52% males, and 48% females.

Male system. The male reproductive system consists of a pair each of testicular follicles, vas deferens, and spine glands; 2 pairs of accessory glands; and a pumping system composed of 3 sections, namely: a muscular ejaculatory pump, a tubular midsection enveloped in a strongly chitinized spermatophore sheath, and a thin membranous spermatophore sac. The ejaculatory pump houses a spine sac with its tube, a sperm tube, and a spermatophore (Fig. 1A).

At emergence, there are 6-8 small testicular follicles on each side, unattached to gland 1. The spine sac is, in the beginning, a short, balloon-shaped organ floating in the ejaculatory pump (Fig. 1C). The spermataphore, too, looks different, consisting of 4 parts: a top membranous part, a dark scaly second part, the third part with longitudinal rows of spines, and the last part of a spiny tail (Fig. 1C). The sperm tube is empty at first; it is a thin, delicate, and segmented tube supplied with trachaeoles. One end of it is inserted into the mouth of the spermatophore, while the other end lies free near the mouth of the ejaculatory pump. As mentioned above, the spine sac, sperm tube, and spermatophore are all contained in the cavity of the ejaculatory pump at this stage. The spermatophore sac, the last part of the pumping system, is a thin membranous sac, the bottom of which is folded inward (Fig. 1A).

As a male matures, the small testicular follicles fuse to form 2 large and 2-3 small follicles all of which become embedded in gland 1 of each side. The anterior tip of the spine sac becomes connected to a pair of spine glands and the sac elongates posteriorly to form a spine tube which runs down the mid section of the pump along with the sperm tube and ends at the point where the spermatophore sac begins (Fig, 1B). The purpose of the spine sac is to supply spines to the spermatophore sac, especially to its front area which comes directly in contact with the vagina during mating. The spermatophore carrying the sperm tube leaves the ejaculatory pump at maturity and descends into the mid section of the pump inside the spermatophore sheath. This movement causes the free end of the sperm tube to be placed precisely at the narrow neck of the ejaculatory pump (Fig. 1B). Only at this position, sperm from the testes can enter the sperm tube and fill the spermatophore (Fig. 1B).

Female system. The female reproductive system of this beetle consists of 2 ovaries each with 5 ovarioles, a main oviduct, a vagina with a pair of chitin rimmed holes (Fig. 3a). Each ovariol ends in a tape-like germarium, the tip of which bears a terminal filament (Fig. 3a). The vagina is, like the ejaculatory pump of the male, muscular and functions as a pump. The spermatheca is equipped with a block of muscles to both its ends and a spermathecal gland (Fig. 3b).

Passage of sperm from testes to spermatophore sac. Since the testicular follicles are embedded in gland 1, the secretion of the gland presumably first mixes with sperm before passing into the vas deferens. The sperm then absorb

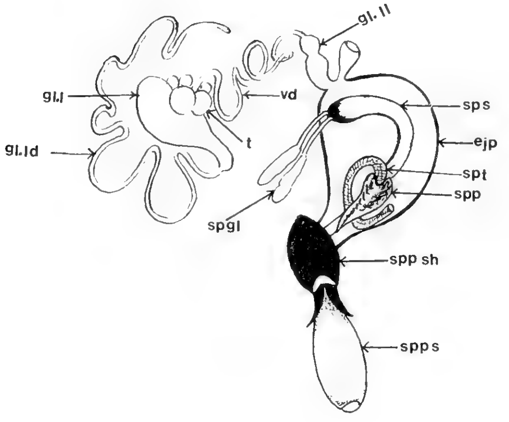

FiG. 1A

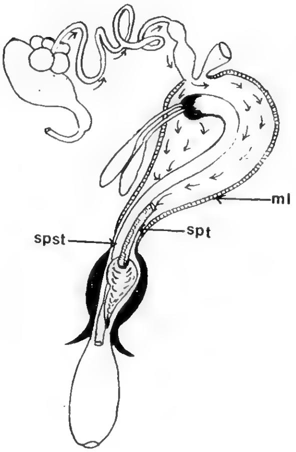

FiG. 1B

Fig. 1A. Male reproductive system: t, testes; vd, vas deferens; gl 1, accessory gland 1; gl 1d, accessory gland 1 duct; gl 11, accessory gland 11; sps, spine sac; spgl, spine gland; ejp, ejaculatory pump; spt, sperm tube; spp, spermatophore; spp sh, spermatore sheath; spps, spermatophore sac.

Fig. 1B. Passage of sperm from testes to spermatophore; ml, muscle layer of ejaculatory pump; spt, sperm tube; spst, spine sac tube.

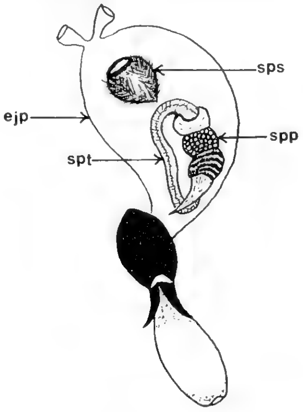

Fig. 1C. Ejaculatory pump in newly emerged male; ejp, ejaculatory pump; sps, spine sac; spp, spermatophore; spt, sperm tube.

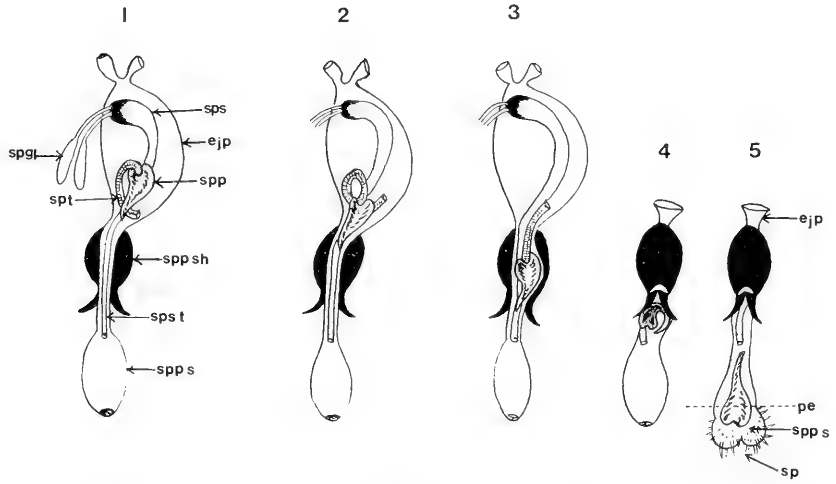

Fig. 2. Successive movements of spermatophore from ejaculatory pump to spermatophore sac. 1, in ejaculatory pump (letters in Fig. 1A and B); 2, descending; 3, in spermatophore sheath; 4, rotating; 5, in spermatophore sac; pe, position of posterior end of body; spp s, inflated spermatophore sac; sp, spine.

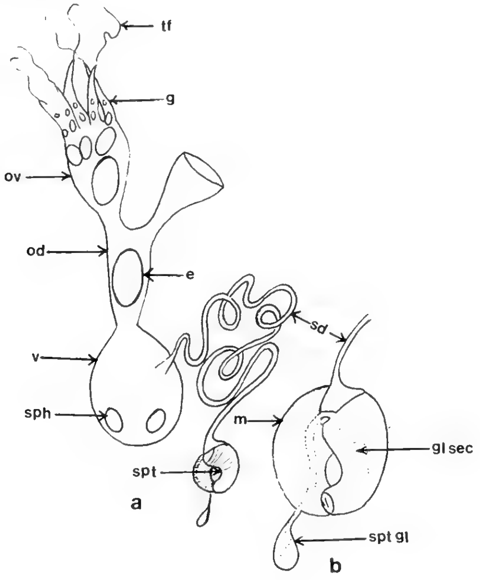

Fig. 3. Female reproductive system. a. Entire system: tf, terminal filament; g, germarium; ov, ovary; e, mature egg; od, main oviduct; v, vagina; sph, sperm hole; sd, seminal duct; spt, spermatheca. b. Spermatheca: m, muscle; gl sec, gland secretion; spt gl, spermathecal gland.

gland II secretion and enter the ejaculatory pump (Fig. 1B). The sperm at this stage are nonmotile and, therefore, the journey from the testes to the pump is affected by the pumping action of the muscular ejaculatory pump. From the pump, the sperm are further forced into the mouth of the sperm tube, situated at the neck of the pump (Fig. 1B, Fig. 2:3).

The sperm occur in bundles and from 2-10 such bundles were observed in the sperm tube entering the mouth of the spermatophore. Before leaving the spermatophore sheath, the sperm-filled spermatophore reverses its position by rotating 180° and finally settles in the spermatophore sac (Fig. 2:4, 5). At the same time, the sac becomes armed with chitinous spines from the spine sac, and is inflated by the pump to form 2 semi-circular lobes sticking out of the male's body, ready to be transferred to a female (Fig. 2:5).

Fig. 4 shows the process of mating. The long spines at the tip of the spermatophore sac first become attached to the muscular surface of the vagina (Fig. 4:1). A contraction of the ejaculatory pump then causes the thin walled spermatophore sac to burst open and partly envelops the vagina (Fig. 4:2). At the same time, it releases the spermatophore which adheres to the 2 sperm holes by its row of spines (Fig. 4:2). The pumping action of the muscular

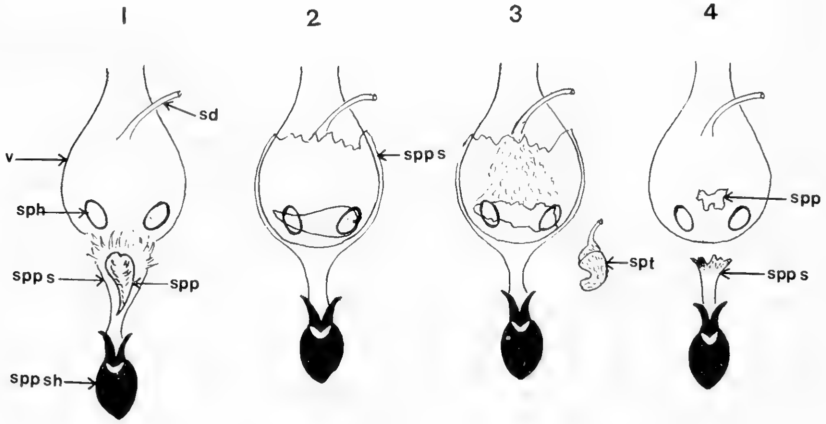

Fig. 4. Process of mating (schematic). 1, spermatophore sac attaches to vagina; 2, spermatophore sac envelops vagina and spermatophore attaches to sperm holes; 3, vagina sucks up sperm and sends them to spermatheca; 4, broken spermatophore sac withdrawn after mating (letters as in Fig. 3, Fig. 2:1).

vagina now sucks the sperm up from the spermatophore (Fig. 4:3). A few more contractions of the vagina send the sucked-in sperm to the spermatheca via the long seminal duct (Fig. 4:3). Under the microscope, before entering the spermatheca, the sperm are seen accumulating at the other end of the seminal duct where the duct widens considerably over the mouth of the spermatheca (Fig. 3:b, Fig. 4:3).

The empty and torn spermatophore sac is now withdrawn by the male (Fig. 4:4). Sometimes during this process, the empty spermatophore is removed along with the spermatophore sac. More frequently, however, the old spermatophore remains on the vaginal surface adjacent to the sperm holes as a piece of tiny wrinkled debris (Fig. 4:4).

Mixing and fertilization

The total number of eggs per female per oviposition period is 10.The eggs, however, do not mature simultaneously so that each ovary usually contains a single mature egg at a time which enters the main oviduct, then the vagina. Each female usually has two oviposition periods in her life time.

The spermatheca contains the sperm of 2-5 males. They are seen surrounding the gland secretion which occupies the center of the spermatheca as one mass (Fig. 3:b). The muscles of the spermatheca then mix the sperm thoroughly so that after mixing, the entire cavity of the spermatheca is homogenously filled with the sperm. Also at this time, the sperm become motile for the first time. The return journey to the vagina, therefore, depends on their own power of locomotion. Besides, while the muscular action of the vagina is powerful enough to propel the nonmotile sperm from the vagina to the spermatheca, the same cannot be done by the spermathecal muscles which are much smaller and weaker. The single egg in the vagina is quickly fertilized and just as quickly voided to be laid.

DISCUSSION

At emergence, the testes of this dung beetle already contain spermatozoa, yet the male is incapable of mating at this time. For the spermatophore has not attained either its final form or the position within the pumping system; the sperm tube is not located in the proper spot to receive sperm; and the spine sac is neither connected to the spine glands nor has developed its connecting tube. Likewise, testicular follicles are small, scattered, and often unattached to the glands. Thus, the male of this species requires a post-emergence development in order to function as an adult male. A similar but more drastic phenomenon occurs in the African carabid, *Pogonus rodolphi* Alluaud, in which a completely new organ system suddenly appears in the female shortly before oviposition (Kaufmann. 1993).

After mating, with the pumping system mutilated, the male soon dies. Since only a single spermatophore is produced in his life, this male beetle is monogamous. His sperm are well protected by the double sacs, each provided with attachment spines, and during the copulation, the sperm are rapidly drained from the spermatophore and immediately transferred to the spermatheca. Thus, the future safely of the sperm is guaranteed; no other male can remove and replace them with his own.

On the other hand, females are not monogamous; each mates with a few different males and their sperm are mixed in the spermatheca before fertilization. Before reaching the egg in the vagina, however, the competing spermatozoa must first pass through the long, looping seminal duct, Many insects possess similar or even longer seminal ducts, the meaning of which has often been discussed by various authors. In this species, I theorize that the duct serves as an arena for contesting spermatozoa which have just become motile shortly before the journey. The fastest and the strongest will fertilize the waiting egg in the vagina so that the genetic diversity and vitality of the species may be maintained.

To protect their own sperm to be used for fertilization, males of various insects practice different tactics. A mating plug is one; for instance, it is known that in *Apis mellifera* L., the male genitalia are detached and left inserted in the female's genital opening. The crippled drone soon dies after mating. Prolonged copulation for hours or even days is another; the praying mantis, *Mantis religiosa* L., is well known for this, with the male often consumed by his mate during the process (Fabre, 1910). A similar case is reported by Downes (1978) in some ceratopogonids. A safer tactic is contact or noncontact mate guarding practiced by dragonflies.

All these are not necessary if only each male's sperm are well protected from other males. Some insects have a simple large, sac-like spermatheca into which sperm from each male accumulate one after another in sequence so that the sperm of the last male are placed in the most favorable position to be used for fertilization. This is so-called "last in, first out" system, or male priority. Other insects have developed a specialized spermatheca provided with a mechanism by which stored sperm from a few different males can be throughly mixed before fertilization. In this nonpriority system, sperm from each male are given an equal chance.

The mating system of this dung beetle is a highly specialized and effective one, far more advanced than mating plugs, prolonged copulations or contact/noncontact mate guardings discussed above. One wonders how long it took to evolve such a complex and sophisticated system. One thing is certain; it must have gone through many twists and turns, and not via a simple and straight passage, as indicated by the complicated anatomy and the post-emergence development of the reproductive organs observed in this beetle.

In my studies over the past dozen years. I have examined 2 species of heterocerids (Kaufmann, 1988), 2 of carabids (Kaufmann, 1986, 1993), 1 of coccinellids (Kaufmann, 1996) and 1 of scarabaeids. Of these 6 randomly selected beetles, 5 were found to have specialized small spermathecae equipped with special muscles, capillary tubes, air pumps, or combination of muscles and pumps all of which function as effective mixers of sperm from a small number of different males. The mixed sperm fertilize from one to a dozen or more eggs at a time depending on the species. All these are nonpriority systems and seem to have evolved from priority systems (Kaufmann, 1993). Priority to nonpriority is a significant step toward genetic diversity and, I believe, is of prime importance in the survival of species.

ACKNOWLEDGMENT

The author wishes to express her appreciation to E. Stebnicka, Polish Academy of Sciences, for the identification of the *Aphodius* species.

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SCIENTIFIC NOTE

INTRODUCTION OF THE MILLIPED, *HELICORTHOMORPHA HOLSTII*, IN FLORIDA (POLYDESMIDA: PARADOXOSOMATIDAE)[1]

Rowland M. Shelley[2], G. B. Edwards[3]

In the continental United States, the milliped family Paradoxosomatidae is represented by four allochthonous species: *Oxidus gracilis* (C. L. Koch), occurring throughout the country and in Canada; *Asiomorpha coarctata* (Saussure), in Florida, Louisiana, and Texas; *Akamptogonus novarae* (Humbert and Saussure), in California; and *Chondromorpha xanthotricha* (Attems), in Texas (Shelley et al. 1998, Hoffman 1999, Shelley 2001).

A fifth species, *Helicorthomorpha holstii* (Pocock), was discovered on 19 September 2000 by Barbara J. Wilder and Anthony N. Capitano of the Florida Department of Agriculture and Consumer Services, Division of Plant Industry, in a heavily infested one-acre greenhouse. Numerous specimens were found in pots of sphagnum moss around *Catleya*, *Oncidium*, and *Phalaenopsis* orchid plants at Foxpoint Farms nursery in Clarcona, Orange County, Florida. The spagnum apparently came from the Okefenokee area of Florida/Georgia, while some of the orchids had been imported as small specimens from Taiwan (others were locally grown). The orchids were imported in a "bare root" condition, without substrate in which the millipeds could hide, causing us to wonder if eggs might have been on the plants.

This milliped is not reported from Taiwan, but it does occur in China, the Ryu-Kyu Islands, Viet Nam, and Hong Kong, in that part of the world; it has also been encountered in Toronto, Ontario, Canada, in association with a Bonsai plant from Hong Kong (Shelley and Lehtinen 1998). Whatever the origin of the infestation, it is quite heavy, and this nursery is shipping orchids throughout Florida thereby potentially spreading the millipeds. One *Phalaenopsis* that was sampled had 30 individuals in the associated sphagnum. Although not yet encountered outside the nursery, the likelihood that this will happen seems so high that we think *H. holstii* should be added to the Florida milliped fauna as detailed by Shelley (2000), bringing the total composition to 51 species. Voucher specimens have been deposited in the authors' institutional collections; diagnostic illustrations of *H. holstii* are available in Shelley and Lehtinen (1998, figs. 22-24).

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[1] Received and accepted January 5, 2001.

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[3] Florida State Collection of Arthropods, Division of Plant Industry, P. O. Box 147100, Gainesville, FL 32614-7100.

SYNOPSIS OF THE RIFFLE BEETLE GENUS *ZAITZEVIA* (COLEOPTERA: ELMIDAE) IN NORTH AMERICA, WITH DESCRIPTION OF A NEW SUBGENUS AND SPECIES[1]

Harley P. Brown[2]

ABSTRACT: *Zaitzevia* is represented in the Western Hemisphere by a rather variable species, *Z. parvula* which ranges from the Yukon of Canada southward to northernmost Mexico and from the Pacific coast eastward to the Black Hills of South Dakota and the Niobrara River of Nebraska. A new species from the Pacific Northwest, *Z. posthonia,* is sufficiently different from all other known species of *Zaitzevia* to merit erection of a new subgenus, *Suzevia.* The most distinctive feature of *Suzevia* is the form of the penis, which is basally swollen rather than slender and cylindrical.

Aquatic entomologists of eastern North America are familiar with *Macronychus* Muller which differs from all other eastern elmids in having short, 7-jointed antennae. *Macronychus* does not occur west of the Great Plains, but throughout much of that region, from northern Mexico far up into western Canada, a smaller member of the same short-horned tribe, *Zaitzevia* (Champion) is often abundant in foothill and mountain streams.

The genus *Zaitzevia* was created by Champion (1923), who characterized it thus: "Antennae extremely short, with 7 clearly separated joints and a stout elongate club, the latter formed by four fused joints, the sutures between them indistinct or invisible; prothorax with an abbreviated median sulcus and a longitudinal groove on each side of it posteriorly; elytra simply punctate-striate, the fifth interstice sometimes costate; body narrow, elongate, resembling that of *Esolus* in general facies; the other characters as in *Grouvellinus* (= *Microdes* Motsch.)."

When created, the genus included only the type-species *Z. solidicornis* and a second species *Z. acutangula,* both taken from the Himalayan foothills of northern India and described along with the genus. Since then, a number of species have been described from Japan and southeast Asia, but some of these have subsequently been split off into new genera such as *Paramacronychus* Nomura 1958, *Zaitzeviaria* Nomura 1961, and *Urumaelmis* Sato 1965. Ironically, the only feature now separating the genus *Zaitzevia* from these "daughter" genera was not even mentioned by Champion in his description of either the genus or the type-species: the elytra of *Zaitzevia* have granulate carinae on strial intervals 5, 7, and 8, but none on other intervals. A total of 18 species are presently known from Asia (Brown 1981).

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[1] Received October 23, 2000. Accepted December 10, 2000.

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ENT. NEWS 112(3): 201-211, May & June, 2001

In the Western Hemisphere, 3 species have been described which are assignable to *Zaitzevia:* (1) *Macronychus parvulus* Horn 1870, from Fort Tejon, California (south central Kern Co.), (2) *Elmis columbiensis* Angell 1892, from the Fraser River Valley of British Columbia, and (3) *Macronychus thermae* Hatch 1938, from a spring with a year-around temperature of ca 22° C, located at the mouth of Bridger Canyon near Bozeman, Gallatin Co., Montana. Hinton (1936) transferred *M. parvulus* to the genus *Zaitzevia.* Angell was obviously not familiar with Horn's species. Sanderson (1938) reported that Angell had apparently designated no type, but that comparison of the holotype of *Z. parvula* with a specimen from the type locality of *E. columbiensis* and determined as that species by Angell convinced him that *E. columbiensis* was a synonym of *Z. parvula.*

It appears from his paper that Hatch (1938), when he described *M. thermae,* was unfamiliar with *Z. parvula* except through Horn's description. The year after *M. thermae* was described, Hinton (1939) transferred it to the genus *Zaitzevia,* stating that it also appeared to be a synonym of *Z. parvula.* As noted from his determination labels, Sanderson in 1946 identified as *Z. parvula* a series of specimens collected by S. A. Forbes in 1891 from the type locality of *M. thermae* and closely resembling the type series of *M. thermae.* Surprisingly, however, Sanderson (1954, p. 11) listed *Z. columbiensis, Z. parvula,* and *Z. thermae* as presumably valid species, without comment and without citing his 1938 paper. Leech and Chandler (1956) obviously accepted Hinton's synonymy, for they used Hatch's figure of *M. thermae* to illustrate *Zaitzevia parvula* (their Fig. 13-54e). I included both *Z. parvula* and *Z. thermae* in my key (Brown 1972), separating them only on the basis of size and habitat, as gleaned from the literature.

Since 1972, however, I have had the opportunity to examine 13 of the 14 paratypes mentioned by Hatch, looking at the genitalia of two males and a female. The genitalia seem indistinguishable from those of *Z. parvula.* The only significant difference I noted between the two was in the body dimensions, most *Z. thermae* being perceptibly smaller than the average *Z. parvula.* Specimens of *Z. thermae* range from 1.8 to 2.2 mm in length and 0.7 to 0.8 mm in width, *Z. parvula* from 1.9 to 2.6 mm in length and 0.7 to 1.0 in width. The difference in width is related to the fact that in all specimens of *Z. thermae* the wings are reduced, whereas many or perhaps most specimens of *Z. parvula* have normal wings. Furthermore, I might point out that the features in which *Z. thermae* differs from *Z. parvula* are the same as those by which other elmids, such as *Microcylloepus,* inhabiting thermal springs differ from typical or normal members of their species. Unless consistent differences in the genitalia are demonstrable, or molecular or genetic evidence indicates otherwise, I am inclined to consider this facies an ecomorphic thermal syndrome and to question the taxonomic validity of such species. Light might be cast upon the problem by rearing larvae under controlled conditions to determine whether they might "change species" when reared under different temperatures or other environmental regimes. – experiments more easily suggested than accomplished. For the present, I shall treat *Z. thermae* as a subspecies, *Z. parvula thermae.* It is of interest that this taxon, whether it be *Z. thermae* or *Z. parvula thermae,* is appropriately listed by the U.S. Fish and Wildlife Service in Category C 1 (Candidate Taxon, Ready for Proposal) – as either endangered or threatened.

Adults of *Zaitzevia* from various localities may differ conspicuously in size and coloration. For example, the seven specimens I have from Alberta and Yukon are 2.1-2.4 mm long with piceous pronotum and rufotestaceous elytra and legs, as are the 22 I have from Nevada Co., California. In contrast, all specimens I have from Inyo and neighboring counties of California are 1.9-2.0 mm long with piceous pronotum and elytra and very dark legs. Specimens from other regions differ noticeably from either of these. In some areas, the individuals are far from uniform in appearance, their differences sometimes varying with the season but sometimes being noticeable within a single collection. In view of such diversity, it seems questionable whether we are dealing with but a single species. To investigate the matter, with the help of Susan Meyer Torrans, I examined several thousand specimens from more than 170 localities in the states of Arizona, California, Colorado, Idaho, Montana, Nebraska, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming, and the Canadian provinces of Alberta, British Columbia, and Yukon. The vast majority of specimens, though widely distributed and rather diverse in appearance, I tentatively consider as representatives of a single species, *Z. parvula,* with genitalia very much like those of all previously described species from Asia. The remaining specimens, from the Pacific Northwest, exhibit a strikingly different form of male genitalia and obviously represent a new species, described below. The genitalia are so different from those of all other known species that I also erect a new subgenus to include this new species.

Zaitzevia Champion 1923, nominate subgenus

Male with penis slender and cylindrical, tapering apically only beyond apices of appressed (and often imperceptible) parameres; last visible abdominal sternum of male about one third as wide at apex as at base (Figs. 7, 9).

Type of subgenus: *Zaitzevia (Zaitzevia) solidicornis* Champion 1923, from northern India.

Suzevia NEW SUBGENUS

Male with penis swollen in basal half, tapering apically from near middle of parameres; last visible abdominal sternum of male about half as wide at apex as at base (Figs. 8, 10).

Type of subgenus: *Zaitzevia (Suzevia) posthonia* NEW SPECIES, from northwestern United States and western Canada.

Etymology: The subgeneric name *Suzevia* is derived from an amalgamation of the name Susan plus the generic name *Zaitzevia,* and is feminine in gender. The new subgenus is named in honor of Susan Meyer Torrans, who assisted me in examining specimens of *Zaitzevia* from many different localities and who first noted the unusual aedeagus of the new species.

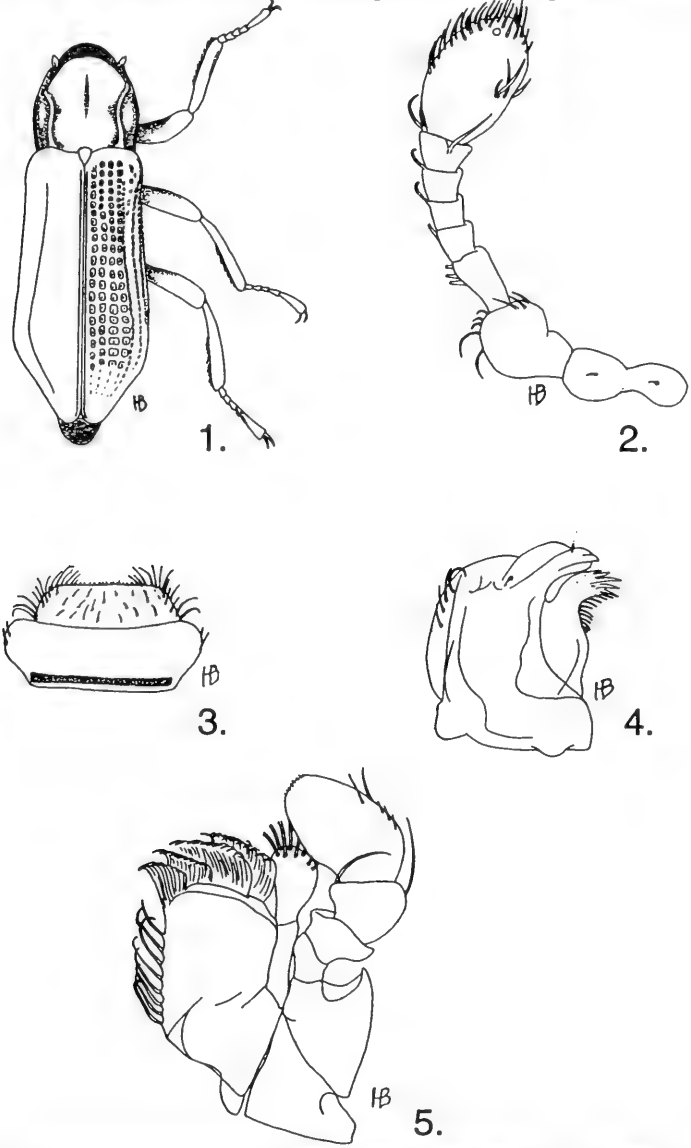


Fig. 1-5. *Zaitzevia (Suzevia) posthonia,* n.sp. 1. Male, dorsal aspect. 2. Antenna. 3. Clypeus and labrum. 4. Mandible. 5. Maxilla.

Zaitzevia (Suzevia) posthonia NEW SPECIES

(Figs. 1-5, 8, 10)

Holotype — Male (Fig. 1). Length, 2.4 mm from anterior margin of pronotum to elytral apex; width 0.9 mm.Body elongate, sides subparallel. Clothed inconspicuously with fine, short, decumbent, testaceous hairs. Cuticle shining, black on head, dark reddish brown on pronotum, testaceous on scutellum, elytra, and legs. Tomentum of elytra from strial interval 5 to margin pale golden

Head covered with silvery tomentum posterior to frontal suture; very feebly impressed along frontal suture. Eyes rather small. Antennae (Fig. 2) testaceous, shorter than width of head capsule, held close to eyes along their anterior and lower margins but with the apical segments directed dorsally or anterodorsally; segment 1 constricted medially, 2 more inflated apically than 1, 3 elongate and subconical, much more slender than 2, 4-7 short and subconical, 8 forming a terminal club with inner border bearing several setae near middle and outer border setose on apical 3/5. Clypeus (Fig. 3) black, with apical angles broadly rounded and apex feebly and broadly emarginate; surface sparsely setose. Labrum (Fig. 3) lighter in color, with apical angles broadly rounded and apical margin straight; surface rather densely setose with pale hairs. Mandible (Fig. 4) as figured, with 3 subacute apical teeth; outer margin with a row of bristles near middle; prostheca entirely membranous and rather densely spinose at apex and on mesial margin in apical half. Maxilla (Fig. 5) with palp 4-segmented; galea much smaller than lacinia, basally rather slender, with apex rounded, knob-like, and bearing a number of spines; lacinia rather broad and flattened, mesial margin bearing a row of spines with recurved tips, and apical margin with 4 overlapping rows of close-set curved setae. Labium with palpigers so well-developed as to make palps appear 4-segmented; terminal segment of each palp slightly longer than broad, with apex rounded subtruncate; apices of palps level with that of ligula; each paraglossa of ligula bearing an apical cluster of about 8 - 12 clavate setae.

Pronotum 0.7 mm long and 0.7 mm wide at broadest point near middle, 0.68 mm wide at base, 0.5 mm at apex. Apical margin as seen from above arcuate at middle, sinuate on each side behind eye before apical angle; apical angles acute but very little produced; sides very feebly sinuate at base, then feebly arcuate to apex; lateral margins feebly crenate; posterior angles subacute, almost rectangular, not produced; basal margin arcuately emarginate on each side and feebly emarginate at middle before scutellum. Median sulcus distinct but shallow, 0.05 mm wide and extending from basal 2/5 to ca apical 1/6. Sublateral carinae extending directly forward from base, then feebly and sinuously first toward midline then toward lateral margin, and ending just beyond middle. With a shallow, opaque (tomentose?) depression along mesial edge of each carina. Lateral borders of pronotum feebly margined. Surface of disk smooth, shining, with shallow punctae separated by several times their own width.

Elytra twice as long as broad (1.8:0.9mm), barely wider than pronotum at base (0.75 mm across humeri), widest at apical 2/5. Elytral apices separately rounded. Lateral and apical margins almost imperceptibly serrate and not at all explanate. Each elytron with 7 apparent longitudinal rows of strial punctures, those on disk being coarse in basal half but becoming finer and virtually obsolete toward apex. There appear to have been 9 striae originally, but 5 and 6 are completely fused, obliterating interval 6, and striae 8 and 9 are almost completely fused. Strial intervals 1-4 (counting the sutural interval as 1) are flat, each bearing a longitudinal row of fine, pale, recumbent hairs. Strial interval 5 bears a low, granular carina composed of ca 35-45 obliquely overlapping scales or elongate granules beginning shortly beyond the base and extending almost to the apex. Similar carinae on intervals 6 and 7 (original intervals 7 and 8) are confluent at base and extend beyond apical declivity. For most of their length, the 3 carinae are parallel to each other, the middle one equidistant from each of the others. Surface of disk smooth, shining, and without tubercles. Sericeous tomentum (plastron) covers the lateral portion of elytron from interval 5 to margin.

Hind wing rudimentary, nonfunctional (If alate specimens turn up, we may expect that such individuals will also exhibit more prominent elytral humeri and elytral striae and strial intervals not quite as described above, because this is the case with *Z. parvula* and with *Macronychus glabratus.)*

Scutellum flat, 0.15 mm long and 0.12 mm wide, with base and sides arcuate, apex acute; color and texture like elytra.

Prosternum with process 0.22 mm long, shorter than length of prosternum anterior to coxae (0.29 mm), subacute at apex, shallowly excavated medially; surface covered with scaly tomentum except on process.

Mesosternum medially excavated to accommodate prosternal process, very short; length between procoxa and mesocoxa only about 1/8 as long as length of metasternum between mesocoxa and metacoxa.

Metasternum transverse, subrectangular, with shallow median longitudinal sulcus extending from level of hind margins of mesocoxae to posterior border of segment and intersecting a bisinuate transverse groove near posterior margin; depressed medially between both mesocoxae and metacoxae; disk feebly convex; posterior margin flanged and grooved medially to accommodate anterior process of first abdominal sternum; surface rather smooth, without noticeable punctae or granules, sides silvery with sericeous tomentum (plastron).

Abdomen 1.2 mm long, 0.8 mm wide at base and slightly wider at level of segment 2; Sternum 1 with median process campanulate or pentagonal, the anterior angles and apex being rounded, broadly and shallowly depressed, raised lateral borders arising between metacoxae and extending obliquely to posterior margin of sternum. Sternum 2 shorter than 1 but longer than 3, 4 subequal to 3, 5 longest and appearing to be composed of 2 fused segments. Sternum 5, which is the terminal segment, has the apex about half as broad as the widest portion near base, and is broadly truncate with angles broadly rounded and apex very feebly and broadly emarginate. All sterna with surface smooth, without noticeable punctation or granules, covered with silvery tomentum except on median 1/3 or 1/4.

Legs each with conspicuous tomentum on inner margin of tibia; femora of front legs somewhat more robust than those of other legs; tarsi slightly shorter than tibiae, not especially large, with claws not unusually large or hooked; surfaces of legs smooth, not granulate; without noticeable secondary sexual characters.

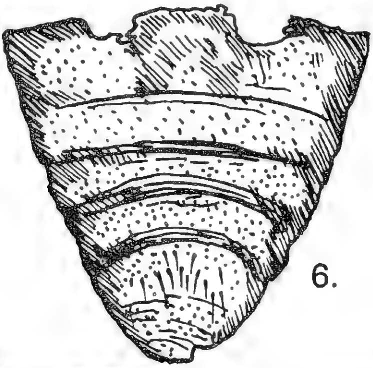
Genitalia (Fig. 10) as figured, total length 1.28 mm, penis 0.92 mm long, 0.25 - 0.30 mm wide, teardrop-shaped with apex subacute; parameres 0.65 mm long, normally closely appressed to sides of penis, very slender, with apices acute and bearing 4 - 10 erect subapical hairs or spines on inner surface; basal piece 0.47 - 0.51 mm long and 0.20 - 0.25 mm wide; internal sac composed of 2 rather large elongate bladders in basal half of penis which communicate medially with a third chamber that extends to the subapical aperture, apparently without hooks or spines.

Variations. Among 50 pinned specimens taken from a dozen different sites, length from anterior margin of thorax to elytral apex ranged from 2.2 to 2.5 mm, maximum width from 0.81 to 0.92 mm. In a few individuals the pronotum was almost as light in color as the elytra and in a few it was almost black; in many the legs were intermediate in color between pronotum and elytra. The sculpturing of the pronotum varied perceptibly in both depth and extent; in one specimen the median sulcus almost reached the base or posterior margin.

Female. Like male but with apex of abdomen much narrower than that of male and more rounded. In some specimens (e.g., those from near Yakima, WA) the posterior margin of each elytron is apparently perforated near the apex, providing a small circular aperture through which the stylus of the genitalia may protrude.

Types. Holotype male: U.S.A.: Oregon: Union Co., McCoy Creek, Starkey Exp. F., 9/VII/74, Meehan. Deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. Also deposited with the holotype and bearing the same data are Allotype female and 2 paratypes of each sex. A total of 20 additional paratypes bearing the same data as the type plus 38 papatypes bearing the following data: OR: Benton Co., Oak Creak 6 mi. NW Corvallis, drift VI/69, Norman H. Anderson, will be deposited in the following collections: The Natural History Museum (London); Canadian National Collection, Ottawa; California Academy of Sciences, San Francisco; Oregon State University, Corvallis; Sam Noble Oklahoma Museum of Natural History (formerly Stovall Museum), Norman; Essig Museum of Entomology at University of California, Berkeley; James Entomological Collection at Washington State University, Pullman; and William D. Shepard Collection, Sacramento.

Other adult specimens examined include the following: from Canada: B.C.: Okanagan Lake, 5/VIII/56, B.F. & J.L. Carr — 1; B.C.: Nine Mile Crk. W of Anarchist Pass on Hwy 3, 7/VII/85, H.P. Brown — 6; from the U.S.A.: CA: Siskiyou Co., Little Shasta River 24/VIII/84, R. Wisseman — 3; CA: Tehama Co., Chico Crk. N Forest Glen, 21/VI/85, H.P. Brown — 1, ID: Benewah Co., SE St. Maries, trib. of St. Joe River beside Hwy 3, 9/VII/85, H.P. Brown — 27; ID: Clearwater Co., Bob's Crk. 5.9 mi ENE Bovill, 3/VI/86, R.S. Zack —2; ID: Idaho Co., O'Hara Crk., 21/VII.71, S.E. Lowell — 1; OR: Benton Co., Berry Crk., 3/IV/85, N. Anderson — 1; OR: Benton Co., Oak Crk. 14/V/38, S.G. Jewett, Jr. — 1;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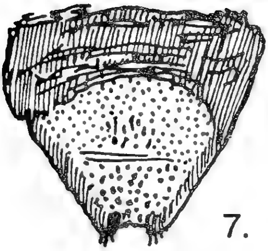
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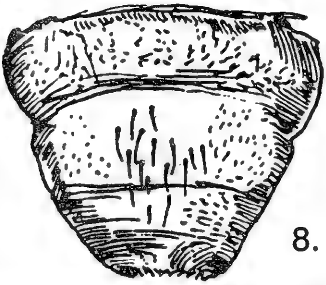
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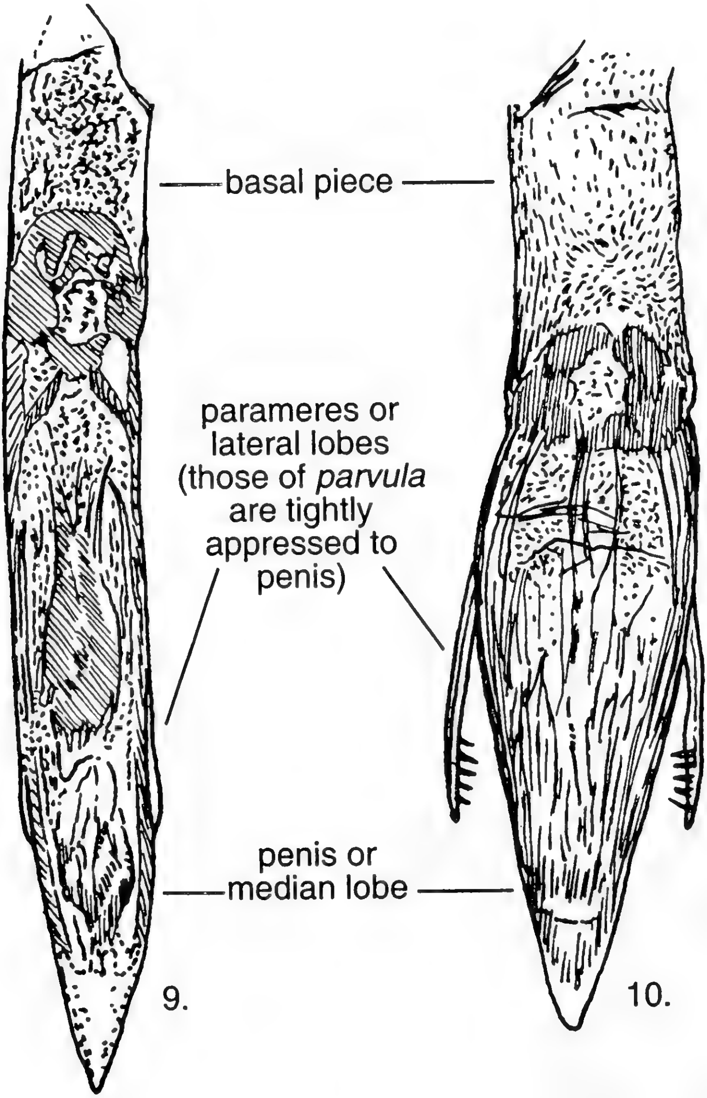
Fig. 6. *Zaitzevia parvula,* ventral aspect of female abdomen. Figs. 7 & 8. Ventral aspect of abdominal sternites 4 and 5 of males: 7, *Z. parvula;* 8. *Z.* (Suzevia) *posthonia,* n.sp.



Figs. 9 & 10. Male genitalia (aedeagi): 9. *Zaitzevia parvula* 10. *Zaitzevia (Suzevia) posthonia,* n.sp.

OR: Benton Co., Tobe Crk., 4/IX/84, R. Wisseman — 8; OR: Benton Co., Rock Crk. 4 mi SW Philomath, 27/VI/85, P. Spangler — 13; OR: Benton Co., Yew Crk. 24/IV/82, G.W. Courtney — 1; OR: Clatsop Co., Lewis & Clark River, 1/VII/85, H.P. Brown — 18; OR: Columbia Co., Merrill Cr., 17/VII/84, R. Wisseman — 5; OR: Crook Co., Canyon Crk., 30/VII/75, R.A. Miller— 1; OR: Crook Co., Ochoco Crk., 26/VII/74, R.A. Miller — 3; same but 2/X/75, R.A. Miller — I; and 21/X/76, R.A. Miller — 1; OR: Durkee, 13/VI/47, M.W. Sanderson — 1; OR: Grant Co., EF Canyon Crk., 29/VIII/84, R. Wisseman — 5; OR: Lake Co., Long Cr,., 14/ VIII/84, R. Wisseman — 1; OR: Lane Co., Mill Crk. 17/VII/78, T.L. Dudley? — 2; OR: Lincoln Co., Trap Crk. 8 mi. W Eddyville, 25/VI/85, P.J. Spangler — 1; OR: Linn Co., ditch by airfield at Albany, 28/VI/85, P.J. Spangler — 1; OR: Union Co., Meadow Crk., 23/VII/74, Meehan — 1 and 7/VII/75, Meehan — 1; WA: Pacific Co., Middle Fork of Nemah River at Hwy 101, 1/VII/85. H.P. Brown — 37; WA: Whatcom Co., Bell Crk. at Hwy 542 S of Kendall, 4/VII/85, H.P. Brown — 8; WA: Yakima Co., 8 mi SW Tieton RS, Bear Crk., Snoqualmie NF, 11-12/VI/73, D. Corredor — 17.

Etymology. Since the most distinctive feature of this species is the basally swollen penis of the male, it seems quite appropriate that the specific epithet be *posthonia,* derived from the Greek word *posthon* which means "one with a large or broad penis." (See p. 627 of R.W. Brown, 1956.)

Habitat. The new species occurs in gravelly creeks and rivers from lowlands to rather high elevations, typically in clean riffles, often beneath cobbles or boulders. In my limited experience, it has most often been accompanied by such fellow elmids as *Narpus, Zaitzevia, Optioservus* and *Heterlimnius*, less often by *Cleptelmis, Lara, Ordobrevia* and *Ampumixis.*

Diagnosis. Within the beetle family Elmidae, this new species will key to the genus *Zaitzevia* Champion 1923 in the adult keys to genera by Sanderson (1953, p. 154), Leech and Chandler (1956, p. 361), Leech and Sanderson (1959, p. 1005), Arnett (1963, p. 476), Hatch (1965, p. 7), and Brown (1972, p. 28). These may be abbreviated in the following key covering known elmids of North America.

1. Antennae with fewer than 9 segments 2
1a. Antennae with more than 9 segments .... all other species of elmids
2. Antennae with 7 segments; pronotum without median impression; on wood in streams east of the Rockies.................. *Macronychus glabratus* Say 1825
2a. Antennae with 8 segments; pronotum with median longitudinal impression; in gravely or rocky montane western streams 3
3. Male with terminal abdominal sternum as in Fig. 7, pimply and rather narrowly biconic at apex; aedeagus as in Fig. 9, slender and cylindrical, with parameres tightly appressed to penis .... *Zaitzevia parvula* (Horn) 1870
3a. Male with terminal abdominal sternum as in Fig. 8, not conspicuously pimply and rather broadly rounded at apex; aedeagus as in Fig. 10, relatively robust, with penis swollen basally and parameres relatively conspicuous .... *Zaitzevia (Suzevia) posthonia* Brown NEW SPECIES

The terminal abdominal sternum of females of both of the above species is rounded apically as in Fig. 6, so how do I determine the species of a female specimen? Assuming that the males choose mates of their own species, I consider females taken in copulo as belonging to the species of their mates. Fortunately, both *Z. parvula* and members of the new species are frequently taken in copulo. As for the identity of unattached females, I am presently uncertain.

ACKNOWLEDGMENTS

My sincere thanks to Cheryl Barr, University of California, Berkeley, and Bill Shepard, California State University, Sacramento, for their critical reading of this manuscript and their constructive suggestions. The citizens of Birmingham, Alabama appreciate Richard Arrington for his 20 years of service as their mayor, but I add my appreciation for his thorough treatment of such riffle beetles as *Zaitzevia parvula* in his dissertation (Arrington 1966).

The members of the Zoology Department here at the University of Oklahoma are blessed in having the services of Coral McCallister to assist with illustrations, and we bless her.

And genuine thanks are certainly due to those who have provided specimens which I have examined for this study: N.H. Anderson, Oregon State University, Corvallis; M. Brusven, University of Idaho, Moscow; California Academy of Sciences, San Francisco; Canadian National Collection of Insects, Ottawa, Ontario; Carnegie Museum of Natural History, Pittsburgh, Pennsylvania; B.F. and J.L. Carr, Calgary, Alberta; W.H. Clark, Boise, Idaho; S. Frommer, University of California, Riverside; Harvard Museum of Comparative Zoology, Cambridge, Massachusetts; L. LeSage, Biosystematics Research Center, Ottawa, Ontario; R.A. Miller, Corvallis, Oregon; G. Peters, Corvallis, Oregon; M.W. Sanderson, Illinois Natural History Survey, Champaign; P.J. Spangler, National Museum of Natural History, Washington, D.C.; C.M.F. von Hayek, Museum of Natural History, London, England; R. Wisseman, Corvallis, Oregon; R.S. Zack, Washington State University, Pullman.

And special apologies to all whom I provided the names *Suzevia* or *Zaitzevia chandleri* or *Z. milleri,* which are now nomina nuda, the valid name now being *Zaitzevia (Suzevia) posthonia* Brown.

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CORRUGATED CARDBOARD TRAPPING FOR LITTER INHABITING SPIDERS AND OTHER ARTHROPODS[1]

Bruce Cutler[2]

ABSTRACT: A method for collecting litter inhabiting arthropods that utilizes strips of corrugated cardboard is described. Invertebrates of diverse phyla were collected, including 12 orders of insects and 3 orders of arachnids. Numerous spiders representing 13 families were collected (Table 1). Trends in monthly usage of traps by spiders were evident during a one year trapping period; abundance peaks were observed in spring and autumn.

There are numerous methods for trapping ground and litter-dwelling arthropods listed in the scientific literature; two extensive compilations are by Martin (1977) and by Peterson (1959). Corrugated cardboard has been used to trap arthropods in other habitats, such as tree trunks (Curtis & Morgan, 1974; Duffey, 1969) and tree crotches (Fye, 1985).

This paper describes a new method of intentional increased cover deposition by depositing strips of corrugated cardboard in ground litter. The method is easy, inexpensive, and effective for trapping certain taxa.

METHODS

Untreated corrugated cardboard from shipping boxes was used. The corrugations (semicircles) were spaced approximately 4.75 mm apart, and were about 2.50 mm high. Different size corrugations are made to accommodate different shipping needs, and may be available from paper manufacturers. The size used was that which was the most readily available from common shipping cartons. Strips about 4 cm. wide and 20 cm. long were cut across the corrugations with a sharp single edge razor blade. It is important that the cutting tool has sharp edges, as the strips should have clean uncrimped edges. Scissors do not work well because they compress the edges.

In 1998-1999 cut ~30 strips of cardboard were set out monthly within the top layers of leaf litter along the borders of a residential backyard (area = ~500 sq m) near the University of Kansas campus in Lawrence, Douglas Co., Kansas, U.S.A.. The original vegetation at this site was tall grass prairie (Lauver, 1989). Currently, the yard consists of a turf grass lawn and accompanying weeds, a large honey locust tree (*Gleditsia triacanthos* L.), two small ornamental apple trees (*Malus* sp.), a vegetable garden, and a larger area of restored prairie. The south, west, and north borders of the yard have a mixture of native forbs (*e.g.*

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ENT. NEWS 112(3): 212-216, May & June, 2001

Eupatorium rugosum Houtt., *Polygonum virginianum* L.); native and introduced shrubs and small trees (*eg. Celtis occidentalis* L., *Lonicera* spp., *Morus rubra* L., *Rosa* spp.); and introduced grasses. Another honey locust tree is near the middle of the south side. The south and west borders have wooden fences; the north side, a wire fence that separates the yard from an adjacent yard. In general, the surrounding yards are similar with mature trees, shrubs, lawns and gardens. Plant names are based on Brooks, 1986.

Exact distances were not set between traps; instead trap deployment was dependent on availability of litter. The approximate number of cardboard strips used biweekly was 30. For inspection and retrieval of organisms strips were picked off the ground and held up to the sky so that light would shine through the corrugations, this enabled the observer to see which corrugations were occupied. Animals from the traps were harvested by inserting a flexible twig into one end of the appropriate corrugation, while holding the other end over a vial and slowly forcing the occupant out. It is important not to use too hard a poking tool (e. g. metal wire or rod), and not too rapid a motion, because both an improper tool and rapid expulsion may crush the occupant. Only arthropods found within corrugations were recorded, not those found on or under the traps. My interest is specifically in spiders, and for this group I kept precise counts of individuals and species.

RESULTS

Numerous arthropods were collected from the traps over the course of a year. The following phyla and classes were found: Nematoda; Annelida - Oligochaeta; Mollusca - Gastropoda; Arthropoda – Arachnida, Chilopoda, Crustacea, Insecta, Diplopoda. The following insect orders were taken: Collembola, Orthoptera, Isoptera, Psocoptera, Thysanoptera, Homoptera, Hemiptera, Coleoptera, Neuroptera, Lepidoptera, Diptera and Hymenoptera. Within the Insecta, Collembola, Isoptera, Coleoptera, and Hymenoptera were the most common, although precise numbers were not kept. During wet weather, isopod crustaceans were abundant, often a hundred or more in each cardboard strip. Although counts were not made, isopods were easily the most common individuals that utilized the strips, especially evident when the strips were wet. Traps with large numbers of isopods rarely had any other arthropods in them except for Collembola. This was probably more a result of the wet physical condition of the traps rather than the presence of the isopods themselves. Infestation of traps by termites and ants seemed to reduce numbers of other arthropods, but only in the immediate vicinity of ant/termite occurrence. In parts of the strip distant from the infested area, one often found other arthropods.

Three orders of arachnids occurred in the strips: Acari, Araneae and Opiliones.

The spider families and their percentage representation in the Kansas cardboard strips are summarized in Table 1. Total spiders captured each month are shown in Figure 1. Seasonal trends in trap occupancy by spiders also were evident; usage peaks were noted during spring (April-May) and autumn (September-November) months. The peak in the spring may represent increased activity following winter diapause, and the peak in autumn representing arboreal spiders, particularly clubionids and anyphaenids, moving into the litter for overwinterng (Duffey, 1969). Diversity within spider families was low and

Table 1. Spiders caught in cardboard strips in Lawrence, Kansas, 1998 - 1999. Immature specimens marked with an asterisk were determined to species by rearing, unique coloration, or unique occurrence within the genus in this region; m = male, f = female, i = immature. Numbers following family name are the total number of specimens for that family and the percentage of all specimens captured (N = 759).

Anyphaenidae - 13, 2%	
Anyphaena sp.	5 i
Hibana gracilis (Hentz)*	5 i
Wulfila saltabunda (Hentz)*	3 i
Clubionidae - 262, 35%	
Clubiona abboti L. Koch	34 m, 82 f
Clubiona sp.	125 i
Elaver excepta (L. Koch)*	21 i
Corinnidae - 170, 22%	
Castianeira variata Gertsch*	1 m
Castianeira sp.	114 i
Meriola decepta Banks	8 m, 22 f, 22 i
Trachelas tranquillus (Hentz)	1 m, 2 i
Gnaphosidae - 107, 14%	
Callilepis imbecilla (Keyserling)	3 f
Drassylus aprilinus (Banks)	1 m, 1 f
Drassylus sp.	1 f
Herpyllus ecclesiasticus Hentz*	2 i
Sergiolus ocellatus (Walckenaer)*	2 i
Gnaphosidae	97 i
Linyphiidae *sensu lato* - 6, 1%	
Lepthyphantes sp.	1 f
Linyphiidae	5 i
Liocranidae - 105, 14%	
Phrurotimpus alarius (Hentz)	6 m, 3 f
Phrurotimpus borealis (Emerton)	1 m
Phrurotimpus sp.	18 i
Scotinella fratrella (Gertsch)	1 f
Scotinella pugnata (Emerton)	2 f
Scotinella redempta (Gertsch)	1 f
Scotinella sp.	18 i
Liocranidae	55 i
Lycosidae -25 - 3%	
Pirata sp.	1 f
Lycosidae	24 i
Miturgidae - 2, >1%	
Cheiracanthium sp.	2 i
Nesticidae - 1, >1%	
Eidmanella pallida (Emerton)*	1 i
Philodromidae - 2, >1%	
Philodromus sp.	2 i
Salticidae - 33, 4%	
Eris aurantia (Lucas)*	3 i
Habrocestum pulex (Hentz)	2 f
Hentzia sp.	2 i
Mevia inclemens (Walckenaer)*	1 i
Marpissa lineata (C. L. Koch)	1 m, 6 f, 8 i
Phidippus audax (Hentz)*	1 i
Phidippus clarus Keyserling*	1 i
Phidippus sp.	4 i
Sitticus concolor (Banks)*	1 i
Synageles bishopi Cutler	1 m
Talavera minuta (Banks)	1 i
Tutelina elegans (Hentz)	1 i
Theridiidae - 32, 4%	
Crustulina sp.	2 i
Euryopis funebris (Hentz)	2 m, 1 f, 20 i
Steatoda sp.	1 i
Theridion sp.	1 i
Theridiidae	5 i
Thomisidae - 1, >1%	
Xysticus sp.	1 i

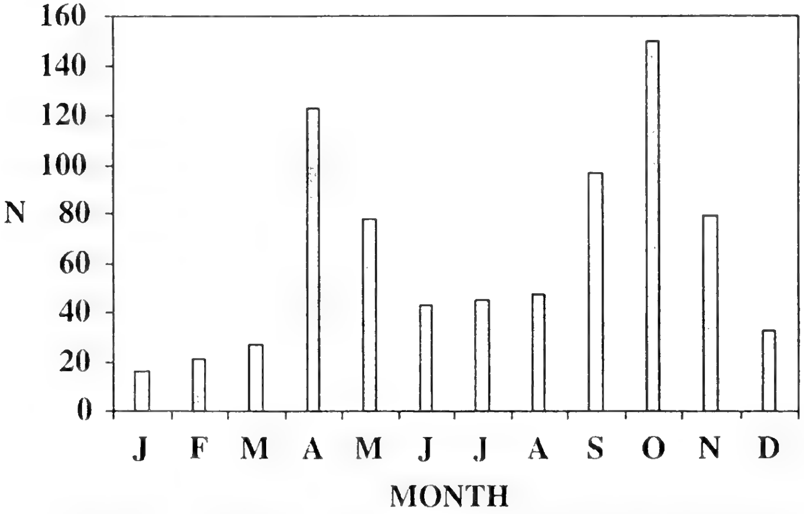

Fig. 1. Total number of spiders collected per month, by corrugated cardboard strips (~30 strips/month) placed in a residential backyard in Lawrence, Kansas, where N = 759.

complicated by numbers of immatures that often could not be determined to species (Table 1). Where species could be determined, the Salticidae were represented by 11 determined species, no more than 5 determined species were noted in any other family. Note that traps were successful even during the winter.

A few strips disappeared during the course of the study. The reasons for such disappearances are unknown, this was not a problem of relocating previously laid down strips.

DISCUSSION

This method of trapping arthropods is very simple. Furthermore, the cardboard strips are environmentally friendly. Strips that are forgotten continue to function as shelters for insects and spiders, and decay over time. Trap construction also is very simple; however, harvesting the material from the traps can be tedious. The advantages of using cardboard strip traps are: the traps are very inexpensive and easy to make, the material is readily available, they are easy to put in place, traps degrade readily and are nontoxic, the traps harvest live specimens which are selected by size and taxon. The main disavantages are: it is time consuming to harvest specimens, traps are useless when wet for most taxa, the traps harvest live specimens which are selected by size and taxon. Notice that the last item appears in both columns because it may be either advantageous or disadvantageous. It has been suggested that placing the strips in a Berlese funnel would allow for more efficient harvest of the specimens in the strips (Susan Riechert, personal comm.).

ACKNOWLEDGMENTS

I thank D. T. Jennings, USDA, Forest Service (ret.) for providing references on the use of corrugated cardboard for trapping arboreal arthropods, and providing important suggestions for improvement after reviewing the manuscript; H. Guarisco, Kansas Biological Survey, and two anonymous reviewers also provided a critical review of the manuscript.

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A NEW FLIGHT-INTERCEPTION TRAP FOR ARTHROPOD SAMPLING[1]

C. A. Dobony, J. W. Edwards[2]

ABSTRACT: We designed a flight-interception trap to assess arthropod abundance and biomass as part of a ruffed grouse study. Traps were constructed of acrylic plexi-glass, relatively inexpensive, and durable. Our design was simple and efficacious in sampling airborne insects and some terrestrials. We captured multiple orders, with several families within most orders.

Arthropod abundance and biomass can be estimated by many different methods (Byerly et al. 1978, Southwood 1978, Bechinski and Pedigo 1982, Ellington et al. 1984, Schotzko and O'Keeffe 1986, Cooper and Whitmore 1990). Factors to consider when choosing a sampling method include the ability of certain insects to cling to vegetation, inclement weather, precipitation, and even the presence of morning dew, as these factors may influence the efficacy of a particular sampling method. In addition to environmental factors, frequency of sampling and observer bias must also be considered when choosing a method.

As part of a ruffed grouse (*Bonasa umbellus*) ecology study, we wanted to obtain data on flying insect populations in different forest cover types. Because of our need to sample daily and under all weather conditions, traditional methods (sweepnet, vacuum sampling) were not practical. Consequently, we developed a flight-interception trap modified from Nijholt and Chapman (1968) and Masner and Goulet (1981) that served our purpose.

Constructed of acrylic plexi-glass (0.20 cm thickness), our trap was approximately 31 cm in height and width (Fig 1.). Each trap consisted of four 31 x 31 cm panels. The first panel served as a base and had four 7.6 x 31 cm sides attached, which formed a reservoir to hold the fixing and preserving agent (5-10% formalin). Two panels were placed on the base and intersected medially to form the "trap" and to provide stability. The remaining panel was placed on top of the intersecting panels to serve as a rain guard. Panels were glued together and sealed using a combination of all-purpose construction adhesive and silicon caulk.The cost of materials to construct one of our flight traps was approximately $7.30 (1998 U.S. dollars).

Our design was used to assess relative abundance, biomass, and family richness of flying insects among cover types. Traps were placed directly on the ground within existing vegetation. We checked traps 5 times each week from 25 May to 5 July 1998. With proper care and handling, we found traps

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[1] Received August 4, 2000. Accepted December 13, 2000.

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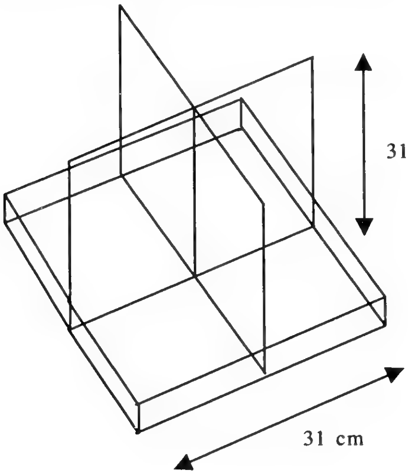
Flight-interception trap with no rain-guard



Flight-interception trap with rain-guard top

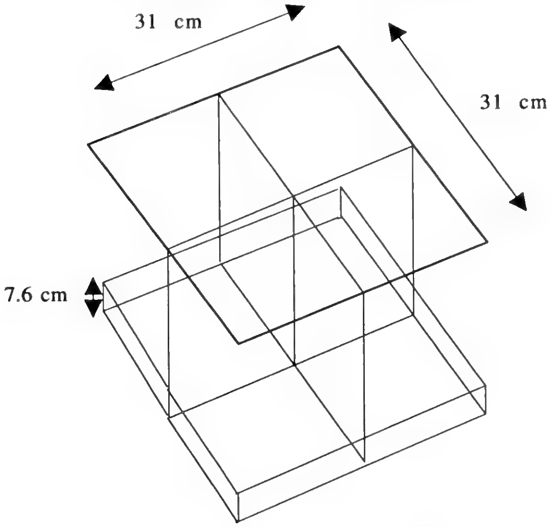


Fig. 1. Flight-interception trap used in arthropod sampling in Randolph County, West Virginia in 1998.

durable and usable over multiple seasons.

Trap design was simple and efficacious in sampling airborne insects and some terrestrials. We captured multiple orders and multiple families within most orders (Table 1; Dobony 2000). Other flight trap designs typically sample in only 1 dimension or plane. We believe that our design increases sampling effort by sampling in 2 planes. Moreover, other traps typically are suspended above ground. Our traps were placed on the ground within vegetation in order to sample the "zone of availability" for young ruffed grouse chicks. When properly constructed and positioned, our flight-interception trap was only impacted by extreme environmental conditions (e.g. high winds).

Table 1. Percent of total capture (*N* = 5358) and families (*N* = 175) in each arthropod order captured in Randolph County, West Virginia, 1998.

Order	% Total Capture	No. of Families	Order	% Total Capture	No. of Families
Blattaria	<1.0	1	Neuroptera	<1.0	2
Coleoptera	41.3	52	Odonata	<1.0	1
Collembola	<1.0	3	Orthoptera	2.0	4
Diptera	26.7	44	Phalangida	4.4	1
Hemiptera	5.0	12	Plecoptera	<1.0	3
Homoptera	5.6	10	Psocoptera	<1.0	2
Hymenoptera	13.6	30	Thysanoptera	<1.0	1
Lepidoptera	<1.0	6	Trichoptera	<1.0	1
Mecoptera	<1.0	2			

ACKNOWLEDGMENTS

Support for this research was provided by West Virginia Division of Natural Resources Pittman-Robertson Federal Aid in Wildlife Restoration Project W-48-R, the Richard King Mellon Foundation, the Ruffed Grouse Society, Westvaco Corporation, and the Division of Forestry, West Virginia University. Linda Butler and Mark Culik provided valuable assistance in sampling design and arthropod identification. L. Butler, J. Strazanac made helpful comments on the manuscript.

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THE UNIFIED NEUTRAL THEORY OF BIODIVERSITY AND BIOGEOGRAPHY. Stephen P. Hubbell. 2001. Princeton University Press. 375 pp. $29.95 paper.

In this book, the author develops a formal mathematical theory that unifies the study of geographic distribution of species (biogeography) and the study of species richness and relative species abundance (biodiversity). When a specialization process is incorporated into the classic theory of island biogeography, the generalized theory predicts the existence of a universal, dimensionless biodiversity number. In theory, this fundamental biodiversity number, together with the migration or dispersal rate, completely determines the steady-state distribution of species richness and relative species abundance on local to large geographic spatial scales and short-term to evolutionary time scales.

A DICTIONARY OF ENTOMOLOGY. G. Gordh & D.H. Headrick. 2001. CABI Publishing. 1032 pp. $140.00 Cloth.

Entomologists now have a comprehensive and updated resource that leaves Torre-Bueno far behind. This book is a fully cross-referenced collection of over 28,000 terms, names, and phrases used in entomology, incorporating an estimated 43,000 definitions. This alphabetical listing or dictionary, covers insect anatomy, behavior, biology, ecology, histology, molecular biology, morphology, pest management, taxonomy, and systematics. This book should be an essential reference source for all professional entomologists as well as students of entomology and related disciplines.

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Ground beetles identified: Carabidae of eastern United States, especially from agricultural, forest, and wetland sites in the Midwest, determined for a reasonable fee. Foster Forbes Purrington, purrington.1@osu.edu, (614) 292-5965, 1735 Neil Avenue, Columbus, OH 43210.

US ISSN 0013-872X
VOL. 112 SEPTEMBER AND OCTOBER, 2001 NO. 4

ENTOMOLOGICAL NEWS

SCIENTIFIC NOTE

THE AMERICAN ENTOMOLOGICAL SOCIETY

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A NEW SPECIES OF *MITRODETUS* (DIPTERA: MYDIDAE) FROM ARGENTINA[1]

Boris C. Kondratieff, Ryan J. Carr[2]

ABSTRACT: A new species of diochlistine mydas fly, *Mitrodectus irwini* is described from La Rioja Province, Argentina. Diagnostic illustrations of the male are provided for comparison with related species.

The mydid subfamily Diochlistinae Bequaert presently includes three genera, *Mitrodetus* Gerstaecker from Chile and Argentina and *Diochlistus* Gerstaecker and *Triclonus* Gerstaecker from Australia (Papavero and Wilcox 1974). Artigas and Papavero (1990) hypothesized that the Diochlistinae are the sister group of all remaining Mydidae. However, a recent reappraisal of the cladistic relationships of the Apioceridae by Yeates and Irwin (1996) provided an alternative hypothesis, with the Diochlistinae clade between the Apiophorinae + Mydinae and Anomalomydinae.

Mitrodetus is easily recognized within the Diochlistinae by the costa ending beyond the apex of M_2 and M_1 ends in R_1 (Fig. 1). Artigas and Palma (1979) provided an excellent review of the genus, including a description of *M. australis* from Patagonia and Santa Cruz Province, Argentina. Michael E. Irwin, University of Illinois, made a large collection of South American mydid flies available for determination. Among this material was a distinctive new species of *Mitrodetus* from Argentina. Terminology follows the McAlpine (1981) except for the male terminalia, which uses the terminology of Sinclair et al. (1993).

Mitrodetus irwini NEW SPECIES

Figs. 1-5.

Male. Length 14.5-16 mm. **Head.** Face with long white hairs, occipital hairs yellow; facial gibbosity short; eye large, with lower eye margin almost at oral cavity margin; proboscis very slender, 4X length of oral cavity, palpus slender, greater than 1/2 length of oral cavity. Antennae black; scape cylindrical, 4X as long as broad, with white to yellow hairs, stout black setae dorsally; pedicel 2-1/4 – 1/5 length of scape, about as broad as long; basoflagellomere cylindrical 1/2-2/3 as long as scape; club reddish, pollinose, collapsed, length subequal to scape and pedicel, about 1/3 as wide as long at 3/4 its length.

Thorax: Ground color black to dark brown; postpronotal lobes with dense yellow to reddish brown hairs; mesonotum white pollinose, with dense semierect yellow hairs; sparser areas forming stripes. Scutellum with long, white to yellow hairs; postscutellum slightly rugose, with dense white hair on lateral slopes; cervical sclerites with dense, erect yellow

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[1] Received September 5, 2000. Accepted February 3, 2001.

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hairs; proepisternum with long, erect white hairs; anepisternum and katepisternum with sparse white hairs; anatergite and katatergite with dense, erect yellow hairs. Pleura with patches of long, dense. white to yellow hairs. **Legs:** Coxae and trochanters black with white hairs, tibia, femur and tarsus brown with short erect black setae; forefemur with erect yellow hairs, midfemur with dorsal patch of erect yellow hairs; hindfemur sparse erect yellow hairs arranged in a row ventrally; fore- and midtibia with thin red to black bristles; hindtibia with sparse heavy black bristles. Tarsi with heavy erect black bristles; tarsomere 2-2/3 length of basitarsomere, segment 3 and 4-1/2 length of basitarsomere, segment 3 and 4-1/2 length of basitarsomere, segment 5 subequal to basitarsomere.

Abdomen: Light brown. Abdominal tergite 1 black with dense, white erect hairs, tergite 2 with dense, white, erect hairs anteriorly; with middorsal diamond-shaped black spot, bulba black; terga 3-4 with middorsal black mark; tergite 5 with middorsal diamond-shaped black spot; tergites 6-7 with anterior dark brown to black margins; tergites 8-9 and terminalia dark brown to black (Fig. 2); short black hairs on tergites 2-8. Sternites 2-4 with sparse, long, white hairs.

Terminalia: Hypandrium bulbous (Figs. 4 and 5); bare laterally, with erect black hairs ventral to T-shaped emargination and surrounding bases of gonocoxites. Gonocoxites tri-lobed (Figs. 4 and 5); inner lobe thick, sculptured, and bare, projecting into genital cavity perpendicular to plane of gonocoxite, enclosing cerci ventrally when retracted; median lobe triangular, with dense, erect, black hairs, apical lobe (remnant of gonostylus) rounded with sparse, erect, black hairs; small, bare, sculptured process on dorsal side. Cerci spatulate or paddle-like; overlapping dorsally then curving ventrally to form a half cylinder (Fig. 3); covered with dense, fine, white hairs ventrally; several thick, black, median hairs dorsally. Epandrium with erect black hairs externally except bare anterio-ventral corners, median lateral lobes broadly rounded with densest hairs at apex, apical lobes (surstyli) with erect black hairs on external surfaces, bluntly pointed and twisted vertically, with a small process projected ventrally into genital cavity allowing surstyli and processes to enclose cerci dorsally when retracted (Figs. 3 and 5).

Aedeagus: As Fig. 6.

Female. -unknown.

Material examined: Holotype male. ARGENTINA. La Rioja Province, Depart. General la Madrid, 1 km E Vinchinia, Hwy 26, km 244, 4240 ft. *Prosopis* covered dunes, 13 X 1997, M. E. Irwin, F. D. Parker and S. Rois (928.8013°S 68.2854°W). Paratypes, 2 males same data as Holotype. The Holotype and one paratype are deposited in the Illinois National

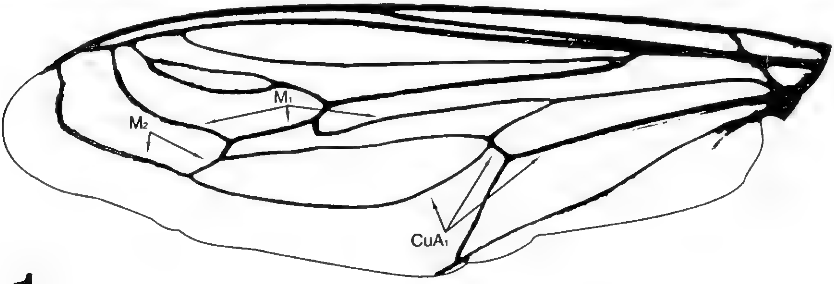

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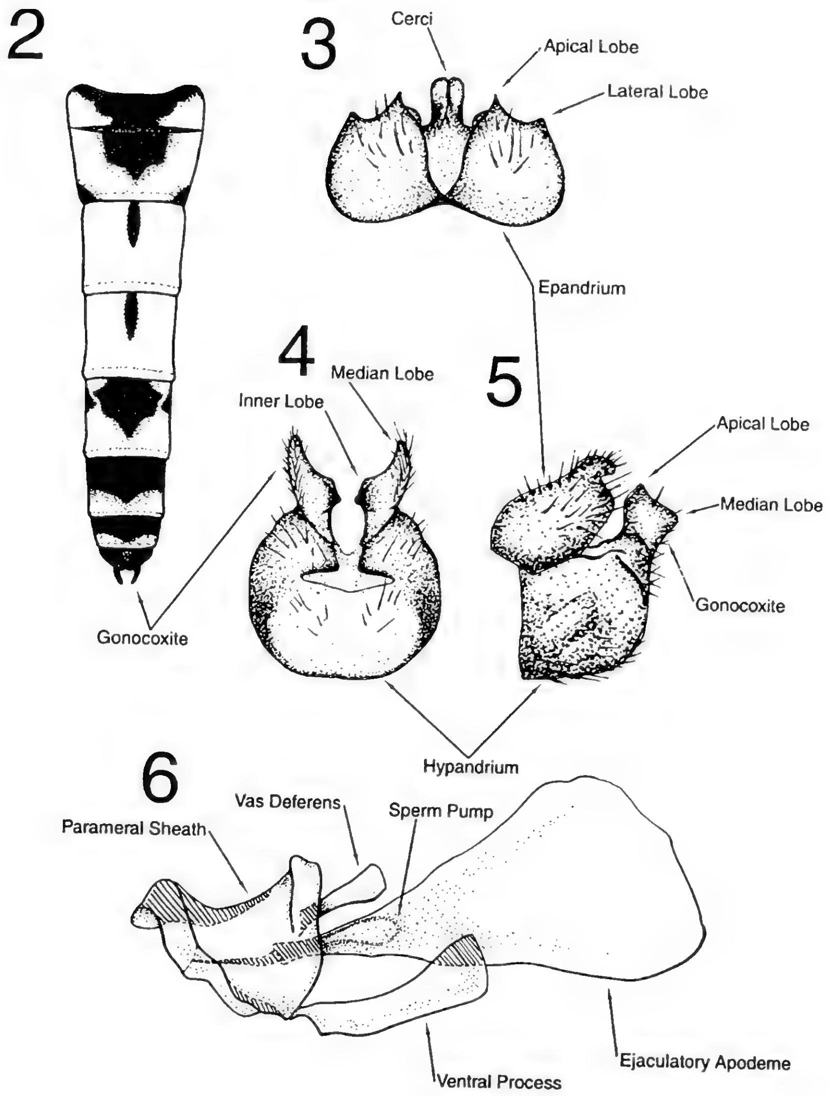
Figure 1. *Mitrodetus irwini*. Left wing.



Figures 2-6. *Mitrodetus irwini*. 2. Abdomen, dorsal view, 3-5. Male genitalia, 3. dorsal

view, 4. ventral view, 5. lateral view. 6. Aedeagus, lateral.
History Survey Collection, Urbana, Illinois, and the remaining paratype in the C.P. Gillette Museum of Arthropod Diversity, Colorado State University.

Etymology. The patrononym honors Michael E. Irwin for his numerous substantial contributions to our knowledge of the Asiloidea.

Diagnosis. The male of *M. irwini* is easily distinguished from all other described species by the distinctive dorsal abdominal maculation (Fig. 2), somewhat reminiscent of certain Chilean *Midacritus* species (Apiophorinae), especially *M. stuardoanus* Seguy. Additionally, the form of the male genitalia of *M. irwini* (Figs. 3-6) differs from all other described *Mitrodetus* (see Artigas and Palma 1979).

ACKNOWLEDGMENTS

We thank Michael E. Irwin for making specimens available. Matt Leatherman provided the illustrations. Howard E. Evans and Stephen W. Bullington provided reviews of the manuscript. An anonymous reviewer provided helpful advice. Caity Delphia and Mark McMillian assisted with the figures.

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OCCURRENCE OF STONEFLIES (PLECOPTERA) IN THE DIET OF THE RED-SPOTTED NEWT, *NOTOPHTHALMUS VIRIDESCENS*[1]

Kevin D. Stewart[2], Charles H. Nelson[3], Richard M. Duffield[2,4]

ABSTRACT: Over a period of one year, diet samples were taken from a population of the eastern red-spotted newt, *Notophthalmus viridescens*, at an impoundment in Frederick Co., Maryland. Approximately 67% of all the recovered diet items were Diptera, of which most were larvae and pupae. Ten stoneflies (Plecoptera) representing the following species were recovered: *Paracapnia augulata* (Capniidae), *Taeniopteryx maura* (Taeniopterygidae), *Amphinemura nigritta* (Nemouridae), *Leuctra sibleyii*, *L. tenella* and *Leuctra* sp. (Leuctridae). All stoneflies were adults except for a mature female nymph of *Paracapnia augulata*. Although there have been several studies of newt diet, this is one of the first to report the species of stoneflies present.

The importance of aquatic insects in ecosystem structure and function is well documented. Unfortunately, there is little information concerning the identity of specific aquatic species and their developmental stages that are consumed by predators. Moreover, what information does exist is scattered throughout the literature and is frequently considered so minor that it is not included in abstracts.

For the past several years we have been investigating the feeding ecology and diet of the adult Eastern Red-spotted newt, *Notophthalmus v. viridescens* (Raf.). This species is the second most widely distributed salamander in North America and the adults are found in permanent and semi-permanent water (Petranka, 1998).

The diet of adult *N. viridescens* has been studied extensively and varies widely depending upon the time of year and geographic region of the investigation. Petranka (1998) notes that adults feed on worms, mollusks, amphibians, a variety of crustaceans and a large variety of both aquatic and terrestrial insects. Earlier, Ries and Bellis (1966) showed that the most important prey for adults numerically in a Pennsylvania pond population were dipterans. However, Burton (1977) observed that adult newts in a New Hampshire lake feed heavily on Odonata larvae and cladocerans. Peak feeding has been shown to occur from July through October (Petranka, 1998).

Here we report the occurrence of several species of Plecoptera in the diet of adult *N. viridescens* from a study site in Maryland.

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MATERIALS AND METHODS

Diet samples were collected at approximately two week intervals between May 26, 1997 and June 9, 1998 from a small 5 acre impoundment (Lat. 39°33'45; Long. 83°27'46) located in the Frederick City Municipal Forest along Little Fishing Creek (Frederick Co., Maryland). Approximately 30 samples were collected during each visit. However, no collecting occurred between November 23, 1997 and February 28, 1998, as the impoundment was frozen over or the newts were inactive.

Newts were collected along the margins of the impoundment using an aquatic insect net. Individuals were placed in a plastic holding pan. The newts were not sexed or measured for length. Each individual was removed from the holding pan by hand and held dorsal side down. The mouth of the newt was pried open with a spatula and a flamed tipped, glass pasteur pipette (14.6 cm length) with a rubber bulb gently placed into the mouth and inserted to the stomach. The pipette had previously been filled with water. The bulb was lightly squeezed, forcing water into the stomach and flushing the stomach contents out of the mouth into a plastic dish (12 cm diameter) held below the head. This process was repeated several times or until no items were flushed from the stomach. The individual was then placed into a second holding pan to be returned to the pond.

The water and stomach contents were transferred to a four-dram vial. After each sample was allowed to settle, the excess water was drawn off. The contents of each vial were fixed with 95% ethanol and assigned an accession number. In the laboratory, the contents of each sample were analyzed using a dissecting microscope. Plecoptera were identified to the species level but other taxa were identified to higher taxonomic levels (e.g., Diptera). The data were recorded on individual data sheets and then entered into an Excel spreadsheet.

RESULTS AND DISCUSSION

During the sampling period 6,696 items were recovered from 652 newt stomach samples for a mean of 10.3 items per sample. Approximately 67% of all items recovered were Diptera, most of which were larvae and pupae. This result agrees with Morgan and Grierson's (1932) study of *N. viridescens* in ponds and spring-fed streams in Massachusetts which reported that the dominant group of organisms in the adult diet in August were insects and that these were predominantly Diptera.

Ten stoneflies (Plecoptera) representing four families and five species were recovered from the diet items (Table 1). All stoneflies were adults with the exception of a mature female nymph of the angulate snowfly, *Paracapnia augulata* (Hansen). Only one sample contained more than a single specimen; a sample from May 24, 1998 contained two adult little black forestflies, *Amphinemura nigritta* (Provancher). All Plecoptera specimens were recovered in late winter and spring with the exception of one adult needlefly, *Leuctra* sp. that was recovered on November 9, 1998. This specimen was partially digested and the species identification was not possible. There are several species of *Leuctra* in Maryland that are known to emerge primarily in the fall (Duffield and Nelson, 1990; 1993).

The five Plecoptera species recovered from the newt diet samples are common in Maryland (Duffield and Nelson, 1990). Along the margins of the same impoundment, Stewart and Duffield (1999) reported the unusual presence of adult *Amphinemura nigritta* stuck to the stems and corollas of flowers of the Mountain Laurel, *Kalmia latifolia* L.. This was observed on May 24, 1998 where the present study was conducted. Two of the newt diet samples obtained on this date contained *A. nigritta* adults.

Sporadic cases of Plecoptera in the diet of *N. viridescens* have been reported previously. In a study of the food consumption of *N. viridescens* in Massachusetts, Morgan and Grierson (1932) documented one stonefly nymph in diet samples collected August 8. However, neither the family nor genus of the specimen was reported. Burton (1977) reported the presence of Plecoptera in the diet of *N. viridescens* adults collected from Mirror Lake in New Hampshire. Stoneflies made up 6.2% of the diet by weight in June but were absent in July, August and October samples. However, neither the species nor the developmental stages were reported. One stonefly species, the least sallfly, *Haplopera brevis* (Chloroperlidae) has been reported in the diet of several species of salamanders, *Desmognathus f. fuscus* (Dusky salamander), *Eurycera bislineata* (Two-lined salamander) (larva and adults) and *Gyrinophilis porphyriticus* (Spring salamander) (Burton, 1976). It is significant to note that for the Two-lined salamander, *H. brevis* nymphs constituted 74 and 61% of the total weight of the diet samples collected in June and July respectively (Burton, 1976).

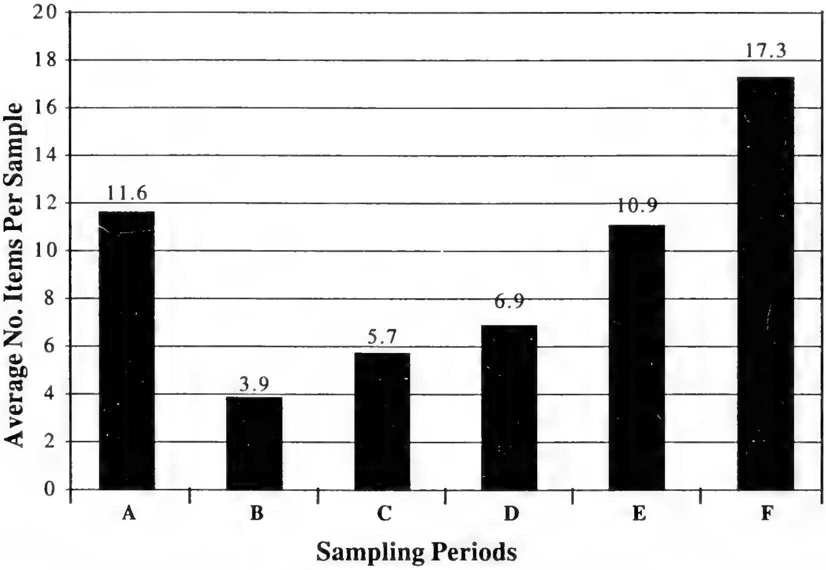
Since the present study site, a lentic environment, is not the typical stonefly lotic environment, we consider it is likely that the adult stoneflies in the diet items were in flight and were captured by adult *N. viridescens* after having been blown or landed on the surface of the impoundment. During the summer we observed adult newts swimming to the surface, breaking the surface and returning to the bottom. However, one of the ten Plecoptera specimens recovered was a mature nymph of *P. angulata* and this does raise the question of whether the nymph was washed or drifted into the impoundment, or whether this species spends some of its life history in this environment. The *N. viridescens* individuals were collected near the outflow of the impoundment, not where Little Fishing Creek flows into the pond. Hynes (1976) and Baumann (1979) have noted that various stonefly genera have been found in cold lentic environments. Moreover, Hynes (2000) notes that *P. angulata* disperses by water to distant islands in the Georgian Bay of Lake Huron and considers that for this to occur this species would have to spend some time in

Table 1. Plecoptera recovered from diet samples of the eastern red-spotted newt, *Notophthalmus v. virdescens,* from a pond in the Little Fishing Creek watershed, Frederick Co., Maryland.

Family/Species	Specimen	Date
Capniidae		
Paracapnia angulata Hanson	1-M	February 28, 1998
	1-FN	March 7, 1998
Taeniopterygidae		
Taeniopteryx maura (Pictet)	1-F	March 22, 1998
Nemouridae		
Amphinemura nigritta (Provancher)	1-M	May 24, 1998
	1-M; 1-F	May 24, 1998
Leuctridae		
Leuctra sibleyi Claassen	1-F	May 10, 1998
	1-F	May 24, 1998
Leuctra tenella Provancher	1-M	May 10, 1998
Leuctra sp.	1-A	November 9, 1997

Legend: A = adult; F = adult female; M = adult male; FN = female nymph.

Figure 1. Average number of diet items per sample for dates that Plecoptera were recovered.



Legend: **A** = 9-Nov.-97, **B** = 28-Feb.-98, **C** = 7-Mar.-98, **D** = 22-Mar-98, **E** = 10-May-98, **F** = 24-May-98 the lake itself.

During this study the mean number of diet items of the adult newts for each of the collecting dates that Plecoptera were recovered increased from a low of 3.9 items per sample in February to a high of 17.3 items per sample in May (Figure 1). The increase in diet items from winter to late spring agrees with that result reported by Morgan and Grierson (1932) and suggests that while stoneflies constitute only a minor part of the overall diet of *N. viridescens*, they occur in the diet at times when little food is available. The stonefly species in the diet of *N. viridescens* of this study are late fall, winter or spring emerging species. Since during the later winter and spring Plecoptera are large compared to other available food items, we propose that on a weight basis stoneflies may be a significant component of the diet of *N. viridescens* at this time of the year.

ACKNOWLEDGMENTS

The senior author (KDS) is a recipient of an undergraduate fellowship from the Environmental Protection Agency (U-915452-01-0). Microscopes used for this study were purchased with funds provided by the Fund for Academic Excellence Grants Program, Howard University. Collecting permits were obtained from the Maryland Department of Natural Resources.

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ON THE IDENTITY OF *ATEMNUS GRACILIS* (PSEUDOSCORPIONES: MENTHIDAE)[1]

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ABSTRACT: *Atemnus gracilis* Banks (1909) has, since 1932, been placed in the genus *Lustrochernes* (Family Chernetidae). It is now shown to belong in *Menthus* (Menthidae) and to be a senior synonym of *Minniza lindahli* Chamberlin (1923).

Recently, while browsing through Harvey's "Catalogue of the Pseudoscorpionida" (1991), I noticed that *Atemnus gracilis* Banks 1909 was assigned to the chernetid genus *Lustrochernes* Beier 1932. Knowing that this assignment is incorrect, I checked back through my notes and came to realize that the misidentification is, in part, my fault. Now I would like to set the record straight — *Atemnus gracilis* is actually a representative of the menthid genus *Menthus* Chamberlin 1930.

Atemnus gracilis was described briefly by Banks (1909) on the basis of material "From Sonora, Mexico" (no other collection information and no illustrations were given). Beier (1932) deemed the description to be insufficient ("ungenügend"), but placed the species as an "unsichere Art" under the chernetid genus *Lustrochernes*. Roewer (1937) followed Beier and placed it doubtfully in *Lustrochernes*. As far as I know, there was no other mention of *Atemnus gracilis* in the literature until Harvey included it in his catalogue as *Lustrochernes gracilis*, without indicating any doubt about the generic assignment (1991: 595).

A number of years ago, I received for study from the Museum of Comparative Zoology, Harvard University, the type collection of *Atemnus gracilis*. There were 2 male pseudoscorpions in the vial; the original labels read "Atemnus gracilis Bks. type" and "San Miguel Horcasitas Sonora Mex. May Eisen"; more recent labels read "Nathan Banks Collection" and "M. C. Z. *Atemnus gracilis* Banks SYNTYPES SONORA: San Miquel Horcasita [sic]". [The material was collected by Gustav Eisen in May 1892 (see Eisen 1895: 763)]. I cleared the two specimens, mounted them on microscope slides, and numbered them with my catalog numbers WM4533.01001-2. I studied them in detail and determined that they belong to the genus *Menthus*. At that time, inexplicably, I was unaware that the species had been described; I thought that Banks had assigned a name to the specimens but had not published a description. Later, when Harvey and I were preparing the manuscript of our study on the family Menthidae, it was my responsibility to research and write the section on *Menthus lindahli* (Chamberlin). I recognized that the specimens of "*Atemnus gracilis*" were conspecific with the holotype of *M. lindahli* (from Tepoca Bay, Sonora, Mexico) and included them in the "Other material examined" for that species, as "Mexico: Sonora: San Miguel Horcasitas, no date, Eisen, 2♂ (MCZ; SL)"

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(Harvey and Muchmore 1990: 950). Now that I am aware that *Atemnus gracilis* Banks is a validly described species, it becomes clear that *Minniza lindahli* Chamberlin is a junior subjective synonym of that species, which should now be called *Menthus gracilis* (Banks). A complete synonymy follows.

Family Menthidae Chamberlin
Genus *Menthus* Chamberlin
Menthus gracilis (Banks), NEW COMBINATION

Atemnus gracilis Banks 1909: 146.
Minniza lindahli Chamberlin 1923: 365-366, pl. II, fig. 12. NEW SYNONYMY.
Menthus lindahli (Chamberlin): Chamberlin 1930: 587; Beier 1932: 178; Roewer 1937: 259; Roth and Brown 1976: 128; Lee 1979: 18-19, figs. 22, 23, 31; Roth and Brown 1980: 349; Harvey and Muchmore 1990: 950-951, figs. 11-13; Harvey 1991: 261.
Lustrochernes(?) *gracilis* (Banks): Beier 1932: 95; Roewer 1937: 290.
Lustrochernes gracilis (Banks): Harvey 1991: 595.

At this time I take the opportunity to designate the specimen (male) numbered WM4533.01001 as LECTOTYPE of *Atemnus gracilis* Banks, the other male specimen becoming a paralectotype.

ACKNOWLEDGMENTS

I am indebted to H. W. Levi and L. Leibensperger of the Museum of Comparative Zoology for the loan of specimens. Thanks are due to M. S. Harvey, J. J. Lewis, the editor, and two anonymous reviewers for helpful comments about the manuscript.

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NEW SPECIES OF *CHOREBUS* (HYMENOPTERA: BRACONIDAE) FROM THE IBERIAN PENINSULA[1]

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ABSTRACT: *Chorebus tergoflavus*, *C. petiobrevis*, and *C. longiventris*, three new species of Braconidae from Spain, are described and compared with allied species of the genus. Identification keys and Illustrations of the most important features are included.

Among Braconidae, the subfamily Alysiinae is characterized by having exodont mandibles (a condition in which the mandibles are twisted so that they are directed outwards apically and do not overlap when are closed), and all species are exclusively endoparasitic on cyclorraphous Diptera. Alysiinae are divided into two tribes: Alysiini and Dacnusini, based on the presence or absence of the r-m cross vein in the forewing.

With approximately 215 Holarctic species, *Chorebus* Haliday is the most widespread genus in Dacnusini. With the exception of *Chorebus gracilis* (Nees von Esenbeck, 1834), which attacks *Psila rosae* (F.) (Diptera, Psilidae), all known *Chorebus* attack Agromyzidae and Ephydridae (Diptera). Most *Chorebus* are easily recognized by densely pubescent metapleura, with the setae often arranged in rosettes of radiating hairs.

Data about imagos of Dacnusini, both at the morphological and biological level, can be found in Griffiths (1964, 1966, 1968, 1984) and Tobias (1986, 1995).

Here, three new species of *Chorebus*: *Chorebus tergoflavus* sp. nov., *C. petiobrevis* sp. nov., and *C. longiventris* sp. nov., discovered in the Iberian Peninsula (Spain), are described.

MATERIAL AND METHODS

The specimens were obtained with an insect net or from their hosts. In the latter case portions of plant organs with agromyzid larvae were collected; the larvae were in an advanced stage or in the pupal phase and were stored in Fahringer boxes. These boxes, which were kept under condition of ambient temperature and humidity, were checked every three days for the emergence of hosts and parasitoids.

For the descriptions and illustrations, a zoom WILD M8 stereoscopic mi

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croscope was used; this was equipped with an Olympus FLQ 85E cold light source to which a 1.35 x drawing tube was attached. Measurements were made essentially following the methodology used by Griffiths (1964) and Wharton (1977).

The terminology used for the different morphological structures (body and wing venation), as well as the methodology employed for the collection of biometric data essentially follow those of Griffiths (1964), Wharton (1977, 1986, 1991), and Achterberg (1993). The concept of *Chorebus* followed is that established by Griffiths (1968).

Chorebus tergoflavus SP. NOV.

Female: Head (Figs. 1, 2) - Transverse, 1.7 times wider than long, 1.2 times higher than long. Occiput bare and shiny. Vertex with numerous long and scattered setae arranged in rows. Ocelli small, not at all protruding, the distance between them twice as large as their diameter. In frontal view, eyes not convergent from below; 1.4 times as long anteroposteriorly as temples. From dorsal view, temples not widened behind eyes. Face 1.2 times wider than long. Antennae as long as body, with 20 antennomeres; flagellomere 1, flagellomere 2, 3 times longer than broad; apical flagellomere 2 times longer than broad. Mandibles (Fig. 2) with some scattered setae at base, widened towards apex, 0.8 times length of head, 4-toothed, with 1st tooth clearly widened, 2nd tooth wide, short and pointed and 3rd and 4th teeth well differentiated, although small. Maxillary palpi not longer than height of head. Labial palpi short, as in *C. rufimarginatus* (Stelfox, 1954).

Mesosoma (Figs. 3, 4) - 1.3 times longer than high, 2 times longer than broad between tegulae, upper side convex. Pronotum bare and shiny; anterior oblique suture broad and rough, with few setae. Mesoscutum with whitish and scattered pubescence on anterior face, central lobe and along the imaginary line of notauli; lateral lobes almost bare; dorsal pit of mesoscutum short, oval, and shallowly impressed; notauli weakly impressed anteriorly, not visible on mesoscutal disc. Prescutellar furrow crenulate. Mesopleuron rough, especially on anterior upper third; sternaulus nearly complete, narrow, weakly crenulate; posterior mesopleural furrow smooth. Metapleuron with poorly defined swelling, with rosette of setae slightly differentiated, atypical, resembling that of *C. canariensis* Griffiths, 1967, with long setae pointing towards the coxa. Propodeum rough, with abundant pubescence, although not very dense (Fig. 3). Hind coxae shiny, with a few slightly visible and scattered setae. Hind femora 5 times longer than broad.

Wings (Fig. 4) - Pterostigma with sides almost parallel, distally gradually merging into the metacarpus, 1.8 times longer than metacarpus; metacarpus ending far from apex of wing. 1st radial segment 0.7 times shorter than length between its insertion and the parastigma and as long as width of pterostigma; rest of radius weakly curved, not sinuate. Radial cell short, ending before the tip of wing. Recurrent vein clearly antefurcal. 3rd discoidal segment incomplete. Brachial cell open on lower distal angle. Length of forewing: 1.5 mm.

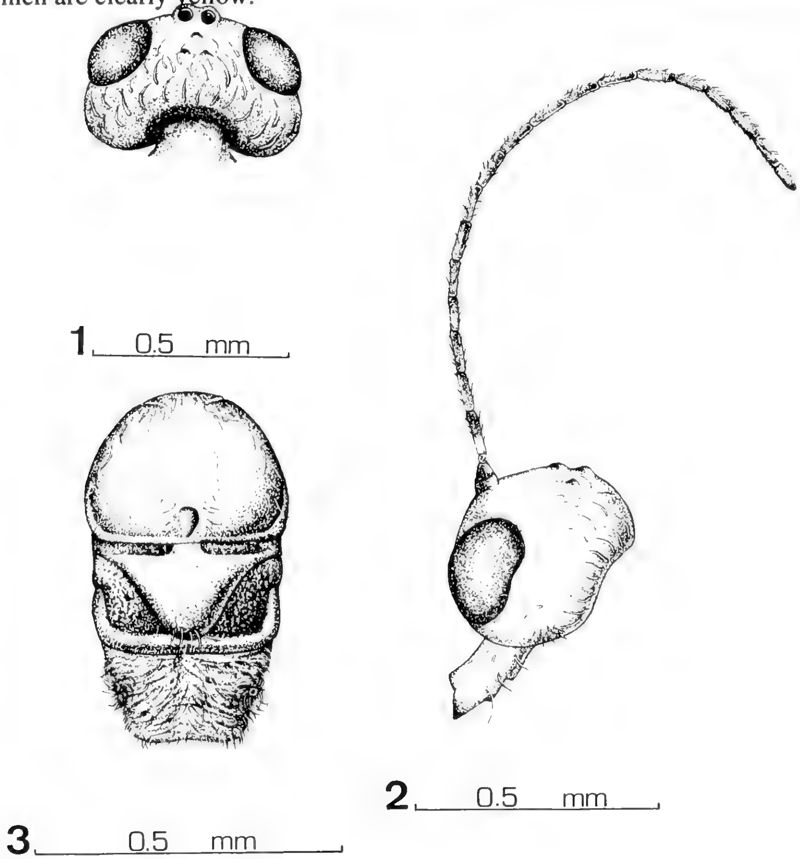
Metasoma - Petiole 1.5 times longer than broad at apex, granulose medially, smooth and shiny at apical angles, almost bare with only a few scattered setae. Tergum 2 and 3 nearly bare, shiny, with a few setae arranged in a row where the joint between the two terga should be situated. Ovipositor short, as in *C. rufimarginatus*, hidden by abdomen from dorsal view; its sheaths with pubescence.

Color and size - Black, with exception of: pedicel of antennae (yellow); center of mandibles (orange); maxillary and labial palpi (yellowish-brown); coxae (yellowish-red), tibiae and femora (brown-orange) of all legs; tergum 2 and 3 (intensely yellow). Length of body: 1.32 mm. Length of mesosoma: 0.55 mm. Wing span: 3.32 mm.

Male: unknown. **Host**: unknown.

Material examined [deposited in the private institution Fundación Entomológica "Torres-Sala" (Docavo Collection) (Valencia, Spain)]: 2 females. Holotype: female, SPAIN: Valencia: Alberique, 10-IV-65 (leg. I. Docavo). Paratype: 1 female, SPAIN: Valencia: Alberique, 10-IV-65 (leg. I. Docavo).

Etymology: The specific name refers to tergum 2 and 3 of the metasoma which are clearly yellow.



Figures 1-3.- *Chorebus tergoflavus* sp. nov. (female).- 1, Head in posterior view showing pubescence of vertex and of occiput; 2, Head in lateral view showing temple, antenna and mandible; 3, mesosoma in dorsal view.

Note: This new species belongs to the "*Chorebus ovalis/lateralis* complex" (Griffiths, 1968), and is similar to *C. rufimarginatus*, from which it is distinguished by the following characters: 1) head not broadened behind eyes; 2) clypeus completely black, not red at apex; 3) notauli very underdeveloped, only visible anteriorly; 4) midpit not continuing through disc via a furrow; 5) sternaulus narrow, shallow and finely crenulate; 6) metapleuron with weakly developed rosette; 7) petiole 1.8 times longer than wide, without ridges converging and joining to form a medial carina, granulose at center, smooth and shiny, especially at apical angles, very slightly pubescen; 8) tergum 2 and 3 clearly yellow, contrasting with the black coloration of the rest of the metasoma.

This species can be accommodated in the key of Griffiths (1968; p. 123) as follows:

20 Petiole almost parallel-sided, twice as long as wide, bare centrally but with some pubescence near its base, along its sides and towards its apical corners (Nixon, 1943, fig. 54). 29 antennal segments (female) .... *C. iphias* (Nixon)

\- Petiole widened towards its apex, about 1.5 times as long as wide, almost bare and shiny or with evenly distributed pubescence 20a

20a Antennomeres: female 25-26; male 29. Petiole with pubescence distributed regularly .... *C. rufimarginatus* (Stelfox)

\- Antennomeres: female 20. Petiole granulose at center; without central ridge; almost bare, although with some very scattered setae; smooth and shiny at apical angles. Tergum 2 and 3 yellow, contrasting with the dark hue of the rest of the metasoma .... *C. tergoflavus* sp. nov.

In the key of Tobias (1995; p. 285), it will key as follows:

50(53) Legs dark brownish yellow, sometimes lighter, almost orange.

51(51a) First abdominal tergite broadened toward apex, 1.5 times as long as its width at apex. Antennae with 25-26 antennomeres (in male with 29 antennomeres), as long as body, apical antennomeres 1.5 times as long as wide. Head massive, broadened behind eyes. First denticle on mandible distinctly deflected sideward, 3rd and 4th denticles obtuse. Notaulices distinct, sculptured. First abdominal tergite with longitudinal keel. Propodeum with numerous white setae. Body 2.5. West; British Isles .... *C. (S.) rufimarginatus* Stelfox

51a(51) Antennae of female with 20 antennomeres; apical antennomere twice as long as broad. Head not broadened behind eyes. Notauli not extending over main portion of mesonotal disc. Length of body: 1.3 mm. Spain. .... *C. (S.) tergoflavus* sp. nov.

Chorebus petiobrevis SP. NOV.

Female: Head - Transverse, 1.4 times wider than long, 1.1 times higher than long. Length of head 3.1 times width of mandibles. Vertex and dorsal zone of occiput with scattered setae arranged in rows. Ocelli small, protruding, the distance between them 1.5 times as large as their diameter. Eyes not converging from below and twice as long as temples. Temples not very broadened behind eyes. Face 1.1 times broader than high. Antennae with 24 antennomeres, with pubescence, neither dense nor scant; flagellomere 1, 2 times longer than broad; apical flagellomere 1.3 times longer than broad. Mandibles with an accumulation of setae at base, bearing slightly more setae than the occiput, not forming a tuft; mandible length 0.3 times head length; 4-toothed, with 1st tooth slightly widened and 2nd slightly longer than 3rd and 4th teeth. Maxillary palpi not longer than height of head. Labial palpi as in *C. leptogaster* (Haliday, 1839).

Mesosoma - 1.4 times longer than high, 2 times longer than broad between tegulae, upper side slightly convex. Pronotum smooth and shiny; anterior oblique suture with dense pubescence that almost conceals its rough surface; rest of pronotum almost bare, with only a few scattered setae. Mesoscutum pubescent, with the exception of a reduced portion of the outer posterior part of the lateral lobes, which are bare; dorsal pit of mesoscutum well defined; notauli very faintly depressed. Prescutellar furrow crenulate. Mesopleuron smooth, shiny, almost bare, with setae only below humeral callus and a patch of pubescence close to the insertion of the middle coxae; sternaulus complete, long, narrow and finely crenulate throughout; posterior mesopleural furrow smooth; metapleural rosette well defined, typical of the "*Chorebus senilis*" group sensu lato (Griffiths, 1967), with a poorly defined swelling with punctation conferring a rough aspect. Propodeum rough, pubescent, with flattened setae over most of surface that fail to hide its rugosities. Hind coxae with a tuft of setae. Hind femora 3.5 times longer than broad. Hind tarsus equal to length of tibia.

Wings - Pterostigma elongate, narrow, parallel sided, narrowed at apex, 1.5 times longer than metacarpus; metacarpus ending far before apex of wing. 1st segment of radius 0.5 times shorter than length between its insertion and parastigma and as long as width of pterostigma; radius scarcely sinuate. Recurrent vein clearly antefurcal. Brachial cell almost closed at posterior distal angle. Length of wing: 1.8 mm.

Metasoma (Fig. 5) - Petiole 2.2 times longer than broad at apex; strongly granulose and rough throughout, except apical angles which are smooth and shiny; with setae on basal area which is extended to center and on part of sides, where they are long and fine; the rest bare. Metasoma beyond petiole 2 times longer than petiole. Ovipositor not projecting beyond apex of metasoma, curved upwards in lateral view.

Color and size - Head black, with the exception of: labrum and palpi (yellowish-brown) and center of mandibles (orange). Mesosoma black, except legs, which are yellowish-brown, except coxae (dark brown) of middle legs and coxae (black), trochanters and trochantellus (yellowish-brown), femora (black), base of tibiae (brown-dark red) and tarsi (brown-dark) of back legs. Metasoma beyond petiole yellowish-orange, with apex brown-dark red. Length of body: 2.12 mm. Length of mesosoma: 0.78 mm. Wing span: 3.98 mm.

Male: Essentially similar to female but with longer antennae, with 27-30 antennomeres. Length of body: 2.45 mm. Length of mesosoma: 0.78 mm. Wing span: 4.61 mm.

Host: *Chromatomyia horticola* (Goureau, 1851) (Agromyzidae).

Material examined [deposited in the private institution Fundación Entomológica "Torres-Sala" (Docavo Collection) (Valencia, Spain)]: 1 female, 3 males. Holotype: female, SPAIN: Valencia: Gandia, 3-IV-60 (leg. I. Docavo). Paratypes: 3 males, SPAIN: Valencia: Gandia, 3-IV-60 (Leg. I. Docavo).

Etymology: The specific name refers to the short petiole.

Note: The systematic position is discussed under *C. longiventris* sp. nov.

Chorebus longiventris SP. NOV.

Female: This new species appears very similar to *C. petiobrevis*, but can be distinguished by the following characters:

Head - Transverse, 1.7 times wider than long, 1.4 times higher than long, upper side convex. Length of head 2.5 times width of mandibles. Ocelli very small, the distance between them 2.5x as great as their diameter. Patch of setae of the base of mandibles more dense.

Mesosoma - 1.6 times longer than high, 1.8 times longer than broad between tegulae. Mesoscutum less setose, lateral lobes being almost bare, with only a few scattered setae; notauli only visible anteriorly. Prescutellar furrow not crenulate. Hind femora 4 times longer than broad. Length of wing: 2.02 mm.

Metasoma (Fig. 6) - Petiole 3 times longer than broad at apex; Metasoma beyond petiole 2.9 times longer than petiole. Ovipositor projecting, in retracted position, beyond last tergum of metasoma by the same length as that of the third tarsomere of the hind tarsus.

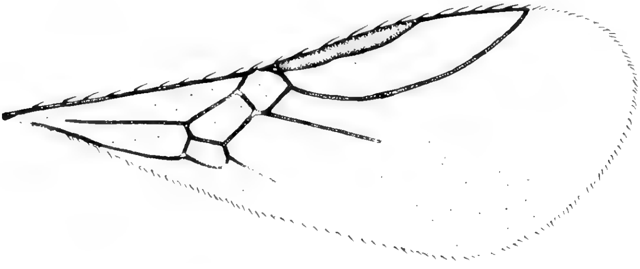
Color and size - Legs with all coxae and femora black; tibiae yellowish-orange on basal 2/3 of length, apical 1/3 dark. Length of body: 2.42 mm. Length of mesosoma: 0.90 mm. Wing span: 4.46 mm.

Male: unknown. **Host**: *Chromatomyia horticola* (Goureau) (Agromyzidae).

Material examined [deposited in the private institution Fundación Entomológica "Torres-Sala" (Docavo Collection) (Valencia, Spain)]: 2 females. Holotype: female, SPAIN: Valencia: Gandia, 3-IV-60 (Leg. I. Docavo). Paratype: 1 female, SPAIN: Valencia: Gandia, 3-IV-60 (Leg. I. Docavo).

Etymology: The specific name refers to the length of the portion of the metasoma beyond the petiole (gaster according to Wharton, 1977, 1986, 1991).

Notes: *C. petiobrevis* and *C. longiventris* belong to the group of *C. petiolatus* (Griffiths, 1967), which are closely related to each other as well as to *C. leptogaster* and differ from *C. leptogaster* by the following characters: **A**) Differences between *C. petiobrevis* and *C. leptogaster*: 1) head less transverse (length/head width = 1.4 (*C. petiobrevis*), 1.8 (*C. leptogaster*) and less high relative to length (length/height of head = 1.1. (*C. petiobrevis*), 1.5 (*C. leptogaster*); 2) vertex with setae arranged in rows; 3) posterior part of head more setose; 4) antennae with 24 antennomeres; 5) labrum yellowish-brown; 6) center of mandibles red-orange; 7) lateral lobes of mesoscutum more setose, the pubescence lacking only on a small portion of the posterior angles; 8) hind femora and tibiae almost black, a vaguely red hue only visible on a short portion of the base of the tibiae; 9) petiole 2.2 times longer than apical width. The presence of such a short petiole would appear to link this species with *C. heringianus* Griffiths 1967 (in *C. leptogaster* it is from 3 to 3.5 times longer), but in the broad pubescence of the mesonotum of *C. Petiobrevis* it more closely resembles to *C. leptogaster*; 10) metasoma beyond petiole bright orange; 11) body length greater than that of wing. In *C. leptogaster* the body length is at most 0.9 times that of the wings. **B**) Differences between *C. longiventris* and *C. leptogaster*: 1) mesoscutum less pubescent: most of the central lobe and lateral lobes with only a few scattered setae; granulose; 2) notauli only distinguishable on anterior part; 3) legs 1 and 2 lighter orange, with coxae darker, brown-dark red, with only last tarsomere black; hind legs with only the trochantellus lighter, brown-reddish, tibiae reddish-yellow on 2/3 of exten-



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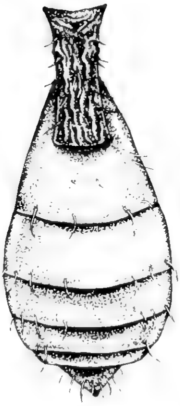

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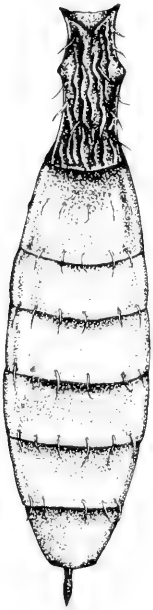

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Figures 4-6.- *Chorebus tergoflavus* (female).- 4, Anterior right wing. *Chorebus petiobrevis* sp. nov. (female).- 5, Metasoma. *Chorebus longiventris* sp. nov. (female).- 6, Metasoma.

sion, only apical 1/3 dark, like whole of tarsus; 4) petiole long, 3 times as long as broad apically, with parallel sides, scantily pubescent and shiny; 5) metasoma beyond petiole longer, 2.9 times as long as petiole, of a darker reddish-brown than legs; 6) Ovipositor projecting beyond apical tergite by length of third tarsomere of hind tarsi.

These two species can be inserted in the key of Griffiths (1967; p. 664) as follows:

22 Petiole extraordinarily elongate, 3-3.5 times as long as wide -except in *C. petiobrevis* sp. nov. in which the petiole is 2.2. times longer than wide-. Back of head more or less bare centrally, pubescent only at its sides (near the mandibles) (*petiolatus* group) 23

\- Petiole not so elongate, less than three times as long as wide -except *C. petiobrevis* included in anterior couplet- 26

23 Very large species, about 5 mm long. Antennal segments: male, 45-51; female: 43-45. Tooth 1 of mandible much expanded. Ovopositor (female) not projecting beyond the apical tergite in the retracted position .. *C. petiolatus* (Nees)

\- Smaller species (up to 2.8 mm long). Not more than 33 antennal segments. Tooth 1 of mandibles hardly expanded (fig. 163). Wing with pterostigma and cell $2R_1$ relatively short (fig. 148 and Tobias, 1962, fig. 48) 24

24 Coxae yellow. Gaster beyond petiole conspicuosly yellow or yellow-brown. Ovipositor (female) projecting beyond the apical tergite in the retracted position .... *C. xiphidius* Griffiths

\- Coxae black, brown or yellow-brown. Gaster beyond petiole varying from reddish yellow to black 25

25 Cheeks somewhat projecting, with distinct tufts of pubescence above the base of the mandibles. Hind femora strongly thickened (Tobias, 1962, fig. 49) (female unknown) .... *C. femoratus* (Tobias)

\- Cheeks not projecting, with only fine inconspicuous pubescence near the base of the mandibles. Hind femora not so strongly thickened 25a

25a Petiole 3-3.5 times longer than wide; labrum black; palpi long; base of hind tibiae brown-dark red, very much lighter than rest. Metasoma beyond petiole 2.3 times longer than petiole, reddish-yellow to almost black. Ovipositor very short, hidden .... *C. leptogaster* (Haliday)

\- Petiole 2.2 times longer than wide; labrum yellowish-brown; palpi short; base of hind tibiae darker, almost no lighter than rest. Metasoma beyond petiole 2 times longer than petiole, yellowy-orange, contrasting strongly with the rest of body. Ovipositor short, hidden in dorsal view...... .*C. petiobrevis* sp. nov.

\- Petiole 3 times longer than wide; labrum yellowish-brown; palpi short; base of hind tibiae yellowy-orange on basal 2/3, apical 1/3 dark. Metasoma beyond petiole 2.9 times longer than petiole, brown-dark red. Ovipositor projecting beyond apical tergite by a length equal to that of third tarsomere of hind tarsi .... *C. longiventris* sp. nov.

The two new species can also be accommodated in the key of Tobias (1986; p. 332) as follows:

423a(422b) Hind femora not thickened, widest in apical third, slightly sculptured on outer side, lustrous, dark brown, rarely very dark brown.

423b(423a) Petiole 3-3.5 times longer than wide; labrum black; palpi long; base of hind tibiae brown-dark red, very lighter than rest. Metasoma beyond petiole 2.3 times longer than petiole, reddish-yellow to almost black. Ovipositor very short, hidden .... *C. leptogaster* (Haliday)

423c(423d) Petiole 2.2 times longer than wide; labrum yellowish-brown; palpi short; base of hind tibiae darker, almost no lighter than rest. Metasoma beyond petiole 2 times longer than petiole, yellowy-orange, contrasting strongly with the rest of body. Ovipositor short, hidden in dorsal view .... *C. petiobrevis* sp. nov.

423d(423c) Petiole 3 times longer than wide; labrum yellowish-brown; palpi short; base of hind tibiae yellowy-orange on basal 2/3, apical 1/3 dark. Metasoma beyond petiole 2.9 times longer than petiole, brown-dark red. Ovipositor projecting beyond apical tergite by a length equal to that of third tarsomere of hind tarsi .... *C. longiventris* sp. nov.

ACKNOWLEDGMENTS

Financial support for this paper was provided by the Junta de Castilla y León (project SA 18/96), and Fundación Entomológica "Torres-Sala".

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CHARACTERIZATION OF THE HYPERPARASITOID COMPLEX OF *COTESIA MELANOSCELUS* (HYMENOPTERA: BRACONIDAE) AT THREE MARYLAND LOCATIONS[1]

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ABSTRACT: The hyperparasitoid complex of *Cotesia melanoscelus*, a primary parasitoid of the gypsy moth, was characterized over one yearly cycle (March 1986 through March 1987) in the three geographic provinces of Maryland: the coastal plain, the Piedmont Plateau, and the Appalachian Mountains. Aspects of this study have been previously reported. The present paper presents additional biological information derived from this data set, including the preferences of the hyperparasitoid species for height in tree, for attacking hidden versus exposed cocoons, observed sex ratios and, for the gregarious species, the numbers of individuals emerging per cocoon. Additionally, we compare and contrast the relative abundance and periodicity of the specific hyperparasitoids at the three Maryland locations with results reported in previously published studies from regions farther north.

The gypsy moth, *Lymantria dispar* (L.) (Lepidoptera: Lymantriidae), is a serious defoliator of forest and shade trees. One of the natural enemies imported into North America to help control the gypsy moth is a braconid wasp, *Cotesia melanoscelus* (Ratzeburg) (Hymenoptera: Braconidae), which is an important parasitoid of early stage (instars 1-3) caterpillars. This wasp has a number of attributes that indicate that it would be a good candidate for augmentative release against the gypsy moth (Wieber et al. 1995b, Webb et al. 1997). Unfortunately, this wasp is itself attacked by a large complex of hyperparasitoids that drastically reduces its potential for gypsy moth control (Wieber et al. 1995b). This complex has been characterized in New England (Muesebeck and Dohanian 1927, Proper 1934, Weseloh 1978, 1979, 1983, 1986), New York (Grimble and Palm 1976), and Ontario, Canada (Bourchier and Nealis 1992), but not in the more southern range of the gypsy moth. The present study characterizes the hyperparasitoid complex of *C. melanoscelus* in the three different geographic provinces of Maryland: the coastal plain, the Piedmont Plateau, and the Appalachian Mountains. Aspects of this study have

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[1] Received December 26, 2000. Accepted January 29, 2001.

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ENT. NEWS 112(4): 241-254, September & October, 2001

been previously reported. A description was given of the niche partitioning (resource sharing) by four species of *Gelis* of the supplied *C. melanoscelus* cocoons (Wieber et al. 1995a). An analysis was made of the optimal timing of seasonal placement of *C. melanoscelus* cocoons for augmentative release (Wieber et al. 1995b). Finally, a comparison was made of the hyperparasitoid attack on two strains of *C. melanoscelus* (Wieber et al. 1996). The present paper presents additional biological information derived from this data set, including the preferences of the hyperparasitoid species for attacking hidden versus exposed cocoons, observed sex ratios and, for the gregarious species, the numbers of individuals emerging per cocoon. Additionally, we compare and contrast the relative abundance and periodicity of the specific hyperparasitoids at the three Maryland locations with results reported in the previously published studies from regions farther north.

MATERIALS AND METHODS

The materials and methods used in this study have been presented in detail elsewhere (Wieber et al., 1995a, 1995b, 1996), and a condensed version is given here with emphasis on aspects of the study pertinent to the data now presented. There were three study sites. The coastal plain site in southern Maryland was midway between Poplar Hill and Aquasco, in the Patuxent River Park, at 38° 36’ 45” latitude, 76° 43’ longitude (Benedict Quadrangle, U. S. Geological Survey 7.5 Minute Series Topographic Map). This was along a power line parallel to Aquasco Farm Road, at 20-50 m altitude. The Piedmont Plateau (north-central Maryland) site was located along the north bank of Prettyboy Reservoir at 39° 37’ 15” latitude, 76° 45' longitude (Hereford Quadrangle, U. S. Geological Survey 7.5 Minute Series Topographic Map), at 200-240 m altitude. The Appalachian Mountains (western Maryland) site was located northwest of Barton, MD, along Swamp Road in the Savage River State Forest, at 39° 35’ latitude, 79° 3’ 15” longitude (Barton Quadrangle, U. S. Geological Survey 7.5 Minute Series Topographic Map), at 730-800 m altitude. Cocoons of *C. melanoscelus* were placed in the field at periodic intervals from March 1986 through March 1987. There were 20 exposure periods each at the coastal plain (new cohorts placed out on Julian dates 64, 85, 106, 134, 148, 168, 176, 190, 204, 219, 231, 248, 267, 289, 310, 330, and 351 in 1986, and 007, 035, 058, ending on 076 in 1987) and Piedmont Plateau sites (new cohorts placed out on Julian dates 63, 85, 108, 128, 148, 163, 176, 191, 205, 219, 233, 246, 267, 288, 310, 329, and 351 in 1986, and 008, 037, 057, and ending on 077 in 1987) and 17 exposure periods at the western Maryland site (new cohorts placed out on Julian dates 69, 88, 115, 150, 163, 178, 193, 205, 221, 247, 269, 290, 312, 338 in 1986, and 010, 037, 063, ending on 077 in 1987). The strain of *C. melanoscelus* used for all exposure periods was from a laboratory colony of the established North American parasitoid that was descended from material collected from Egg Hill, Maryland (in

Cecil County) by K. W. Thorpe in 1984. However, at each site, 5 consecutive exposure periods (25 June through 5 September 1986) were used to compare the susceptibility to the overall hyperparasitoid communities of the Maryland strain with that of a Korean strain. Results, presented in Wieber et al (1996), demonstrated that there was little or no difference in measurements of the hyperparasitoid communities attacking the Maryland and the Korean strains; therefore, data for the two strains are combined in the present report. Both strains of parasitoid were reared by the procedure of Kolodny-Hirsch (1988), with photophase kept less than 16 h to yield cocoons containing diapausing third-instars. Cocoons were attached to 10-cm diameter white cardboard tab ice cream cup lids using a polyvinyl glue. Five cocoons (termed "hidden") were glued to a lid and then a second lid was stapled to the first lid over the top of the cocoons, allowing a 1-cm gap for hyperparasitoid entry. Five additional cocoons (termed "exposed") were placed in a line on a second lid without a cover, which was placed on the opposite side of the cage from the "hidden" cocoons. Once in the field, 5-mm mesh wire screening was placed around the exposed cocoons (as 10 X10 X 10-cm cages) to protect against vertebrate predators. The caged cocoons were placed at ground level and at 1.5 m on 40 trees at each site, and in the canopy of 5 of those trees at 7-m average height. Cocoons were exposed for 2-3 week periods, and then replaced by a new cohort of cocoons. The retrieved cocoons were returned to Beltsville, Maryland where they were held in plastic cups under natural conditions in a field insectary and monitored periodically for emergence of *C. melanoscelus* or hyperparasitoids.

Identifications: Specimens of all hyperparasitoid species were sent to appropriate authorities for identification. Ichneumonidae (*Gelis tenellus* (Say), *G. apantelis* (Cushman), *G. obscurus* (Cresson), *Gelis* species-4 (undescribed), *Lymeon orbus* (Say), *Isdromas lycaenae* (Howard), *Lysibia mandibularis* (Prov.) and *Acrolyta* sp.) were determined by R. W. Carlson, Systematic Entomology Laboratory (SEL), ARS-USDA, Beltsville, MD. Encyrtidae, including *Ooencyrtus kuvanae* (Howard), *Ooencyrtus* species-2, and *Cheiloneurus* sp., were determined by M. E. Schauff, SEL, who also identified *Anastatus pearsalli* Ashmead (Eupelmidae), and *Aprostocetus* sp. (Eulophidae). *Aprostocetus* specimens were identified using the concept of the genus contained in LaSalle (1994). E. E. Grissell, SEL, identified the *Conura meteori* (Burks) (= *Ceratosmicra meteori* Burks (Delvare and Boucek 1992)) (Chalcididae), *Eurytoma verticillata* (F.) (Eurytomidae), and the Pteromalidae (*Dibrachys cavus* (Walker), *Tritneptis scutellata* (Muesebeck), and *Hypopteromalus inimicus* Muesebeck). G. Gibson, Biosystematics Research Centre, Ottawa, Ontario, Canada, confirmed the *A. pearsalli* identification and identified the *Arachnophaga picea* (Riley) (Eupelmidae) and a second, undescribed, *Anastatus* species, *Anastatus* n. sp. near *reduvii*. Although most of the *Anastatus* specimens keyed to *A. pearsalli*, there is no key for the males of this group, so for this paper, all *Anastatus* material is combined as *Anastatus* species complex.

RESULTS AND DISCUSSION

Twenty species of hyperparasitoids were identified emerging from *C. melanoscelus* cocoons from one or more of the Maryland locations (Table 1). Several of these species can act on occasion or preferentially as tertiary parasitoids (Muesebeck and Dohanian, 1927). In general, hyperparasitoids are less discriminating than primary parasitoids in their host selection. Some, such as the *Gelis* complex and *Dibrachys cavus*, will attack almost anything resembling the cocoons of hymenopterous primary parasitoids (Muesebeck and Dohanian, 1927). In agreement with 8 previous studies of the hyperparasitoid complex of *C. melanoscelus* (Muesebeck and Dohanian, 1927, Proper, 1934, Grimble and Palm, 1976, Weseloh, 1978, 1979, 1983, 1986, Bourchier and Nealis 1992), our results demonstrated devastating levels of parasitism for *C. melanoscelus* cocoons at all 3 Maryland locations. This aspect of the study was presented in Wieber et al., 1995b.

At all 3 Maryland locations in 1986, and in all 8 of the northern studies (studies conducted over a 60 year period and widely spaced by location), at least 2, and usually 3, members of the *Gelis* complex (*G. apantelis, G. obscurus, and G. tenellus)* were present and prominent. Additional described or undescribed species of *Gelis* sometimes play a minor role. In Maryland, the *Gelis* complex accounted for 65.6% of the parasitized *C. melanoscelus* cocoons. Preference for height in the tree varied for the 3 major *Gelis* species. Since each location had 85 evaluation points (40 points at ground level, 40 points at 1.5 m, 5 points in the canopy) the expected values, if there was no preference for height, was 47.1%, 47.1%, and 5.8% for the three levels. For *G. tenellus,* we recorded (Table 2) fewer than expected attacks on cocoons placed at ground level (22.1% recorded, 47.1% expected), while greater than expected attacks occurred at 1.5 m on the tree bole (67.4% recorded, 47.1% expected), and in the tree canopy (10.5% recorded, 5.8% expected). In contrast, *G. obscurus* generally attacked cocoons placed at the base of the tree (71.9% recorded, 47.1% expected). Fewer than expected numbers of *G. obscurus* emerged from cocoons placed at 1.5m (27.5% recorded, 47.1% expected), while few *G. obscurus* adults emerged from cocoons placed in the canopy (0.6% recorded, 5.8% expected). In yet a third pattern, *G. apantelis* did not exhibit a pronounced preference for height. *Gelis* sp. # 4 (undescribed) made a token appearance at the Piedmont Plateau and Coastal Plain sites, but made up 8% of the hyperparasitoids collected in the Appalachian site. It was active from March to September with an early peak in April but with no clear summer peak. Like *G. obscurus*, it generally attacked cocoons placed at the base of trees (75%), was less abundant from cocoons placed at 1.5 m (25%), and was not recorded from cocoons placed in the canopy. The significance of the relative occurrence of the several *Gelis* species on the tree is discussed in detail in Wieber et al. (1995a). However, height preferences were not reported for the other 16 species.

Four other ichneumonid hyperparasitoids emerged from the exposed *C. melanoscelus* cocoons (Table 1), but none in great numbers. *Acrolyta* sp. was recorded from a few cocoons at each of the 3 Maryland sites. Muesebeck and Dohanian (1927) reported that *Acrolyta empretiae* (= *A. nigricapitata* (Cook and Davis), as per Krombein et al., 1979) was a minor hyperparasitoid of *C. melanoscelus* in New England, and this seems to be the case in Maryland. *Isdromas lycaenae* was not recorded for *C. melanoscelus* in Krombein et al. (1979), but it was recorded from several closely related species. The geographic range for *I. lycaenae* is given as Pennsylvania south to Alabama, west to Iowa and Texas (Krombein et al. 1979), which may explain why it was not reported from the 8 northern studies. Although only 16 specimens emerged from exposed cocoons in the Maryland study, *I. lycaenae* may become a more important hyperparasitoid of *C. melanoscelus* farther south. *Lysibia mandibularis* was discussed as a fairly common hyperparasitoid of *C. melanoscelus* by Muesebeck and Dohanian (1927) (misdetermined as *Hemiteles fulvipes* Gravenhorst as per Krombein et al. 1979), but only 4 specimens were so identified from the Maryland material. *Lymeon orbus* was not recorded for *C. melanoscelus* in Krombein et al. (1979), but it has a large geographic range, has been recorded from a variety of species, and it is not surprising that it appeared as an incidental (3 specimens) hyperparasitoid in the Maryland study.

Anastatus mixed species was active in 2 of the 3 Maryland sites, representing 18% of hyperparasitoids reared from the Piedmont Plateau site, and 28% of the hyperparasitoids reared from the Coastal Plain site (Table 1). *Anastatus* was active against *C. melanoscelus* from May through September, with attacks peaking in late-May to mid-June. *Anastatus* emerged in numbers that were close to expected values from all tree-placement levels, indicating no clear preference. Attacks occurred at expected frequencies to cocoons placed at ground level (42.5% recorded, 47.1% expected), at 1.5m on the tree bole (48.2% recorded, 47.1% expected), and in the tree canopy (9.3% recorded, 5.8% expected) (Table 2). *Arachnophaga picea* emerged from 3% of the parasitized cocoons from the Coastal Plains site and from 1% of the parasitized cocoons from the Piedmont Plateau site; it was not recorded from the Appalachian site. *A. picea* was not recorded for *C. melanoscelus* or from any closely related species in Krombein et al. (1979). It was described by Gahan (1943) from spider egg sacs from several locations in California and Arizona, and has also been recorded from New Jersey and Illinois (Krombein et al., 1979). Attacks upon *C. melanoscelus* cocoons were recorded from mid-June through July at the Coastal Plains site, and from late-July through August at the Piedmont Plateau site. Most attacks occurred to cocoons placed at ground level (52.1% recorded, 47.1% expected) or at 1.5m on the tree bole (46.2% recorded, 47.1% expected), rather than in the tree canopy (1.7% recorded, 5.8% expected).

Dibrachys cavus composed 1.4% of the parasitoids from the Coastal Plains site, 4% of the parasitoids from the Piedmont Plateau site; and 6.8% of the parasitoids from the Appalachian site. *D. cavus* was listed from *C. melanoscelus* and as a primary, secondary, or tertiary parasitoid of many orders of insects, plus spiders, in Krombein et al. (1979), and has a worldwide distribution. Attacks upon *C. melanoscelus* cocoons in the Maryland study were recorded from May to October, with highest numbers of attacks recorded from June through September. Weseloh (1978) reported that *D. cavus* attacks increase with height. In Maryland, we recorded fewer than expected attacks occurred to cocoons placed at ground level (17.8% recorded, 47.1% expected), while greater than expected attacks occurred at 1.5 m on the tree bole (73.8% recorded, 47.1% expected), and in the tree canopy (8.4% recorded, 5.8% expected).

Tritneptis scutellata was recorded only from the Appalachian Mountain site in our study, emerging from 1.3 % of the parasitized cocoons at this site. Attacks on *C. melanoscelus* were recorded only during July and August. Interestingly, *T. scutellata* demonstrated a distinct preference for height in the tree. No attacks were recorded at ground level (0% recorded, 47.1% expected), less than expected attacks occurred at 1.5 m on the tree bole (23.1% recorded, 47.1% expected), and much greater than expected attacks were recorded in the tree canopy (76.9% recorded, 5.8% expected). Since our study had considerably fewer stations in the canopy than at the other 2 levels, *T. scutellata* may be under-represented in our counts. Moreover, Bourchier and Nealis (1992) found far more *T. scutellata* emerging from *C. melanoscelus* cocoons collected under burlap bands than emerging from laboratory-reared *C. melanoscelus* cocoons exposed on disks, suggesting that our experimental methods may have worked against detecting this species.

Hypopteromalus inimicus was recorded only from the Piedmont Plateau site in our study, emerging from 7.1 % of the parasitized cocoons at that site. *H. inimicus* emerged in numbers that were close to expected values from all 3 placement levels, indicating no clear preference (Table 2). Two broods were seen at the Piedmont Plateau site: one in May-June and the second in September-October. Muesebeck and Dohanian (1927) regarded this species as a minor hyperparasitoid attacking *C. melanoscelus*, and this seems to be the case in Maryland.

Ooencyrtus kuvanae was active at all 3 Maryland locations from March through September, and emerged from 5.8% of the parasitized cocoons from the Coastal Plains site, 6.4% from the Piedmont Plateau site; and 7.7% from the Appalachian site (Table 1). We recorded fewer than expected attacks occurring to cocoons placed at ground level (35.6% recorded, 47.1% expected), but greater than expected attacks at 1.5 m on the tree bole (54.9% recorded, 47.1% expected), and about as expected in the tree canopy (5.9% recorded, 5.8% expected) (Table 2). Two other species of encyrtids, *Ooencyrtus* sp # 2 and *Cheiloneurus* sp, were incidental (7 and 2 specimens, respectively) hyperparasitoids in the Maryland study.

Eurytoma verticillata (Eurytomidae) was recorded only from the Piedmont Plateau site in our study, emerging from 5.4 % of the parasitized cocoons at that site. Attacks were recorded from July through September. *E. verticillata* emerged in roughly equal numbers from *C. melanoscelus* cocoons placed at ground level (52.1%) and at 1.5 m (47.9%), but no adults emerged from cocoons placed in the canopy. *E. verticillata* was the most prominent hyperparasitoid recovered in Connecticut, although *E. verticillata* was present there only in July and August, which is consistent with the situation in Maryland (Weseloh 1979).

Conura (= *Ceratosmicra*) *meteori* (Chalcididae) was recorded only from the Piedmont Plateau site in our study, emerging from 1.3 % of the parasitized cocoons at that site. All attacks were recorded during one exposure period in July. *C. meteori* emerged in roughly equal numbers from *C. melanoscelus* cocoons placed at ground level (56.5%) and at 1.5 m (43.5%), but no adults of this hyperparasitoid emerged from cocoons placed in the canopy (Table 2). *C. meteori* is widespread, and has been recorded from *C. melanoscelus* and related primary parasitoids in the past (Krombein et al. 1979); however, it was not mentioned by Muesebeck and Dohanian (1927), or in any of the other more northern studies (Proper 1934, Weseloh 1978, 1979, 1983, 1986, Grimble and Palm 1976, Bourchier and Nealis 1992).

Aprostocetus sp. (Eulophidae) was recorded only from the coastal plains site in our study, emerging from 0.8 % of the parasitized cocoons at that site. Attacks were recorded during 2 exposure periods in June and July. *Aprostocetus* sp. demonstrated a distinct preference for height in the tree. Of the 20 cocoons attacked, one (5%) was at ground level (5% recorded, 47.1% expected), 4 cocoons were attacked at 1.5 m on the tree bole (20.0% recorded, 47.1% expected), and much greater than expected numbers (15) were attacked in the tree canopy (75% recorded, 5.8% expected). None of the 71 species of *Aprostocetus* recorded in LaSalle (1994) have been recorded from *C. melanoscelus* cocoons.

In summary, 14 of the 20 species were recovered in sufficient numbers to allow a characterization of height preference. Five of the hyperparasitoid species seem to prefer the lower strata and to avoid the canopy: *G. obscurus, G.* sp. # 4, *A. picea, C. meteori, and E. verticillata.* Conversely, 5 of the species preferred the 1.5 m site and the canopy while being less prominent at ground level: *G. tenellus, Acrolyta* sp., *D. cavus, T. scutellata,* and *Aprostocetus* sp.; the remaining 4 species showed no preference for height: *G. apantelis, H. inimicus, O. kuvanae,* and *Anastatus* mixed species. Thus members of the *Gelis* complex reflect a range of height preferences (one species preferred the lower sites, one the higher sites, and one had no preference) typical of hyperparasitoid species in general (or at least for those species examined in this study).

Hyperparasitoid preference for hidden versus exposed cocoons of *C. melanoscelus*, sex ratios, and number per cocoon for the gregarious species. All the hyperparasitoid species (except for *Lymeon orbus* with an n = 3) had sex ratios that favored the female (Table 1), often dramatically so. While the males of all Hymenoptera are produced parthenogenetically, *G. tenellus* exhibits thelytokous parthenogenesis (that is, females are produced from unfertilized eggs); therefore, the male unknown (Muesebeck and Dohanian, 1927). Although *O. kuvanae* is a solitary internal primary parasitoid of gypsy moth eggs (Crossman, 1925), it is gregarious as a secondary parasitoid of *C. melanoscelus*, averaging 4.0 individuals per cocoon in Maryland in 1986 (Table 1), whereas *Ooencyrtus* species # 2 averaged 7.9 individuals per cocoon. The other gregarious species, *Aprostocetus* sp., *Cheiloneurus* sp., *D. cavus*, and *T. scutellata*, average between 2.5 and 3.5 individuals per cocoon (Table 1). Van Sickle and Weseloh (1974) found that hidden cocoons were attacked more readily than exposed cocoons. Evidently these hyperparasitoids search for hosts primarily in concealed locations. As most cocoons of *C. melanoscelus* are found in nonexposed situations, especially under bark flaps, the hyperparasitoids are well adapted to exploit this insect. In the Maryland study, 9 species preferred hidden cocoons (Table 2), including the important *Gelis* complex, supporting the above observation. Of the more prominent species, only *O. kuvanae* showed a preference for exposed cocoons. This agrees with observations concerning *O. kuvanae* as an egg parasitoid. Herard (1978) found that *O. kuvanae* preferred the sunniest gypsy moth egg masses. Weseloh (1971) and ODell et al. (1989) showed that *O. kuvanae* is positively phototactic. ODell et al. (1989) suggested that egg masses found in dark locations would be less parasitized by *O. kuvanae*.

Comparison of the Maryland complex with that seen farther north: The makeup of the complex in Maryland was somewhat different from that reported in the 8 previous studies (Muesebeck and Dohanian, 1927, Proper, 1934, Grimble and Palm, 1976, Weseloh, 1978, 1979, 1983, 1986, Bourchier and Nealis 1992). All 8 of these studies were done farther north (from Maryland) in New England, New York, and Ontario. Table 3 presents the relative important by rank order of reported numbers of hosts attacked, of the more importance species found either in Maryland or in one or more of the more northern studies. Members of the *Gelis* complex were the most frequent hyperparasitoids encountered at all three Maryland locations, and were prominent in all 8 of the more northern studies. The most striking difference found in Maryland was the status of *E. verticillata* (= the *Eurytoma appendigaster* (Swederus) reported in most of the northern accounts (Grissell, 1985)). *E. verticillata* was the most important species attacking *C. melanoscelus* in 6 of the 8 northern studies, and was present in the other 2 studies. However, in Maryland, *E. verticillata* was a minor component at one location, and absent from the other 2 locations. Conversely, *Anastatus* spp., primarily *pearsalli*

Table 1. Number of parasitized *C. melanoscelus* cocoons (% of total in parenthesis) from which identified hyperparasitoid species emerged. Cocoons were exposed for two/three week periods at three Maryland locations, March, 1986-March, 1987, with sex ratios, as % females, and number of hyperparasitoids emerging per cocoon for gregarious species.

Species	Total	Coastal Plain	Piedmont Plateau	Appalachian Mountains	no.per cocoon	% female
Superfamily Ichneumonoiidea						
Ichneumonidae						
Gelis apantelis	2280 (27.7)	677 (25.9)	1175 (32.1)	428 (21.5)	1.0	56.4
G. obscurus	1645 (20.0)	738 (28.7)	405 (11.1)	502 (25.2)	1.0	60.5
G. tenellus	1317 (16.0)	112 (4.3)	500 (13.7)	705 (35.4)	1.0	100.0
G. sp. # 4	156 (1.9)	4 (<0.1)	1 (<0.1)	151 (7.6)	1.0	62.7
Lymeon orbus	3 (<0.1)	0	3 (<0.1)	0	1.0	0.0
Isdromas lycaenae	16 (0.2)	0	15 (0.4)	1(<0.1)	1.0	68.8
Lysibia mandibularis	4 (<0.1)	4 (<0.1)	0	0	1.0	75.0
Acrolyta sp.	33 (0.4)	18 (0.7)	3 (<0.1)	12 (0.6)	1.0	87.9
Superfamily Chalcidoidea						
Pteromalidae						
Dibrachys cavus	317 (3.9)	35 (1.4)	147 (4.0)	135 (6.8)	3.1	69.9
Tritneptis scutellata	26 (0.3)	0	0	26 (1.3)	3.2	87.2
Hypopteromalus inimicus	260 (3.2)	0	260 (7.1)	0	1.0	65.8
Encyrtidae						
Ooencyrtus kuvanae	477 (5.8)	163 (6.4)	283 (7.7)	31 (1.6)	4.0	78.3
Ooencyrtus sp # 2	7 (<0.1)	3 (<0.1)	4 (<0.1)	0	7.9	89.1
Cheiloneurus sp	2 (<0.1)	0	2 (<0.1)	0	3.5	71.4
Eupelmidae						
Anastatus mixed spp.[a]	1382 (16.8)	724 (28.2)	658 (18.0)	0	1.0	84.2
Arachnophaga picea	117 (1.4)	77 (3.0)	40 (1.1)	0	1.0	82.9
Eulophidae						
Aprostocetus sp.	20 (0.2)	20 (0.8)	0	0	2.5	83.9
Chalcididae						
Conura meteori	46 (0.6)	0	46 (1.3)	0	1.0	n.d.
Eurytomidae						
Eurytoma verticillata	119 (1.4)	0	119 (5.4)	0	1.0	80.9
Total	8227	2575	3661	1991		

[a] **Primarily *A. pearsalli*, with some *A.* n. sp. near *reduvii*. Problems with male identifications prevent precise quantitative analyses of these species.**

Table 2. Preferences of hyperparasitoid species for height in tree and for hidden versus exposed cocoons. Data combined for 3 Maryland sites, March 1986 to March 1987. Species emerging from less than 25 cocoons are omitted from this table. There were 40 trees with ground placements, 40 trees with placements at 1.5 m, and 5 trees with canopy placements.

	Preference for height of cocoon placement			Preference for cocoon exposure	
Species	% Ground level	% 1.5 m	% Canopy	% hidden	% exposed
Gelis apantelis	49.6	49.2	1.2	53.3	46.7
G. obscurus	71.9	27.5	0.6	55.1	44.9
G. tenellus	22.1	67.4	10.5	52.0	48.0
G. sp. # 4	75.0	25.0	0.0	51.3	48.7
Acrolyta sp.	21.2	27.3	51.5	39.4	60.6
Dibrachys cavus	17.8	73.8	8.4	68.5	31.5
Tritneptis scutellata	0.0	23.1	76.9	69.2	30.8
Hypopteromalus inimicus	42.7	50.8	6.5	52.3	47.7
Ooencyrtus kuvanae	35.6	54.9	5.9	24.9	75.1
Anastatus mixed spp.	42.5	48.2	9.3	42.9	57.1
Arachnophaga picea	52.1	46.2	1.7	47.9	52.1
Conura meteori	56.5	43.5	0.0	42.6	57.4
Eurytoma verticillata	52.1	47.9	0.0	45.4	54.6
Aprostocetus sp.	5.0	20.0	75.0	60.0	40.0
Expected:	47.1	47.1	5.8	50	50

Table 3. Relative importance (by rank order of reported numbers of hosts attacked) of selective hyperparasitoid species against *C. melanoscelus* at 3 locations in Maryland in 1986 compared with 8 previously published studies from Canada, New York, and New England.

	MD 1986							Connecticut			
Species	Coast. Plain	Pied. Plat.	Appal. Mtns	Ontario, Canada '89-90[1]	New York '74-75[2]	New Engl. '20-23[3]	New Engl. '29-30[4]	'74-76[5]	'77[6]	'81[7]	'84[8]
Anastatus sp.	3rd	2nd	0	0	0	minor	0	0	2nd	0	0
Dibrachys cavus	7th	7th	5th	0	5th	2nd	3rd	minor			
Dimmockia sp.	0	0	0	6th	2nd	4th	minor	3rd	1st	5th	3rd
Eurytoma verticillata	0	8th	0	4th	1st	1st	1st	1st	5th	1st	1st
Gelis apantelis	2nd	1st	3rd	3rd	4th	6st	0	2nd	2nd	2nd	5th
G. obscurus	1st	4th	2nd	0	6th	5st	4th	2nd	4th	4th	5th
G. tenellus	5th	3rd	1st	2nd	3rd	3rd	2nd	2nd	3rd	3rd	2nd
Ooencyrtus kuvanae	4th	5th	6th	0	0	minor	0	minor			
Tritneptis scutellata	0	0	7th	1st	0	minor	0	0	0	0	0

[1] Bourchier and Nealis (1992). [2] Grimble and Palm (1976). [3] Muesebeck and Dohanian (1927). [4] Proper (1934). [5] Weseloh (1978). [6] Weseloh (1979). [7] Weseloh (1983). [8] Weseloh (1986).

with an undescribed species as a minor component, was prominent at 2 Maryland locations (although absent at the Appalachian site), but *Anastatus* was unreported in 6 of the 8 northern studies. *Anastatus disparis* Ruschka was the second most common hyperparasitoid of *C. melanoscelus* recorded by Weseloh (1979). *A. disparis* and *A. pearsalli* were both mentioned as minor hyperparasitoids of *C. melanoscelus* by Muesebeck and Dohanian (1927). Krombein et al. (1979) lists *E. verticillata* as occurring from Ontario to Pennsylvania, while *A. pearsalli* is listed from Massachusetts to North Carolina, and *A. disparis* is listed from Maine to New Jersey. It may be that *E. verticillata* is at the southern end of its range in Maryland, where its niche is occupied by *Anastatus* species, primarily *pearsalli*. The *Gelis* complex seems a bit more prominent in Maryland than farther north, perhaps due to the absence of *E. verticillata*, which out-competes *Gelis* in individual competition (Weseloh, 1988). Conspicuous by its absence in Maryland is *Dimmockia* sp., which was present, and sometimes rather prominent, in all 8 of the northern studies. *Dibrachys cavus*, considered important in New England by Muesebeck and Dohanian (1927), and by Proper (1934), was a minor hyperparasitoid of *C. melanoscelus* at all 3 Maryland locations as well as in the New York and the Connecticut studies; it was not reported from the Ontario study.

Tritneptis scutellata, reported as the most important hyperparasitoid in Ontario, was a minor hyperparasitoid of *C. melanoscelus* at one Maryland location, and was not recorded from the other 2 locations. It was also not recorded, except as a minor hyperparasitoid by Muesebeck and Dohanian (1927), from the other northern studies. *Ooencyrtus kuvanae*, a primary egg parasitoid of the gypsy moth, has long been known to be a facultative hyperparasitoid of *C. melanoscelus*. However, Muesebeck and Dohanian (1927) reported that its impact on *C. melanoscelus* was so small as to be negligible. The other 7 northern studies either failed to record *O. kuvanae*, or considered it of minor importance against *C. melanoscelus*, although Kamran (1977) reported that field collected cocoons of *C. melanoscelus* from Long Island yielded many individuals of *O. kuvanae* during 1971 and 1972. In Maryland, *O. kuvanae* emerged from an impressive number of *C. melanoscelus* cocoons exposed at all 3 locations, suggesting either that *O. kuvanae* was adapting to *C. melanoscelus* over time, or that under warmer conditions in the south, *C. melanoscelus* becomes a more suitable host. This development demonstrates the wisdom of Weseloh et al. (1979) recommending against releasing an Indian gypsy moth egg parasitoid, *Anastatus kashmirensis* Mathur on the basis of its potential as a hyperparasitoid of *C. melanoscelus*. The above analysis indicates that as *C. melanoscelus* populations move south and west along with the advancing gypsy moth population, it may leave behind a hyperparasitoid species or two, but there will be other species waiting to fill any resulting niche.

The hyperparasitoid guild attacking *C. melanoscelus* in North America is not strikingly different from that found in Europe. Vasic and Minic (1976) characterized the hyperparasitoid species emerging from cocoons of solitary *Apanteles* species and *Meteorus versicolor* Nees., that were the primary parasites of the gypsy moth and the satin moth in Yugoslavia. During studies that began in 1967, Vasic and Minic (1976) found that the most important hyperparasitoid species attacking *C. melanoscelus* were *E. verticillata*, *D. cavus*, and *Gelis areator* (Panzer) (= *Hemiteles pulchellus* Gravenhorst), a bisexual species closely related to *G. tenellus*. They noted a close similarity between the hyperparasitoid fauna attacking *C. melanoscelus* in Yugoslavia with that reported in New England by Muesebeck and Dohanian (1927); they found 35 species in New England versus 31 species in Yugoslavia. Vasic and Minic (1976) noted that *C. melanoscelus* was no more effective in North America than it was in Europe, since it encountered a guild of polyphagous hyperparasitoids with no need to adapt to it, and use the same ecological niches as their European relatives.

A thorough understanding of the makeup of the hyperparasitoid complex attacking *C. melanoscelus* is needed to develop release protocols that will facilitate its escape from its hyperparasitoid complex. The present paper examines selected biological parameters of 20 species of hyperparasitoids active in Maryland against *C. melanoscelus*. Since little is known about the biology of most of these species, results give useful insights on the nature of hyperparasite complexes in general as well as insights into the preferred methods of releasing *C. melanoscelus* in particular. Results should be useful to agencies contemplating the release of *C. melanoscelus* as well as to general studies of parasitoid release into an environment rampant with hyperparasitoids.

ACKNOWLEDGMENTS

We thank Michael Schauff (USDA SEL) and Kevin Thorpe (USDA Insect Biocontrol Laboratory) for reading and suggesting changes to an earlier draft of this manuscript. We further thank two anonymous reviewers for their reviews and taxonomic corrections.

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SCIENTIFIC NOTE:

ADDITIONAL ILLINOIS AND WISCONSIN MAYFLY RECORDS, INCLUDING *HOMOEONEURIA AMMOPHILA* (EPHEMEROPTERA: OLIGONEURIIDAE) IN ILLINOIS.[1]

T. H. Klubertanz[2], C. R. Hess

Randolph and McCafferty (1998) summarized the literature and presented new records of mayflies from Wisconsin, Illinois, and four other Midwest states. In 1999 and 2000, streams in northern Illinois and southern Wisconsin were sampled to locate species suspected but not yet found in one or both of these states. These efforts resulted in 3 new Illinois and 4 new Wisconsin records. All specimens were collected by the authors. Newly reported materials are deposited at the Purdue Entomological Research Collection, West Lafayette, IN (PERC) and in the collection of the first author (THK).

New Wisconsin records include *Procloeon irrubrum* Lowen and Flannagan [larva, Turtle Creek, bridge on Smith Road between Shopiere and Tiffany, Rock Co., WI, VII-27-1999, PERC]; *P. rubropictum* (McDunnough) [2 larvae, Turtle Creek, bridge on Smith Road between Shopiere and Tiffany, Rock Co., WI, VII-27-1999, PERC]; and *Timpanoga lita* (Burks) [3 larvae, Sugar River, 100 yds N of Hwy 11 bridge, 1 mi SW of Brodhead, Green Co., WI, V-26-1999, PERC; larva, Sugar River, Albany, Green Co., WI, V-26-1999, THK].

New Illinois records include *Centroptilum bifurcatum* McDunnough [2 larvae, Sugar River, Sugar River Forest Preserve, Winnebago Co., IL, V-22-2000, PERC], *P. irrubrum* [larva, Sugar River, Sugar River Forest Preserve, Winnebago Co., IL, VII-5-1999, PERC] and *Pseudocloeon ephippiatum* (Traver) [larva, Sugar River, bridge on Yale Bridge Road, 3 mi NW of Shirland, Winnebago Co., IL, VII-9-1999, PERC].

In addition, we report the first recent record of *Homoeoneuria ammophila* (Spieth) from Illinois [19 larvae, 1 subimago, Sugar River, bridge on Yale Bridge Road, 3 mi NW of Shirland, Winnebago Co., IL, IX-24-1999, PERC and THK]. Lillie (1992) also found this species in the Sugar River, but about 6 mi upstream in Wisconsin. *H. ammophila* is known from a number of other Midwest states, including Indiana, Iowa, and Kansas (McCafferty and Hubbard 1998; Pescador and Peters 1980; Randolph and McCafferty 1998). The only published records from Illinois are of specimens taken from the Rock River in 1925 (Burks 1953). We collected larvae from a sand bar in the center of the river channel using a D-framed aquatic net, occasionally yielding several larvae per sample.

(continued on page 284)

HAGEN'S SMALL MINNOW MAYFLY (EPHEMEROPTERA: BAETIDAE) IN NORTH AMERICA[1]

M. D. Meyer, W. P. McCafferty[2]

ABSTRACT: The study of newly acquired larvae and adults of *Diphetor devinctus* associated by rearing in California showed larvae to be indistinguishable from those of *D. hageni*. This, and the further observation from extensive materials that male genitalia differences previously accorded the two species do not hold up but are highly subject to individual and population variability, are the basis for placement of *D. devinctus* as a junior subjective synonym of *D. hageni*, n. syn. The complex nomenclatural history of the North American species and monobasic genus as well as characterization are reviewed, and distribution is documented.

The history of nomenclature and of discovery surrounding the now relatively well known North American baetid species *Diphetor hageni* (Eaton), or Hagen's Small Minnow Mayfly, is complex. The species was originally described as *Cloe unicolor* Hagen (Hagen 1861) based on a female adult taken in the District of Columbia, the type of which resides at the Museum of Comparative Zoology (MCZ) at Harvard University. Eaton (1871) recombined the species with the genus *Baetis* Leach. Somewhat later, when the original name was found to have been used previously by Curtis (1834) for another species, Eaton (1885) renamed Hagen's species *Baetis hageni* Eaton. American workers for much of the 20th Century, however, did not use the replacement name proposed by Eaton (e.g., McDunnough 1923, Traver 1935, Burks 1953), but continued to refer to the species as *B. unicolor*. McDunnough (1923) purportedly associated males with the females of the species in Canada, but later (McDunnough 1925a) indicated that his identification was actually applicable to *B. brunneicolor* McDunnough.

McDunnough (1921, 1925a) and Traver (1935) indicated that *Baetis unicolor* (Hagen) could not be identified with certainty based on re-examination of the type by both Nathan Banks (see McDunnough 1921) and James Needham (see Traver 1935). Burks (1953) also claimed that the species was unrecognizable and therefore could not confirm Walsh's questionable identifications of the species from Rock Island, Illinois collected in the 1860's.

Edmunds (1962) provided clarification that the use of Hagen's name *unicolor* was incorrect according to applicable nomenclatural rules. He therefore upheld Eaton's rejection of the secondary homonym in question and the use of the newer name *Baetis hageni*, and for some 25 years hence the species was known as *B. hageni* (e.g. Edmunds et al. 1976). Careful restoration of the

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[1] Received January 13, 2001. Accepted January 25, 2001.

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type of *B. hageni* by Edmunds (1962) revealed that the species was equivalent to what had in the meantime been described as *Baetis herodes* Burks from Illinois and Indiana (Burks 1953), and as a result Edmunds synonymized the latter name with the former. Edmunds (1962) also indicated that several adult specimens from throughout much of eastern North America, identified by Herman Spieth as *Baetis parvus* Dodds and deposited at the American Museum of Natural History, were actually *B. hageni.* Finally, because Burks (1953) had also associated and described the larval stage of his *B. herodes*, Edmunds (1962) was able to show that larvae from Ontario previously described as *B. parvus* by Ide (1930) were also applicable to *B. hageni*, and had represented the first larval description of the species.

In their comprehensive study of larvae of *Baetis* in North America, Morihara and McCafferty (1979) showed that *B. hageni* was a highly unique species that was probably most closely related to *B. devinctus* Traver, based on similarities of the adults (the latter remained unknown in the larval stage). Morihara and McCafferty (1979) confirmed the Edmunds conclusions regarding synonymy and further showed that *B. parvus*, originally described from Colorado by Dodds (1923) was also a junior synonym of *B. hageni.* Morihara and McCafferty (1979) also restudied the larvae that Burks (1953) had associated with the species. As a result of reared associations of larvae and adults of *B. hageni* in Indiana by Morihara and McCafferty (1979), those authors showed that the male larva described by Burks was actually *B. macdunnoughi* Ide, but that he had correctly associated the female larva.

Waltz and McCafferty (1987a) designated *B. hageni* to be the type of their new North American genus *Diphetor* Waltz and McCafferty. The species has thus been known as *D. hageni* since that time (e.g., McCafferty 1996). *Diphetor* is not related to *Baetis* and other related genera of the *Baetis* complex as is shown, for example, by the absence of a villopore in the larval stage. Waltz and McCafferty (1987a) further distinguished the genus by the lack of gills on abdominal segment 1 in combination with a reduced prostheca of the right mandible. The only other species placed in *Diphetor* was *D. devinctus* Traver, a species that Morihara and McCafferty (1979) had deduced from adults was closely related to *D. hageni.* Traver (1935) in her description of *D. devinctus* (as *Baetis*) compared it with *B. parvus* and had indicated that it differed from the latter only in its possession of a tubercle on the medial margin of the forceps base of the male genitalia. Waltz and McCafferty (1987a) indicated that their generic placement of *D. devinctus* was based on the study of reared but undescribed larvae of the species, with no other details provided at the time.

Soldán and Thomas (1983) described the species *Baetis rhithralis* Soldán and Thomas from larvae and adults from Algeria. Waltz et al. (1994) placed that species in the genus *Diphetor.* At about the same time, Novikova and Kluge (1994) considered *Diphetor* as a subgenus of *Baetis.* Waltz and

McCafferty (1997) reiterated conclusively that *Diphetor* could not be a subgenus of *Baetis* because it did not even belong to the same complex of genera, as shown, for example, by the fact it did not possess a villopore. Lugo-Ortiz and de Moor (2000) were able to study the type material of the Soldán and Thomas species from Algeria and showed that it is actually a member of the Old World genus *Nigrobaetis* Kazlauskas, rather than *Diphetor*. Thus *Diphetor* appears restricted to North America, and its listing among world genera (Lugo-Ortiz and McCafferty 1999) for the Palearctic region should therefore be emended.

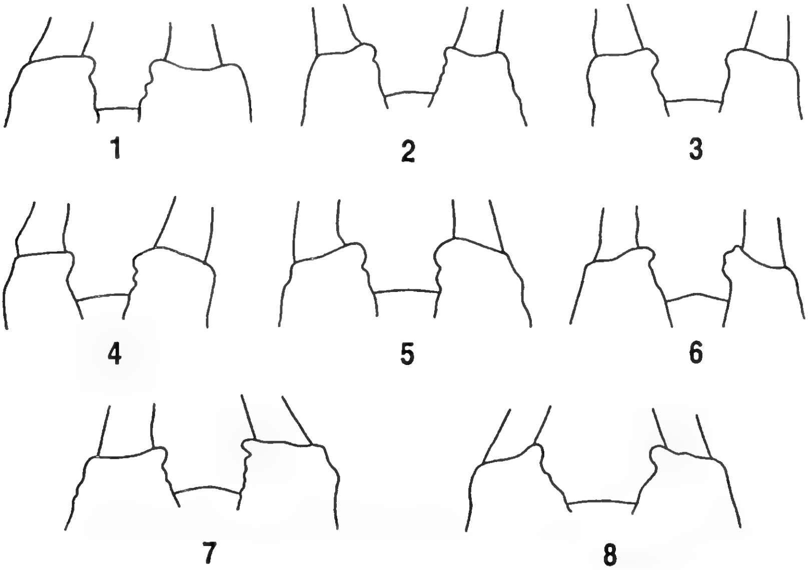
The North American range of *Diphetor hageni* is relatively widespread. In Canada, it is known from New Brunswick to British Columbia in the southern tier of provinces (McDunnough 1925b, Walley 1927, Eidt 1975, Scudder 1975, Morihara and McCafferty 1979, Flannagan and Flannagan 1982, McCafferty and Randolph, 1998), but has yet to be reported from Newfoundland and Prince Edward Island. In northern Canada, it is known only from Nunavut (Cobb and Flannagan 1980, Randolph and McCafferty 2001). The species is not known from Alaska, but its range in the conterminous United States is considerable. The only large geographic region in which it is not represented is the southwest region (see McCafferty and Waltz 1990), and it is not known from the southern tier of southeastern states and Georgia. Otherwise, the species has been reported as relatively widespread in the southeast, northeast, and northwest regions (Traver 1935, Edmunds 1954, Allen and Edmunds 1956, Newell 1970, Moss and Lichtwardt 1975, McCafferty and Provonsha 1978, Newell and Minshall 1978, Dellucchi and Peckarsky 1989, McCafferty 1990, Burian and Gibbs 1991, McCafferty et al. 1993, Long and Kondratieff 1996, Grant et al. 1997, McCafferty et al. 1997, Sarver and Kondratieff 1997, Randolph and McCafferty 1998, Pescador et al. 1999, McCafferty et al. 2001).

Diphetor devinctus has been reported from four counties in California (Traver 1935, Day 1956), a state where it evidently co-occurred with *D. hageni*.

VARIABILITY

As part of our current study of the California Ephemeroptera fauna, we realized that the unknown larval stage of *D. devinctus* needed to be discovered and described so that *D. hageni* and *D. devinctus* could be differentiated as larvae where their ranges overlap. In this respect, we were able to acquire larvae and adults from Marin County, California (see Material Examined) that were associated through rearing by Lawrence Serpa. Male adults had the typical form of genitalia that had historically been associated with *D. devinctus*. A thorough examination of the morphology of the larvae indicated that they were identical to those described for *D. hageni* by Morihara and McCafferty (1979), with the exception that one leg of one specimen was found to have one less claw denticle than the range reported for the latter species. That difference, however, is inconsequential.

The identicalness of the larvae that could now be associated with either name, strongly suggested to us that there was actually only one species involved. Baetid workers in general (e.g., Müller-Liebenau 1970, Morihara and McCafferty 1979, Waltz and McCafferty 1987b, Lugo-Ortiz and McCafferty 1996, 1998) have found that larval differences are foremost in species level discernment. Nonetheless, we undertook a comprehensive study of male genitalia in extensive materials of both *D. hageni* and *D. devinctus* to determine if perhaps adults but not larvae demonstrated species differences. We found that the medial shape of the forceps base—the character used to separate the species of *Diphetor*—varied considerably among *D. hageni* individuals from non-California populations. Variability (Figs. 1-5) included having very little or undetectable medioapical development to having a somewhat developed apical rim medially to having what has been referred to as a tubercle medioapically, as originally associated with *D. devinctus* (Traver 1935). This characteristic not only varied between populations, but also varied within populations, and in some cases was found to vary from the left to right forceps base on the same individual. We also found variability in California material (Figs. 6-8).



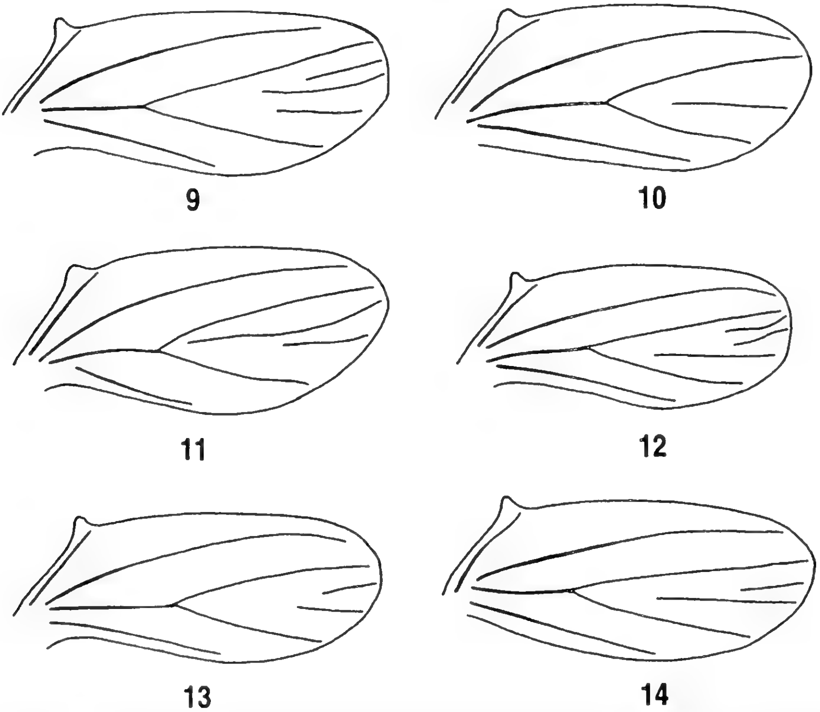
Figs. 1-8. *Diphetor hageni* adult male genetalia [Var. = variant, Pop. = population]. 1. Var. 1 (ID), 2. Var. 2 (IN Pop. 1), 3. Var. 3 (IN Pop. 2), 4. Var. 4 (IN Pop. 2), 5. Var. 5 (MT), 6. Var. 6 (CA Pop. 1), 7. Var. 7 (CA Pop. 2), 8. Var. 8 (CA Pop. 2).

Because there evidently is no distinction between either the larvae or the adults of what have been called *D. hageni* and *D. devinctus*, we herein formally place *D. devinctus* as a subjective junior synonym of *D. hageni*, n. syn. It was of interest to us that among Day's collected California materials in our possession, there were adult specimens he collected together in 1950 that he identified variously as *D. devinctus*, *D. hageni*, and *D. parvus*. This is now certainly explicable based on the subsequent synonymy of *D. parvus* by Morihara and McCafferty (1979) and on our present synonymy of *D. devinctus*. Day may have been suspicious of the integrity of the species in California because he did not mention his *D. hageni* or *D. parvus* material in his later review of California mayflies (Day 1956).

In identifying adults of *Diphetor* among other similar baetid adults in North America, the presence of a forked second vein originating in the basal half of the hindwings has been utilitarian (e.g., see key couplet 34 in Edmunds and Waltz 1996). Waltz and McCafferty (1987a) and Durfee and Kondratieff (1993) had shown that a forked second vein was not entirely exclusive to *Diphetor*, however, because it can occur in some *Baetis* species, but originating in the distal half of the wing or barely so. When examining variability in the adults of *D. hageni*, we found the presence of the fork was stable, but there was variability with respect to the position of the fork (originating at approximately midlength or somewhat basad of midlength) and the number and relative development of the marginal intercalaries within the fork (one to three of various lengths) (Figs. 9-14). Variability in the intercalaries is to be expected in baetid hindwings, but we would caution that the position of the origin of the fork of a forked second vein must now be used with caution because occasionally variants of the very common species *B. tricaudatus* Dodds and some variants of *D. hageni* demonstrate a fork originating very near the midlength of the wing.

MATERIAL EXAMINED

The following materials are deposited in the Purdue Entomological Research Collection, West Lafayette, Indiana. ARKANSAS: Newton Co, Mill Cr, St Rd 7, 1 mi S Dogpatch, V-29-1974, McCafferty et al. (larvae). CALIFORNIA: Napa Co, Sage Cr, V-13-1950, Day (adults); Marin Co, Lagunitas Cr, .5 mi W Jewell, VIII-26-1982, Serpa (larvae, adults reared). COLORADO: Saguache Co, Los Pinos Cr, 6 mi SW St Work Ranch, VI-28-1976, Alstad, Taylor (larvae). IDAHO: Bingham Co, Blackfoot, VIII-8-1963, Edmunds (adults); Blaine Co, Trib Big Wood R, VII-24-1964, Jensen et al. (adults); Bonneville Co, Snake R, Palisades, US Hwy 26, VI-28-1964, Jensen, Richardson (larvae); Boundary Co, Deep Cr, US Hwy 95, 5 mi N Naples, III-26-1965, Nebeker (larvae); Custer Co, Warm Cr at Challis, VIII-15-1963 (larvae). INDIANA: Crawford Co, Stinking Frk Blue R, St Rd 66, 1.5 mi S Sulfur Springs, V-14-1976, Provonsha, Minno (larvae); Dubois Co, Trib Flat Cr, St Rd 64, 2 mi W Mentor, V-14-1975, Provonsha, Minno (adults); Fountain Co, Bear Cr nr Fountain, V-26-1978, Provonsha, Minno (larvae); Jennings Co, Green Br, Crosly St. Fish & Wildlife Area, V-7-1974, Provonsha, Dersch (larvae); Lawrence Co, small stream 6 mi SW Bedford, Hwy. 460 W, IV-7-1978, Minno, Bloodgood (adults); Sugar Cr, 1 mi S



Figs. 9-14. *Diphetor hageni* adult hindwing [Var. = variant, Pop. = population]. 9. Var. 1 (ID), 10. Var. 3 (IN Pop. 2), 11. Var. 5 (MT), 12. Var. 6 (CA pop. 1), 13. Var. 7 (CA Pop. 2), 14. Var. 8 (CA Pop. 2).

Bono, VI-20-1974, Provonsha, Dersch (larvae, adults reared); Gullets Cr, 1 mi N Needmore, IV-25-1975, Provonsha, Minno (adults); small stream 4.5 mi S Williams, VI-7-1978, Minno, Bloodgood (larvae); Spring Mill Cr at Spring Mill St Prk, IV-25-1975, V-14-1976, Provonsha, Minno (larvae); Martin Co, Lost R at Windom, VII- 3-1974, Provonsha et al. (larvae); Owen Co, Limestone Cr at St Rd 67, 1.5 mi W Gosport, IV-11-1975, Provonsha, Dersch; Perry Co, Poison Cr, 5 mi NW Derby, V-15-1975, Provonsha et al. (larvae); Oil Cr, 2.5 mi N Leopold, V-15-1975, Provonsha et al. (larvae); Tippecanoe Co, Flint Cr, West Point, IV-8,V-2,5-1975, Provonsha et al. (larvae, adults); Warren Co, W Brch Kikapoo Cr, 2 m. SE Winthrop, V-21-1976, Minno, Morihara (larvae); Little Pine Cr at Highbridge, IV-30-1972, Huff et. al. (larvae); Trib Little Pine Cr, 1 mi W Greenhill, III-25-1972 (larvae). MISSOURI: Barry Co, Roaring R, X-26-1971, Baumann (larvae); Jackson Co, Blue R, IX-28-1971, Lorenz (larvae). MONTANA: Glacier Co, Swiftcurrent Cr, Glacier Nat Prk, VII-24-1955 (adults). NORTH CAROLINA: Forsyth Co, Parkers Cr, III-1987 (larvae). OREGON: Jefferson Co, Metolius R, Riverside For Camp, VII-30-1966, Lehmkuhl (adults); Metolius R, Camp Sherman, VI-20-1954, Edmunds (adults); Metolius R headwaters, VI-15-1966, Lehmkuhl (adults); Wallowa Co, Wallowa R at Wallowa L, VIII-1952, Edmunds (adults). SOUTH DAKOTA: Beadle Co, Hitchcock, V-6-1959 (adults); Lawrence Co, Jim Cr, 3 mi S Nemo, VI-13-1975, McCafferty et al. (larvae); Penningron

Co, Rapid Cr , mouth Dark Cany, Rapid City, VI-13-1975 McCafferty et al. (larvae, adults). UTAH: Box Elder Co., George Cr, 7.5 mi. SE Yost, VII-12-1947, Preece (adults); Cache Co, Blacksmith Frk Cany, VI-14-1046, Harmston (adults); Iron Co, Red Rock Cany nr Parowan, VI-7-1951, Edmunds (adults); Salt Lake Co, Mill Cr, VII-10-1945, Edmunds (larvae); Emmigration Cany, VIII-8-1945, Edmunds (adults); Butterfield Cany, Salt Lake City, VII-4-1945, Mulaik (adults); Sanpete Co, San Pitch R, Fairview, VII-7-1945, Edmunds (adults); Huntington Cany, VII-9-1945, Edmunds (adults); Summit Co., Weber R below Peoa, X-18-1968 (larvae); Summit Co, Wanship, VIII-18-1945, Edmunds (adults); Tooele Co., S Willow Cany, VII-15-1945, Mulaik (adults); Utah Co., Aspen Grove Cr nr Jct, W lower Provo R, Wildwood, X-7-1968 (larvae); Provo R, Hwy 189/91, VII-2-1947 (adults); Orem, IX-16-1944, Edmunds (adults); Wasatch Co, Daniels Cany, VII-22-1947, Edmunds (adults). WYOMING: Laramie Co, Snowy Range Mnt, VII-10-1949, Denning (adults).

ACKNOWLEDGMENTS

We thank R. P. Randolph (West Lafayette, Indiana) for assisting with distributional data and reviewing the draft, and A. V. Provonsha (West Lafayette, Indiana) for advice regarding the illustrations and reviewing the draft. We also thank R. D. Waltz (Indianapolis) for donating reared California specimens to PERC, formerly received from L. Serpa. This research was supported by NSF Grant DEB-990577 to WPM, and the paper has been assigned Purdue ARP Journal No. 16442.

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FIRST RECORD OF *HARMONIA AXYRIDIS* (COLEOPTERA: COCCINELLIDAE) IN SOUTH DAKOTA AND NOTES ON ITS ACTIVITY THERE AND IN MINNESOTA[1]

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ABSTRACT: The first specimen of the exotic coccinellid, *Harmonia axyridis*, from South Dakota was collected in Brookings County in October 1996. Twenty-eight more specimens of *H. axyridis* were collected in Brookings County through April 2000, but none was found at other collecting sites in the state. Specimens were also collected from Minnesota, but subsequent to previous reports of *H. axyridis* there. All of our specimens were adults of the *succinea* color form. Most were collected outdoors and associated with autumn aggregations. Some *H. axyridis* were active in low numbers at a residence in South Dakota throughout winter 1999-2000. Implications of our findings are discussed regarding the behavior and origin of *H. axyridis* in South Dakota and Minnesota, and its possible impact on resident arthropod communities.

Harmonia axyridis (Pallas) (multicolored Asian lady beetle) is a Palearctic species with established populations in North America. It was released intentionally in several states of the US many times between 1916 and 1985 for biological control of various homopteran pests (Coulson 1982, Gordon 1985, McClure 1987, Hoebeke and Wheeler 1996). The first established population in North America was found in Louisiana in 1988 (Chapin and Brou 1991). Populations of *H. axyridis* were subsequently found in several other states (Chapin and Brou 1991, Lyon 1994, Tedders and Schaefer 1994, Dreistadt et al. 1995, Kidd et al. 1995, Pfannenstiel 1995, LaMana and Miller 1996, Krafsur et al. 1997, Brown and Miller 1998, Colunga-Garcia and Gage 1998) and in eastern provinces of Canada (Coderre et al. 1995, Hoebeke and Wheeler 1996, McCorquodale 1998). Widespread but disjoint distribution of *H. axyridis* in North America indicates establishment at distinct times and locations on the continent. In some cases, *H. axyridis* appears to have established via intentional releases (LaMana and Miller 1996), whereas accidental establishment may explain the appearance of other populations in eastern North America (Day et al. 1994).

Various aspects of the biology of *H. axyridis* in North America are becoming clear with the publication of research results and observations from several states and provinces. Knowledge about North American populations of *H. axyridis* includes information on their behavior and activity, morphology, natural enemies, predation, competition, habitat preferences, and population trends (McClure 1987, Tedders and Shaefer 1994, LaMana and Miller 1996,

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[1] Received August 8, 2000. Accepted December 10, 2000.

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ENT. NEWS 112(4): 264-270, September & October, 2001

Nalepa et al. 1996, Brown and Miller 1998, Colunga-Garcia and Gage 1998, Cottrell and Yeargan 1998, LaMana and Miller 1998). We now report the first collections of *H. axyridis* in South Dakota, and recount some observations on its behavior and activity there and in Minnesota.

COLLECTIONS AND OBSERVATIONS

South Dakota. We sampled for coccinellids in eastern South Dakota from October 1996 through April 2000. We collected one *H. axyridis* in 1996, 26 in 1999, and 2 through April 2000 (Table 1). All specimens were adults having orange elytra with varying degrees of black maculation ranging from minute maculae (almost absent) to large, slightly coalescent maculae (*succinea* color form, Komai 1956). Our collections of *H. axyridis* were biased toward maximizing the variation in size, color, and elytral maculation.

All *H. axyridis* were collected in Brookings County (east-central part of the state). Moreover, all but two specimens were collected within a 1-km^2 area about 1 km north of the city of Brookings (T110N, R50W, sec. 12). Many additional *H. axyridis* adults were observed, but not collected, outdoors in October 1999 at this site. One of us (D.A.B.) observed live *H. axyridis* adults several times within a home in the area north of Brookings from November 1999 through April 2000. One specimen was collected on 29 Apr 2000 inside this residence. The area north of Brookings included our laboratory and about 20 homes with lawns, ornamental plants, and fruit and shade trees. The surrounding landscape consisted primarily of agricultural land devoted to field crops and livestock.

The two remaining specimens were collected from two other sites in Brookings County. One was brought to us for identification after it was collected on a yellow sticky trap that had been deployed from 31 Aug to 6 Sep, 1999, in a maize field just north of Aurora (about 5 km east of Brookings, Brookings Co.; T110N, R49W, sec. 34). No other *H. axyridis* were found on an additional 3621 traps that were deployed among that maize field and several others within a 41-sq.-km area between 7 July and 7 September, 1999. The sticky traps were deployed to capture *Diabrotica* spp. (Coleoptera: Chrysomelidae, corn rootworm beetles; Karr and Tollefson 1987). However, they also routinely captured various non-target insects, including individuals of the eight or so coccinellid taxa commonly found in South Dakota maize fields (Elliott et al. 1996). The remaining specimen of *H. axyridis* was collected on March 7, 2000, as the beetle flew about 1 m above a lawn on the campus of South Dakota State University in Brookings.

Between October 1996 and April 2000, we sampled for coccinellids at several other times and locations in eastern South Dakota. For instance, we sampled for adult coccinellids by enumerating species and numbers seen while walking parallel to rows within wheat or barley fields, similar to a method described by Elliott et al. 1991. This type of sampling occurred roughly weekly during May and June 1998 in both a wheat field in Clay County (about 160 km south of Brookings) and a barley field about 2 km north of Brookings. Our efforts also included several avocational collecting trips throughout eastern South Dakota during the summer and autumn months of 1996 through 1999. We found various species of coccinellids, but not *H. axyridis*, at these other locations.

Minnesota. Our sampling for coccinellids in Minnesota was limited to October 1998 and November 1999. In October 1998, 18 *H. axyridis* adults were collected outdoors at Rochester (Olmsted County), and, in November 1999, a single adult was collected indoors at Chanhassen (Carver County) (Table 1). Many additional *H. axyridis* adults were present at the Rochester site. Specimens from Rochester were collected with bias toward maximizing variation in size, color, and elytral maculation. Like those from South Dakota, *H. axyridis* from Minnesota also had the *succinea* color form. Voucher specimens from both states are housed at the Northern Grain Insects Research Laboratory, Brookings.

DISCUSSION

Our collections of *H. axyridis* in South Dakota are the first specimens reported from there. *Harmonia axyridis*, however, had been found previously in Minnesota (Kimball 1998). The origin of *H. axyridis* in South Dakota and Minnesota is unknown, but we have not found records that *H. axyridis* have ever been intentionally released in either state (Coulson 1982, Gordon 1985, McClure 1987). *Harmonia axyridis* may have arrived in South Dakota and Minnesota by geographic range expansion from adjacent states, by accidental introduction(s) (Day et al. 1994), or by both means. Populations of *H. axyridis* in North America are capable of rapid geographic range expansion (Tedders and Schaefer 1994, Kidd et al. 1995, LaMana and Miller 1996, Wheeler and Stoops 1996, Colunga-Garcia and Gage 1998, McCorquodale 1998), as indicated by the radiation of this species during the last decade across much of the eastern half of North America (Tedders and Schaefer 1994, Hoebeke and Wheeler 1996) and west coast of the U.S. (Dreistadt et al. 1995, LaMana and Miller 1996). Alternatively, major air and shipping ports in Minnesota could have allowed for the accidental introduction of *H. axyridis*, as the first collections of many adventive coccinellids in North America are associated with major ports (Day et al. 1994).

Our specimens of *H. axyridis* from South Dakota and Minnesota are variants of the *succinea* color form, and specimens from both states were similar in the range of elytral color form variation. The *succinea* color form predominates in *H. axyridis* populations of North America (Tedders and Schaefer 1994, Coderre et al. 1995, LaMana and Miller 1996, Nalepa et al. 1996).

We collected specimens of *H. axyridis* both outdoors and indoors. Most (45 of 48) specimens were collected outdoors, where they were active on plants, sun-warmed surfaces of buildings, or in flight. We observed and collected many *H. axyridis* as they aggregated in autumn. Similarly, in Oregon, LaMana and Miller (1996) found *H. axyridis* aggregating outdoors in autumn on buildings, outcroppings of rocks, and other conspicuous features of the landscape. In North Carolina and Virginia, Nalepa et al. (1996, 2000) collected *H. axyridis* from buildings in both urban and agricultural areas.

We collected other specimens indoors as they crawled on potted plants or around windows or doorways. In autumn, *H. axyridis* adults can be active in large numbers inside homes, other buildings, and among the hives of domesticated honey bees, making this beetle species a nuisance pest (Tedders and Schaefer 1994, Kidd et al. 1995, Caron 1996, Knodel and Hoebeke 1996, Kimball 1998, Nalepa et al. 2000).

During the winter, *H. axyridis* adults enter diapause (Sakurai et al. 1988), and individuals can overwinter outdoors in North America (McClure 1987). However, we observed indoor activity of *H. axyridis* through the winter. Coccinellids may become active without breaking reproductive diapause during warm periods in winter (Anderson and Richards 1977). Nalepa et al. (2000) have suggested that coccinellid activity may be relatively continuous throughout the winter in heated buildings.

During spring and summer, *H. axyridis* utilizes a wide range of environments, including annual and perennial crop fields and arboreal habitats (Tedders and Schaefer 1994, Coderre et al. 1995, LaMana and Miller 1996, Brown and Miller 1998, Colunga-Garcia and Gage 1998, Cottrell and Yeargan 1998, LaMana and Miller 1998). Individuals prey on a wide range of Homoptera and other arthropods (Tedders and Schaefer 1994, Coderre et al. 1995, Dreistadt et al. 1995, LaMana and Miller 1996, Brown and Miller 1998, Cottrell and Yeargan 1998, LaMana and Miller 1998). The presence of *H. axyridis* in apple orchards in West Virginia improves biological control of *Aphis spiraecola* Patch (Homoptera: Aphididae) (Brown and Miller 1998). Both South Dakota and Minnesota contain a variety of major vegetation types, including some arboreal habitats and many grassland and field crop habitats (Johnson and Larson 1999). As *H. axyridis* was not released for control of any particular arthropod pest in these two states, it will be important to determine its impact on different prey species within the various habitats.

Harmonia axyridis may also impact resident coccinellids in South Dakota and Minnesota. Another exotic coccinellid, *Coccinella septempunctata* L., is associated with reduced abundance of two native coccinellids, *Adalia bipunctata* (L.) and *C. transversoguttata richardsoni* Brown, in South Dakota (Elliott et al. 1996). In West Virginia (Brown and Miller 1998) and in Michigan (Colunga-Garcia and Gage 1998), *H. axyridis* has been associated with population declines of other coccinellid species, including *C. septempunctata*.

It is difficult to predict the eventual effect of an introduced polyphagous predator like *H. axyridis* on biological control of arthropods and on populations of other coccinellids (Elliott et al. 1996). This underscores the need for monitoring in ecosystems in which an exotic predator has been introduced. The recent advent of *H. axyridis* in South Dakota and Minnesota provides opportunities to monitor expansion of its geographic range and to assess its impact upon arthropod communities. Results of such studies can improve our understanding of the merits and limitations of exotic predators within the ecological landscape.

Table 1. Collection data for *Harmonia axyridis* collected in South Dakota and Minnesota.

Collection date	Nearest town	Description of collection site	Number collected
South Dakota, Brookings County			
25 Oct. 1996	Brookings	Outdoors, south-facing walls of garden shed	1
6 Sep. 1999	Aurora	Outdoors, maize field, yellow sticky trap	1
18 Sep. 1999	Brookings	Outdoors, *Zinnia* sp. flowers	1
8 Oct. 1999	Brookings	Outdoors, south-facing walls of garden shed	6
9 Oct. 1999	Brookings	Outdoors, south-facing walls of garden shed	2
10 Oct. 1999	Brookings	Outdoors, south-facing walls of garden shed	3
14 Oct. 1999	Brookings	Outdoors, south-facing walls of garden shed	7
22 Oct. 1999	Brookings	Outdoors, flower bed	1
24 Oct. 1999	Brookings	Indoors, near window of house	1
25 Oct. 1999	Brookings	Outdoors, south-facing walls of garden shed	3
26 Oct. 1999	Brookings	Outdoors, in flight over lawn	1
7 Mar. 2000	Brookings	Outdoors, in flight over lawn, South Dakota State University campus	1
29 Apr. 2000	Brookings	Indoors, above doorway of house	1
Minnesota, Olmsted County, Visitor Center, Quarry Hill Nature Reserve			
24 Oct. 1998	Rochester	Outdoors, south-facing walls of visitor center	8
26 Oct. 1998	Rochester	Outdoors, south-facing walls of visitor center	3
28 Oct. 1998	Rochester	Outdoors, south-facing walls of visitor center	7
Minnesota, Carver County			
25 Nov. 1999	Chanhassen	Indoors, window of house	1

ACKNOWLEDGMENTS

We thank Robert D. Gordon for identifying specimens of *H. axyridis*. Debra Hartman furnished the specimen of *H. axyridis* collected near Aurora and information about its collection. Norman C. Elliott, B. Wade French, J. Bruce Helbig, Lauren A. Hesler, and Paul J. Johnson graciously reviewed drafts of this manuscript.

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BOOKS RECEIVED AND BRIEFLY NOTED

HANDBOOK OF VEGETABLE PESTS. John L. Capinera. 2001. Academic Press. $8^1/_2$ x 11 format. 729 pp. Hard. $150.00.

This volume provides a comprehensive survey of all garden and farm pests likely to be encountered in North America. This Handbook provides thorough identification guides, descriptions of past life histories, and pest management recommendations. The text is illustrated with hundreds of line drawings as well as color plates for ease in identification.

THE TRIUMPH OF SOCIOBIOLOGY. John Alcock. 2001. Oxford University Press. 256 pp. Hard. $27.50.

In this objective approach to the sociobiology debate, the author shows how sociobiologists study behavior in all species. He confronts the principal scientific and ideological objections with a compelling analysis of case histories that involve topics as sexual jealousy, beauty, gender differences, parent-offspring relations, and rape and, in so doing, shows that sociobiology provides the most satisfactory scientific analysis of social behavior available today.

FIRST CANADIAN RECORDS OF *TENUIPHANTES CRACENS* AND *WALCKENAERIA CLAVIPALPIS* (ARANEAE: LINYPHIIDAE), PLUS THIRTEEN NEW PROVINCIAL RECORDS AND A CONFIRMATION FOR QUÉBEC[1]

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ABSTRACT: The occurrence of *Tenuiphantes cracens* and *Walckenaeria clavipalpis* is reported for the first time in Canada. Thirteen other species are reported for the first time in Québec. The total number of species for Québec is now estimated at 825. *Poeciloneta aggressa* is the first cordilleran animal species recorded on the eastern side of the North-American continent. A biogeographical approach is complementary to strict contiguity criteria to predict species distribution.

Our knowledge of the spider fauna of eastern Canada and Québec has increased considerably during the last decade, thanks to the species list of Bélanger and Hutchinson (1992), the work of Hutchinson (1994), Koponen (1987, 1990, 1994), and Dondale and Redner (1994). According to Hutchinson and Bélanger (1994), 171 species records might be added to the Québec list on the basis of their occurrence in nearby localities from adjacent Canadian provinces or American states.

The purpose of this paper is to present new Canadian and provincial records and to confirm a doubtful record for Québec.

METHODS

We have worked with specimens collected during spider diversity projects in Abitibi and Gaspé Park. Other records were added when identifying specimens from three collections: CNC (Canadian National Collection), CPAD (Paquin and Dupérré Collection) and LLC (Laurent LeSage Collection).

RESULTS

The following section presents collection data for the new Canadian records, the new records for Québec, and finally the confirmation of a doubtful provincial record. The acronym at the end of data given for each species indicates where the specimens are deposited.

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Taxonomic note. We are following Platnick (1998) for taxonomy and synonymy up to 1995, Buckle et al. (2001) for taxonomy and synonymy of the Linyphiidae and Saaristo and Tanasevitch (1996) who split the genus *Lepthyphantes* and created numerous new genera including the genus *Tenuiphantes*, which is treated here.

New records for Canada:

Tenuiphantes cracens (Zorsch, 1937) (Linyphiidae). •Québec: Gaspé-Ouest co., Gaspé Park, Lac du Caribou (Site #3). 1 male, pitfall trap, 12-19.VIII.1991. F. Landry. CNC. •Québec: Gaspé-Ouest co., Gaspé Park, Mount Jacques-Cartier in subalpine zone, 1 male, 08.VII.1991. J. Bertrand. CPAD.

Walckenaeria clavipalpis Millidge, 1983 (Linyphiidae). •Québec: Gaspé-Ouest co., Gaspé Park, Lac du Caribou (Site #3). 2 females, pitfall trap, 30.VI-07.VII.1991. F. Landry. CNC.

New records for Québec:

Coriarachne brunneipes Banks, 1893 (Thomisidae). •Québec: Saguenay co., Sept-Iles. 1 female, under bark, 08.IX.1991. C. Chantal. CPAD.

Ebo pepinensis Gertsch, 1933 (Philodromidae). •Québec: Saguenay co., Moisie, under dry pieces of wood on the shore. 1 female, 19.VI.1991; 1 female, 22.VI.1991. C. Chantal. CPAD.

Euophrys monadnock Emerton, 1891 (Salticidae). •Québec: Pontiac co., Parc de la Gatineau, Luskville. 1 male, flight-interception trap in forest clearings, 10-17.VI.1986. L. LeSage. CPAD.

Floricomus nasutus Emerton, 1911 (Linyphiidae). •Québec: Pontiac co., Lac de la Vieille, Réserve faunique La Vérendrye. 2 females, sifting moss in bog, 16.VI.1982. C.D. Dondale and J.H. Redner. CNC.

Halorates alascensis (Banks, 1900) (Linyphiidae). •Québec: Gaspé-Ouest co., Gaspé Park, Mines Madeleine. 2 females, sifting leaf litter, 30.VI.1989. J.M. Campbell. CNC. •Québec: Gaspé-Ouest co., Gaspé Park, Mount Jacques-Cartier in subalpine zone, 1 female, damp *Sphagnum* and krummholz, 29.VII.1991. S. Forest. CPAD. •Québec: Gaspé-Ouest co., Gaspé Park, Lac Sainte-Anne. 1 female, beating *Equisetum* and *Carex* on lake shore, TP10, LL89-51, 02.VII.1989. L. LeSage. CNC.

Oxyopes scalaris Hentz, 1845 (Oxyopidae). •Québec: Pontiac co., Sheenboro, LL92-40 sample. 2 males, 1 female, 5 juveniles, beating *Juniperus communis*, 13.VI.1992, L. LeSage. CPAD, LLC. •Québec: Pontiac co., Fort-Coulonge, LL92-39 sample. 1 male, in a forest opening with *Rumex acetosella* L. and pines, 13.VI.1992, L. LeSage. CPAD.

Pelecopsis mengei (Simon, 1884) (Linyphiidae). •Québec: Abitibi co., Lac Duparquet, cedar/balsam fir forest. 1 male, sifting litter and berlese extraction, 06.X.1993, P. Paquin. •Québec: Saguenay co., Rivière aux Bouleaux. 1 female, under washed up algae, 01.VII.1991. C. Chantal. CPAD.

Poeciloneta aggressa (Chamberlin & Ivie, 1943) (Linyphiidae). •Québec: Gaspé-Ouest co., Gaspé Park, Mount Logan (1040m), in a black spruce opening. 1 male, pitfall trap, 20.VI-07.VII.1993. F. Landry. CPAD.

Sciastes dubius (Hackman, 1954) (Linyphiidae). •Québec: Gaspé-Ouest co., Gaspé Park, Mount Albert, Lac Quiscale. 1 female, pitfall trap, 15-22.VI.1991; 1 female, pitfall trap, 01-07.VII.1991. D. Milette. CNC.

Sisicottus quoylei Miller, 1999 (Linyphiidae). •Québec: Gaspé-Ouest co., Gaspé Park, Lac de la Tonne. 1 female, beating on lake shore, 03.VII.1989, L. LeSage. CPAD.

Tapinocyba flagellata (Emerton, 1911) (Linyphiidae). •Québec: Gaspé-Ouest co., Gaspé Park, Lac du Caribou, TP17, LL 89-67 Sample. 1 female, beating in forest trail, 05.VII.1989. L. LeSage. CNC.

Tapinopa bilineata Banks, 1893 (Linyphiidae). •Québec: Missisquoi co., St-Armand. 2 females, trampling vegetation in marshes, 11.X.1999. C. Chantal. CPAD.

Walckenaeria lepida Kulczynski, 1885 (Linyphiidae). •Québec: Saguenay co., Moisie. 1 male, beating vegetation along seashore, 25.VI.1991. C. Chantal. CPAD.

Confirmation of a doubtful record for Québec

Ero leonina (Hentz, 1850) (Mimetidae). •Québec: Abitibi co., Lac Duparquet, cedar/balsam fir forest. 1 male, Malaise/flight-interception trap, sample #3825, 01-08.IX.1996. P. Paquin. CPAD. •Québec: Nouveau-Québec Territories: 49°48'N, 78°53'W (122km N. of La Sarre), open black spruce forest. 1 female, pitfall trap, sample #5518, 28.IX-05.X.1997. P. Paquin & N. Dupérré. CPAD. •Québec: Nouveau-Québec Territories: 49°48'N, 78°43'W (126km N. of La Sarre), open black spruce forest. 2 females, flight-interception trap, sample #P-2496, 07-14.IX.1997. P. Paquin & N. Dupérré. CPAD. •Québec: Nouveau-Québec Territories: 49°51'N, 78°38'W (131km N. of La Sarre), mature black spruce forest. 1 male, flight-interception trap, sample #P-1975, 17-24.VIII.1997. P. Paquin & N. Dupérré. CPAD.

DISCUSSION

Ten of the sixteen species records reported here for Québec were included in the predictions of Hutchinson and Bélanger (1994) established on the basis of their known distributions which are contiguous with this province. These species are widespread in Canada and/or were known from adjacent localities, provinces and states. The occurrence of *Coriarachne brunneipes, Ebo pepinensis, Euophrys monadnock, Halorates alascensis, Oxyopes scalaris, Pelecopsis mengei, Tapinocyba flagellata, Sciastes dubius, Tapinopa bilineata* and *Walckenaeria lepida* is now established in Québec. The records of *O. scalaris* adds the family Oxyopidae to the provincial list and brings to 27 the number of families known for this province.

The remaining six species were not included in Hutchinson and Bélanger (1994) probably because these are rarely collected and known only from a few specimens and localities which makes predictions based on distribution data rather difficult. Predictions based only on contiguous distribution from localities adjacent to the Québec border are rather limited and less reliable than those based on biogeographical characteristics, especially for species with a discontinuous distribution. As an example, LeSage and Paquin (2001) defined the alpine-appalachian biogeographical category for species that live above the tree line, exclusively on top of the highest Appalachian mountains. Consequently, species currently known from the top of Mount Marcy, Mount Kathadin, Mount Washington, and Mount Whiteface in the United States can be expected on the highest summits of Gaspé Peninsula (Mount Jacques-Cartier, and other summits above 1000m) because this mountain chain extends well into the Gaspé Peninsula.

The only previous record of *Walckenaeria clavipalpis* is from the type-locality: Mount Whiteface (NY) (Millidge 1983), and *Tenuiphantes cracens* was known from Mount Whiteface, its type-locality, but also from Mount Marcy (NY) (Zorsch 1937). As mentioned above, these localities are situated in the Appalachians, a mountain chain that reaches its northern limit in the Gaspé Park. The known records from New York state mountains suggested some alpine and appalachian affinities and our collections in the Gaspé Park support it. These two new records from Canada add a second and a third locality for the species. According to LeSage and Paquin (2001), thirteen biogeogaphical elements characterize the faunal and floral components of Gaspé Park. These two species might fit into the appalachian and alpine-appalachian biogeographical categories; the first category describes the species found in the appalachian zone and the second one refers to species restricted to the alpine and subalpine habitats of the same zone. According to this classification, the species that belong to the alpine-appalachian category show a disjunct distribution restricted to summits of the Appalachian mountain chain. On the basis of actual knowledge, this category applies to *W. clavipalpis* and *T. cracens* because both show disjunct distributions and are only known from alpine habitats. Further collecting may however reveal a wider distribution than actually pictured and demonstrate that these species are not restricted to mountain areas.

This biogeographical approach of LeSage and Paquin (2001) is also of interest for the interpretation of the known distribution of *Poeciloneta aggressa.* In addition to Gaspé Park, the only other Canadian record is from Chinook Lake, Alberta, at an elevation of 1396m (Buckle et al. 2001 and D. Buckle pers. comm.). Three additional localities are known from the United States: lodgepole forest on a mountain top in Wyoming (Levi and Levi 1951), Wasatch Mountains and Uintah Mountains in Utah (Chamberlin and Ivie 1943), and Washington from an unnamed locality that ranges from 700 to over 2000m (Crawford 1988). *Poeciloneta aggressa* in now known as a Nearctic species that would fit the cordilleran category of LeSage and Paquin (2001). Similar disjunct distributions were discovered by the botanist M.L. Fernald while he was collecting rare plants on the mountains of Gaspé Park (Fernald 1925). According to him, these plants survived on nunataks during the last glaciation. However, recent studies on the Quaternary period proved that such nunataks did not exist in Gaspésie (Richard et al. 1997). Consequently, the hypothesis of a migratory corridor at the front of the ice sheet as originally proposed by another botanist, Marie-Victorin, seems to be the correct interpretation of the present apparent disjunct distribution of these plants and animals (Marie-Victorin 1938). It must be pointed out, however, that since these species are always extremely rare and difficult to find, it is possible that their present disjunct distribution reflects only a lack of information rather than a real biogeographical phenomenon. For instance, the Bracted Honeysuckle, *Lonicera involucrata* (Richards.) Banks, considered cordilleran by Fernald and Marie-Victorin, appeared clearly transcontinental and subarctic after 50 new stations were added (Raymond 1950). It is possible that similar misinterpretation also applies to *P. aggressa*, but on the basis of the information presently at hand, it appears to be a typical cordilleran species which has migrated to Gaspé in the past. Eskov and Marusik (1992) also reported *P. aggressa* from northern Asia but it later turned out to be a misidentification for *Poeciloneta dokutchaevi* Eskov & Marusik, 1994 (Eskov 1994).

The one previous record in Canada for *Floricomus nasutus* is from near Belleville, Ontario (Dondale 1971). The other known localities are from the United States: New Hampshire, New York, New Jersey and the District of Columbia (states recorded in Buckle et al. 2001). The present record of *F. nasutus* extends its northern distribution by more than 300km.

Sisicottus quoylei is a recently described species that occurs in Newfoundland, New Brunswick, Nova Scotia and New York (Miller 1999). These records are adjacent to Québec and our record perfectly fits the known distribution.

The records of *Ero leonina* are reported here to clarify its presence and identity in Québec. This species has been mistaken for *Ero canionis* or *Ero furcata* (see Paquin et al. 2001 for details). *Ero leonina* is a widespread species and its distribution extends from the United States to southern Canada (Kaston 1978). The records given here confirm its presence in the province and broaden its distribution to latitude 49°51'N, into the Canadian boreal forest.

CONCLUSION

Hutchinson and Bélanger (1994) have estimated a fauna of approximately 700 spider species for Québec. With the records reported here, 623 species are now known for the province but there are still 148 expected species (Paquin et al. 2001). However, a significant proportion of species newly recorded herein (6 of 16 records) were not included in the predictions of Bélanger and Hutchinson (1994). If the same ratio is applied to estimate the entire spider fauna of the province, we obtain a figure of 825 species for Québec, which demonstrates that contiguity should not be taken as the only predictive tool to establish probable faunal lists. A biogeographical approach could lead, in this regard, to complementary predictions, especially in the case of species with disjunct distributions.

Lalongé et al. (1997) found three species new to Canada in cultivated fields at l'Acadie in southern Québec, of which two were recently introduced in North America. In contrast, the fact that all species reported here are native reveals important gaps in our knowledge rather than a recent species introduction or an expansion of a population. Our knowledge about our native fauna is very sparse.

ACKNOWLEDGMENTS

We are thanking C.D. Dondale, P.P. Harper and R. Hutchinson for their comments on an earlier version of the manuscript. We are also grateful to Jim Redner for his comments and expertise. We also thank Fred Coyle and Don Buckle for their review. Finally, we are grateful to all the staff members of Gaspé Park for their assistance and work in the field.

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BOOK RECEIVED AND BRIEFLY NOTED

ESSENTIAL ENTOMOLOGY: An Order by Order Introduction. George C. McGavin. 2001. Oxford University Press. 318 pp. Soft. $35.00.

An order by order introduction and reference handbook for students of biological sciences in general and entomology in particular. This is a concise guide to the insect orders world-wide and to what makes insects special and successful. In brief, it is an affordable, accessible, and short entomology primer that makes the differences between the orders very clear.

NEW NEOTROPICAL RECORDS FOR THREE *ZOROTYPUS* SPECIES (ZORAPTERA: ZOROTYPIDAE)[1]

Michael S. Engel[2]

ABSTRACT: New locality records are provided for three species of Neotropical *Zorotypus*. New locality data within Peru for *Zorotypus huxleyi* Bolivar y Pieltain and Coronado and *Z. manni* Caudell are presented as are records of *Z. gurneyi* Choe in Costa Rica.

The order Zoraptera is a small, enigmatic group with a pantropical distribution. Presently 34 species are recognized, only three of which are distributed outside of the Tropical zone — *Zorotypus hubbardi* Caudell in North America and *Z. medoensis* Hwang and *Z. sinensis* Hwang in Tibet. Although multiple genera have been proposed for the order (e.g., Kukalová-Peck and Peck 1993; Chao and Chen 2000), these have all been synonymized with *Zorotypus* and the recognition of multiple genera for this homogenous and species-depauperate group is superfluous (see Engel and Grimaldi 2000). In addition to the living species, two fossils have been discovered in early Miocene amber from the Dominican Republic (Poinar 1988; Engel and Grimaldi 2000) and additional fossils await description (Engel and Grimaldi in prep.). Species are gregarious, live under bark in decaying logs, and feed mostly on fungi although they may also prey on small invertebrates such as mites. Owing to the ephemeral, subcortical environments that *Zorotypus* species inhabit, an ability to disperse is critical. The presence of two morphs within a species (i.e., apterous and blind *versus* winged and fully eyed) is associated with the dispersal of individuals to new habitats. As in termites and ants that nest in logs and where most individuals are wingless, *Zorotypus* species use winged forms for dispersal to new nesting sites and establishment of new colonies. Since it appears as though females mate prior to dispersing (Choe 1992), the rarity of winged males is not unusual. Once a new site is found, individuals shed their wings and apterous, eyeless morphs are produced. The presence of eyes in winged, dispersal-oriented individuals is intuitive since such individuals would perhaps need additional sensory information for locating and selecting a suitable nest-site. Although individuals have not been observed dispersing, the idea that winged morphs are produced for dispersal is further corroborated by the demonstration that factors such as crowding and habitat quality can affect the production of winged females (Choe 1992). The dispersal abilities of *Zorotypus* species is at least partially supported by the

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[1] Received February 17, 2001. Accepted March 13, 2001.

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ENT. NEWS 112(4): 278-280, September & October, 2001

growing body of distributional information for some species.

Herein I provide additional locality information for three Neotropical species of this poorly recorded order of insects.

Zorotypus huxleyi Bolivar y Pieltain and Coronado

New records. PERU: Department of Madre de Dios: 2 apterous ♀♀, 2 apterous ♂♂, 2 dealate ♂♂, 1 nymph, Pantiacolla Lodge, Monk Saki Trail, Alto Madre de Dios River, 400 m, 12°39'22"S, 71°13'55"W, 25 October 2000, R. Brooks, PERU1B00-095, ex: under bark. Deposited in the Division of Entomology, Natural History Museum and Biodiversity Research Center, University of Kansas.

Remarks. This is a remarkably distinctive species. While the genitalic structure is indeed diagnostic, the species can more quickly be recognized by the unique structure of the metafemoral spines. The posterior row on the ventral surface of the metafemur is comprised of three or four exceedingly stout, slightly curved, elongate spines, progressively decreasing in size toward the metafemoral apex (Bolivar y Pieltain and Coronado 1963). This species was previously recorded from near Manaus, Brazil (New 1978) and recently from Pucallpa, Loreto Province, Peru (Engel 2000). The current specimens are the first records for the province of Madre de Dios.

Zorotypus manni Caudell

New records. PERU: Department of Madre de Dios: 5 apterous ♀♀, 1 nymph, Cocha Otorongo, Reserved Zone, Manu National Park, 310 m, 12°2'1"S, 71°11'58"W, 21 October 2000, R. Brooks, PERU1B00-059, ex: under bark. Deposited in the Division of Entomology, Natural History Museum and Biodiversity Research Center, University of Kansas.

Remarks. This is an uncommon species that was previously known from Bolivia. Recently I recorded a single female collected in Junin Province, Peru (Engel 2000). The current material partially fills in the distribution gap between the type locality in Bolivia and the population in south-central Peru and is also the largest series presently known for the species. The male for *Z. manni* remains undiscovered.

Zorotypus gurneyi Choe

New records. COSTA RICA: Guanacaste Province: 1 apterous ♀, 1 apterous ♂, 10 dealate ♀♀, 4 dealate ♂♂, Cacao Biological Station, 1050 m, 10°55'38"N, 85°27'7"W, 10 July 2000, J. Ashe, R. Brooks, Z. Falin, CR1ABF00-086, ex: under bark. 4 apterous ♀♀, 4 apterous ♂♂, 20 nymphs, Cacao Biological Station, 1050 m, 10°55'38"N, 85°27'7"W, 11 July 2000, J. Ashe, R. Brooks, Z. Falin, CR1ABF00-098, ex: under bark. 4 apterous ♀♀, 2 apterous ♂♂, Patilla Biological Station, 610 m, 10°59'22"N, 85°25'33"W, 13 July 2000, J. Ashe, R. Brooks, Z. Falin, CR1ABF00-119, ex: under bark. Deposited in the Division of Entomology, Natural History Museum and Biodiversity Research Center, University of Kansas.

Remarks. This species has not previously been found outside of Panamá [Panamá, Colón, Bocas del Toro, and Chiriquí Provinces (Choe 1989, 1992)]. Owing to its distribution inside of Panamá, it is not altogether surprising that the species should eventually be discovered in Costa Rica. The specimens reported upon herein are from the northern province of Guanacaste, quite near to the type locality for *Z. neotropicus* Silvestri (Silvestri 1916). The exact identity of *Z. neotropicus* has not been established confidently by subsequent authors (e.g., Gurney 1938; Choe 1989) since it was described on the basis of a single adult female and a nymph. Female genitalia are relatively homogenous among species and thus the specific identity of *Z. neotropicus* has remained somewhat elusive. Despite this mystery, *Z. neotropicus* can be distinguished from *Z. gurneyi* by the spines on the metafemur: Silvestri described them as being quite short and non-robust in *Z. neotropicus*, while in *Z. gurneyi* they are stout and well-developed. The genitalia of the Guanacaste specimens are identical to those of the Panamanian populations.

ACKNOWLEDGMENTS

I am grateful to Robert W. Brooks and James S. Ashe for bringing this interesting material to my attention. Molly G. Rightmyer and two anonymous reviewers kindly commented on the manuscript. This is contribution Nr. 3263 of the Division of Entomology, Natural History Museum and Biodiversity Research Center, University of Kansas.

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A NEW STATE RECORD FOR *TROGODERMA TEUKTON* (COLEOPTERA: DERMESTIDAE) IN COLORADO WITH NOTES ON OTHER *TROGODERMA* SPECIES[1]

R. Jason Bishop, E. J. Bernklau, L. B. Bjostad[2]

ABSTRACT: The dermestid beetle species *Trogoderma teukton* is newly reported from Colorado. This species previously has been reported in the U. S. only from Iowa, Minnesota, North Dakota, and Washington. Beetles were recovered from traps baited for *T. granarium*. Notes on the occurrence of *T. glabrum*, *T. granarium*, *T. inclusum*, *T. simplex*, and *T. variabile* also recovered from traps are presented. Included is a list of Coleoptera trapped in commercial grain elevator and storage facilities in Colorado.

A survey of potential insect pests associated with grain elevators and storage facilities was conducted in Colorado during the summers of 1996 and 2000. The trapping survey was initiated to monitor for the khapra beetle, *Trogoderma granarium* Everts, a well-known and serious pest of stored grain (Hinton 1945; Beal 1956; Armitage 1958; Barak 1989). Initially detected in California in 1953, *T. granarium* was eradicated from the United States and Mexico by 1966 (Barak 1989). The khapra beetle, considered the most destructive member of the Dermestidae to stored grain products (Anonymous 1978), is now a quarantined insect in the United States and under strict USDA regulations governing the importation of goods from infested countries (Anonymous 1984; Barak 1989). In cooperation with the United States Department of Agriculture (USDA-APHIS-PPQ), this survey was conducted as a component of the Cooperative Agricultural Pest Survey (CAPS) program.

Six trapping locations, with two to three bait stations per location, were established in 1996 across four counties in western Colorado. Grain elevators and storage facilities in Olathe (Montrose county), Delta (Delta county; two sites), Fruita (Mesa county; two sites), and Silt (Garfield county) were chosen based on availability, accessibility, and a known presence of dermestid beetles. All specimens recovered during the survey were collected using vertical wall mount insect traps (AgriSense®, Fresno, Calif.). Traps were baited for *T. granarium* using a combination of pheromone lure and wheat germ food bait. All trap locations were initially set up on 4 June and serviced every two weeks until 21 August. Servicing of traps included the removal of all insects captured and replacement of food bait and pheromone lure. Trap captures were taken to the laboratory for separation, identification, and enumeration.

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ENT. NEWS 112(4): 281-284, September & October, 2001

A total of 65 traps was screened for *T. granarium.* Although the target insect was not detected, a typical diversity of Coleoptera associated with stored grain was found (Table 1). Of particular note are the *Trogoderma* recovered over the course of the trapping season. A single specimen of *Trogoderma teukton* Beal was collected 24 July from a bait station located in a grain elevator in Fruita, Colorado. A single specimen of *T. inclusum* LeConte was also collected on this date from the same bait station. *Trogoderma teukton* previously had been reported in the United States only from Iowa, Minnesota, North Dakota (Beal 1956), and Washington (Hatch 1962), with possible distribution in Illinois and Indiana (Downie and Arnett 1996). The species has also been found but not previously reported from Montana with single specimens taken at Laurel, Yellowstone Co., 21-IV-58 (Bartholf), and Lewiston, Fergus Co., 2-VII to 14 VIII-88 (Lindgren funnel trap; C. E. Seibert). The former is on deposit at the U. S. National Museum of Natural History; the latter in the collection of Montana State University (R. S. Beal, *in litt.*). *Trogoderma teukton*

Table 1. Beetles collected from baited trap stations placed in grain elevators and storage facilities located in select Colorado counties in 1996 and 2000.

Taxa	Common name	County
Anobiidae		
Stegobium paniceum (L.)	drugstore beetle	Weld
Bostrichidae		
Rhyzopertha dominica (F.)	lesser grain borer	Mesa, Montrose, Weld
Cucujidae		
Cryptolestes sp.	grain beetle	Weld
Oryzaephilus surinamensis (L.)	sawtoothed grain beetle	Delta, Montrose, Weld
Curculionidae		
Sitophilus zeamaise Motschulsky	maize weevil	Weld
Dermestidae		
Attagenus unicolor unicolor Brahm	black carpet beetle	Weld
Trogoderma glabrum Herbst	glabrous cabinet beetle	Garfield, Mesa, Montrose, Weld
Trogoderma inclusum LeConte	larger cabinet beetle	Mesa
Trogoderma simplex Jayne	no common name	Delta, Garfield, Mesa, Weld
Trogoderma teukton Beal	no common name	Mesa
Trogoderma variabile Ballion	warehouse beetle	Delta, Garfield, Mesa, Montrose, Weld
Mycetophagidae		
Typhaea stercorea (L.)	hairy fungus beetle	Weld
Tenebrionidae		
Alphitobius diaperinus (Panzer)	lesser mealworm	Delta, Weld
Cynaeus angustus (LeConte)	larger black flour beetle	Delta, Mesa, Weld
Palorus subdepressus (Wallaston)	depressed flour beetle	Delta, Mesa, Montrose, Weld
Tribolium castaneum (Herbst)	red flour beetle	Weld
Tribolium confusum J. duVal	confused flour beetle	Delta, Mesa

has been reported in Canada only from Montreal, Quebec (Campbell et al. 1989). *Trogoderma simplex* Jayne and *T. glabrum* Herbst were encountered in low numbers throughout the survey with total captures of 9 and 39 beetles, respectively. High numbers of the ubiquitous warehouse beetle *T. variabile* Ballion (Beal 1954) were consistently removed from traps across all locations throughout the survey period. An average of 25 beetles per week per bait station was recorded for *T. variabile*.

A similar survey was conducted in 2000 utilizing six trapping locations throughout Weld county in eastern Colorado. As the trap used in the previous survey was no longer commercially available, Storgard® FliteTrak® M^2 pitfall traps (Trece, Inc., Salinas, Calif.) baited specifically for khapra beetle, *T. granarium*, and warehouse beetle, *T. variabile*, were used. The bait was a combination of khapra beetle and warehouse beetle pheromone and oil-based food attractant. A total of 120 traps was screened for *T. granarium* with no positive identifications. Only three *Trogoderma* species were caught in Weld county traps from 25 May through 19 September. *Trogoderma variabile* was recovered in high numbers at each servicing date, averaging 42 beetles per bait station per week. *Trogoderma simplex* and *T. glabrum* appeared less consistently and in lower numbers totaling 150 and 12 beetles, respectively. Further trapping is necessary to determine a distribution of *T. teukton* and *T. inclusum* east of the Rocky Mountains. All specimens recovered, including all *Trogoderma* reported here, were deposited in the C. P. Gillette Museum of Arthropod Biodiversity, Colorado State University.

ACKNOWLEDGMENTS

The authors thank R. S. Beal, Jr., for identifying all the dermestids and reviewing this manuscript. Additional gratitude is extended to Charles A. Triplehorn for his tenebrionid identifications and Whitney S. Cranshaw for his manuscript review. We are thankful to Boris C. Kondratieff for his additional taxonomic assistance as well as his thorough and prompt review of manuscript materials. Erich Fromm is recognized for his assistance in the field and laboratory. We thank the United States Department of Agriculture (USDA-APHIS-PPQ) Cooperative Agricultural Pest Survey (CAPS) program and the Colorado Agricultural Experiment Station for funding our survey efforts and providing trapping supplies.

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ACKNOWLEDGMENTS

We thank N. Wiersema for assistance in identifying the *Centroptilum bifurcatum* larvae from Illinois. We also thank B. Kondratieff and M. Petro for reviewing the manuscript prior to submission.

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US ISSN 0013-872X
OL. 112 NOVEMBER & DECEMBER, 2001 NO. 5

ENTOMOLOGICAL NEWS

THE AMERICAN ENTOMOLOGICAL SOCIETY

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RETIREMENT ANNOUNCEMENT FROM EDITOR

Effective with the publication of this November/December 2001 issue, and completion of Volume 112, I have asked to be relieved from my responsibilities as editor of Entomological News. I have taken this action with reluctance and regret but it has become necessary due to advancing age and increasing infirmities. I have agreed, however, to continue on an issue to issue basis until a successor can be secured and is in place, provided this interim period does not extend unacceptably long.

For nearly 28 years, I have felt both privileged and honored to be able to serve The American Entomological Society, and the entomological community at large, in this capacity. When Dave Rentz (Dr. David C. Rentz, now C.I.S.R.O., but then President of our Society) asked me to take on this responsibility beginning in May, 1974. I'm sure neither of us had any idea I would continue as editor for such a long period of time.

Throughout my editorship, while trying to adhere to basic editorial procedures, I also have tried to be a liberal rather than a rigid editor. At the same time, I have tried to move Entomological News away from being a compilation of short notes and species checklists toward more comprehensive papers. Whether this has succeeded, or whether this was even desirable, is for others to judge. Finally, I have consistently tried to publish only the highest possible quality of scientific contributions to entomological literature. When I took over, Entomological News had no peer review process in place. One was soon established and today nearly 100% of all papers are peer reviewed by at least two, sometimes more, recognized authorities in the taxon or field of the paper's subject. As I look back over the years, I believe we have succeeded in achieving our Society's goal of providing the best possible medium for the prompt publication of relatively short scientific papers on entomology.

There have been several highlight experiences and accomplishments over these years: the special issues commemorating the 125th anniversary of The American Entomological Society, and the 100th anniversary of Entomological News, the inauguration of peer reviews of all papers, and the complete turnaround in financial strength resulting from improved business management. This, along with two generous bequests, has allowed us to keep to a bare minimum both subscription rates and costs to authors for page charges.

One of the rewards of serving in a capacity such as this is the friendships one makes, both personally and by correspondence, with like-minded individuals. This certainly has been the case for me for, over these many years, I have acquired a host of entomological friends. I have appreciated these friendships. I particularly wish to thank the many, many authorities, far too numerous to mention by name, who, graciously and unstintingly, have contributed their time and expertise to review papers and make recommendations regarding their publication. All these have helped make my tenure as pleasurable and successful as I believe it has been. Without the contributions of these individuals, Entomological News could not possibly have achieved its current stature in the entomological world. I wish each and every one of you, authors and reviewers alike, as well as readers, continued productive entomological research and good pubications.

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H.P.B

ENT. NEWS 112(5): 286, November & December 2001

DESCRIPTIONS OF THE FIRST INSTARS OF *LECANODIASPIS BROOKESAE* AND *L. CRASSISPINA* (COCCOIDEA: LECANODIASPIDAE)[1]

P. L. Lambdin[2], Elzbieta Podsiadlo[3]

ABSTRACT: The first instars of *Lecanodiaspis brookesae* and *L. crassispina* from Australia are described and illustrated. *Lecanodiaspis brookesae* is distinguished by the presence of fleshy anterior and posterior spiracular setae, ten labial setae, and two setae on the anal plates, while *L. crassispina* is differentiated from other species of *Lecanodiaspis* by fleshy anterior and spine-like posterior spiracular setae, ten labial setae, and three setae on the anal plates. A modified key is provided to separate these species from other known species in this taxon.

Borchsenius (1960) separated the genus *Lecanodiaspis* from the family Asterolecaniidae and elevated it as the nominal genus for the family Lecanodiaspididae. Identification of scale insect species is primarily based on the adult female. The immature stages of scale insects are only rarely described and illustrated. With the exception of *Lecanodiaspis*, comparatively few scale insect immatures are available for description as a result of their cryptic appearance, small size, and period of development throughout the season. Of the 67 known species of *Lecanodiaspis* (Howell and Kosztarab 1972, Howell et. al 1973, Lambdin et. al 1973), first instars for 26 species have been adequately described (Williams and Kosztarab 1970, Morrison and Morrison 1927).

Identification of the immature stages is important to implement control efforts should the species be an economical pest. Such information is also necessary prior to initiating any applied or ecological studies (Kosztarab and Schaefer 1990) on these species. The objective of this study was to describe and illustrate two first instars of *Lecanodiaspis* from available specimens to distinguish them from the immatures of similar species.

Materials and Methods: Measurements (in micrometers) were obtained from 10 slide-mounted specimens, and are presented as averages followed by ranges in parentheses, unless otherwise stated. Terminology in the descriptions follows that of Williams and Kosztarab (1970). The gender of the first instars was not determined. Enlargements of the various structures in the margin of each figure are not proportional, but illustrate the general appearance of the specific structure.

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RESULTS

These two species may be identified using a modification of the key to the first instars of *Lecanodiaspis* (Williams and Kosztarab 1970) as follows:

6. Labium with 10 setae and with posterior spiracular setae.................... 6a
Labium with 6-8 setae (if 10, posterior spiracular setae lacking) 7
6a. With fleshy posterior spiracular setae; claws with denticle............. *brookesae*
With spine-like posterior spiracular setae; claws without denticle...... *crassispina*

Lecanodiaspis brookesae Howell & Kosztarab (Fig. 1a-l)

Description of slide-mounted first instar. Body (Fig. 1a) elliptical, length 482 (444-504), width 231 (215-248).

Dorsal Surface (Left Half): Anal lobes rounded, with apical seta 252 (236-272) long, and spine-like subapical seta on outer margin 10 (9.0-12.0) long, and a needle-like seta on inner margin 7.0 (5.0-8.0). Anal ring (Fig. 1b) subcircular, 15.0 (12.0-19.0) long, 21.0 (18.5-24.2) wide; with 6 setae, each 35.5 (30.5-42.8) long, with a row of translucent, nipple-shaped pores on margin. Anal plates (Fig. 1c) deltoid, with several ridged and scalloped areas laterally; each half 35.6 (28.0-37.8) long, 15.5 (14.0-20.0) wide; with a pair of medial setae on anterior base of plates ca. 7-10 long, a dorsal seta on posterior half of inner margin 5.0 (4.0-9.0) and a ventral seta on inner margin 9.0 (7.0-11.0). Arched plate (Fig. 1d) crescent shaped, 8.0 (5.5-9.2) long, 34 (30.0-40.0) wide. Figure 8-shaped pores (Fig. 1e) slightly bent, in 3 longitudinal marginal, submarginal, and submedial rows; each 4.1 (4.0-5.0) long, 2.1 (2.0-2.5) wide. Setae: 16 (16-17) stout needle-like segmental setae (Fig. 1f) on margin, each 5.0 (4.2-6.0) long; seta on outer margin of anal lobe ca. 8-9 long. Other tack-like segmental setae in submedial longitudinal row, each 3.0 (2.0-4.5) long. Simple disc pores (Fig. 1g) rare, usually found between marginal and submarginal row of 8-shaped pores, few (1 or 2) often found in submedial row on cephalothorax, and one adjacent to anal plate; each pore 2.0 (1.5-2.0) in diam.

Ventral Surface (Right Half): Antennae with 6 segments; length 159 (141-176), width at base 27 (24-30), scape 16 (12-18); segments II to VI: 24 (21-28), 32 (29-34), 21 (20-24), 24 (21-27), and 40 (38-45) long, respectively; segment II with sensory pore, all segments with at least 1 pair of hairlike setae 27.2 (16.0-42.5) long; a fleshy seta on segment IV and 2 on segment V, each ca. 18 long; terminal segment with long hairlike setae 40-65 long and 3 fleshy setae 17-19 long. Bilocular pores (Fig.1h) rare, restricted to 1 pore laterad of cephalothorax, 1 pore laterad of each spiracle, and on anterior abdominal segments 3 and 4 laterad of row of flat 8-shaped pores; each 1.2 (1.0-2.0) diam. Eyespot visible, ca. 9-10 diam. Clypeolabral shield length 98.0 (92.0-105.0), width 65 (62-68), with a pair of hairlike setae on dorsum 9-10 long. Flat 8-shaped pores (Fig. 1i) arranged in marginal row consisting of 4 cephalic, 3 thoracic, and 8 abdominal pores; each 3.1 (3.0-3.5) long, 1.8 (1.5-2.0) wide. Labium triangular, 37.5 (30.0-48.0) long, 49.0 (44.0-52.0) wide; with 10 hairlike setae, each 8.7 (4.0-13.0) long. Legs well-developed, 5-segmented; each leg ca. equal in length, prothoracic 203 (195-216), mesothoracic 205 (200-207), and metathoracic 194 (187-206) long, well developed claw with minute denticle 18 (16-20) long, and a pair of tarsal and claw digitules, 21 (19-24) and 27 (22-35) long, respectively. Setae variable; with 3 pairs of hairlike setae medially located from apex of clypeolabral shield to antennal base, progressively increasing in size posteriorly 14.7 (12.0-17.5), 16.3 (12.0-22.0), 24 (18.0-26.0) long, respectively; a longitudinal row of submedial tack-like setae (Fig. 1j) 2.0 (1.5-2.2) long on abdominal segments 3-8; a submarginal row of small, needle-like setae between margin and flat 8-shaped pores, each 4.0 (3.0-5.0) long; with 5 submedial pair in longitudinal row on abdomen consisting of 4 pair of hairlike setae 14-16 long and a pair of prevulvar setae 50.3 (30.0- 62.5). Simple disc pores (Fig.1g) rare, in submarginal area on abdomen, shape and size similar to those on dorsum. Spiracles in submargin; each 13.5 (12.0-16.0) long, 7.5 (5.0-10.0) wide at peritreme, atrium 2.1 (2.0-3.0) in diam.; with 3 (2-3) quinquelocular pores (Fig. 1k) associated with anterior and 1(1) pore with posterior spiracle, each 3.2 (2.5-4.0). Spiracular setae fleshy (Fig. 1l); anterior spiracular furrow with 2 setae, unequal in size on mesothroax; longer one variable in shape but usually banana-like or clubbed, 11.7 (9.0-14.0) long, smaller clubbed seta 6.0 (4.0-7.0) long. Posterior spiracular furrow bifid, each with one fleshy clubbed seta, each 5.0 (4.0-7.0) long.

Material Studied. On Bamoderm (unknown species), 37 specimens on 4 slides, New South Wales, Australia, 26 Sept. 1917. Coll. Jones.

Lecanodiaspis crassispina Howell and Kosztarab (Fig. 2a-o)

Description of slide-mounted first instar. Body (Fig. 2a) elliptical, length 445 (422-490), width 262 (220-284).

Dorsal Surface (Left Half). Anal lobes rounded, with apical seta 264.0 (235.2-284.2) long and needle-like subapical seta 5.0 (5.0) long. Anal ring (Fig. 2b) subcircular, 23.5 (22.0-24.0) diam.; with 6 setae, each 39.1 (30.0-44.0) long, an inner (5) and outer (7) row of nipple-shaped pores on margin. Anal ring rests in horizontal position beneath arched plate. Anal plates (Fig. 2c) deltoid, with several ridged areas laterally; each half 39.6 (36.0-42.0) long, 17.0 (16.0-20.0) wide; with 3 needle-like setae, 1 near posterior outer margin and 2 on inner margin, each 6.6 (5.0-9.0) long; a medial pair of setae at base of plates 8.0 (7.0-10.0) long. Arched plate (Fig. 2d) crescent-shaped, 40.4 (38.0-44.0) long, 15.2 (14.0-16.0) wide. Figure 8-shaped pores (Fig. 2e) slightly bent, in 3 longitudinal rows (occasionally double); submarginal row with 15 (15-16) pores, sublateral row with 7 (6-9) pores, and submedial row with 11 (10-13) pores, each pore 4.3 (4.0-4.5) long, 2.1 (2.0-2.5) wide. Setae stout, becoming needle-like and longer on the head, 16 marginal segmental setae (Fig. 2f), each 4.1 (3.0-6.0) long, arrangement 5 on head and prothroax, 2 on mesothorax, 1 on metathorax, and 1 on each of the abdominal segments 1-8; 10-11 tack-like submedial segmental setae (Fig. 2g) arranged in longitudinal row with 1 on head, 0-1 on prothorax, 1 on each meso-and metathorax, and 1 on each abdominal segment 1-7; each seta 2.7 (2.0-4.0) long. Simple disc pores (Fig. 2h) arranged in submarginal and submedial longitudinal rows, with 10 in submarginal (4 on cephalothorax and 6 on abdomen) and 5 in submedial (4 on cephalothorax and 1 on abdomen), each pore 2.0 (1.8-2.5) in diam.

Ventral Surface (Right Half). Antennae 6 segmented; length 189 (172-208), width of base 24.0 (20.0-28.0), scape 14.4 (12.0-16.0); segments II to VI: 23.2 (20.0-28.0), 30.4 (28.0-32.0), 21.2 (20.0-24.0), 28.0 (24.0-32.0), and 72.0 (68.0-76.0) long, respectively. Segment I with 1 hairlike seta, II with 2 hairlike setae and 1 sensillum, III with 3 hairlike setae, IV with 1 fleshy seta, V with 3 hairlike and 1 fleshy setae, VI with 9-10 setae (3-4 hairlike setae, and 5-6 fleshy setae). With two types of bilocular pores, one large pore (Fig. 2i) located at base of each antenna, 4.0 (4.0) long, 2.6 (2.0-3.0) wide; 6 other more heavily sclerotized dark-rimmed pores (Fig. 2j) arranged as follows:1 posterior to base of antenna, 1 posterior to anterior spiracle, 1 lateral to posterior spiracle, and 1 each on abdominal segments 2-4; each pore 2 long and 1.5 wide. Flat 8-shaped pores (Fig. 2k) straight or slightly bent, often heavily rimmed, 14 pores arranged in submarginal row, consisting of 4 on head and prothorax, 2 on mesothorax, 1 on metathorax, and 1 on each abdominal segments 1-7; each pore 3 (2.5-3.2) long, 1.9 (1.5-2.0) wide. Clypeolabral shield length 99.6 (92.0-104.0), width 74.0 (68.0-76.0). Labium triangular, 43.2 (40.0-48.0) long, width 50.8 (48.0-56.0); with 5 pairs of setae, each 10.3 (5.0-14.0) long. Legs well-developed, 5-segmented; each leg ca. equal in length, prothoracic 200 (192-212), mesothoracic 212 (200-232), and metathoracic 205 (200-220) long, well developed claw

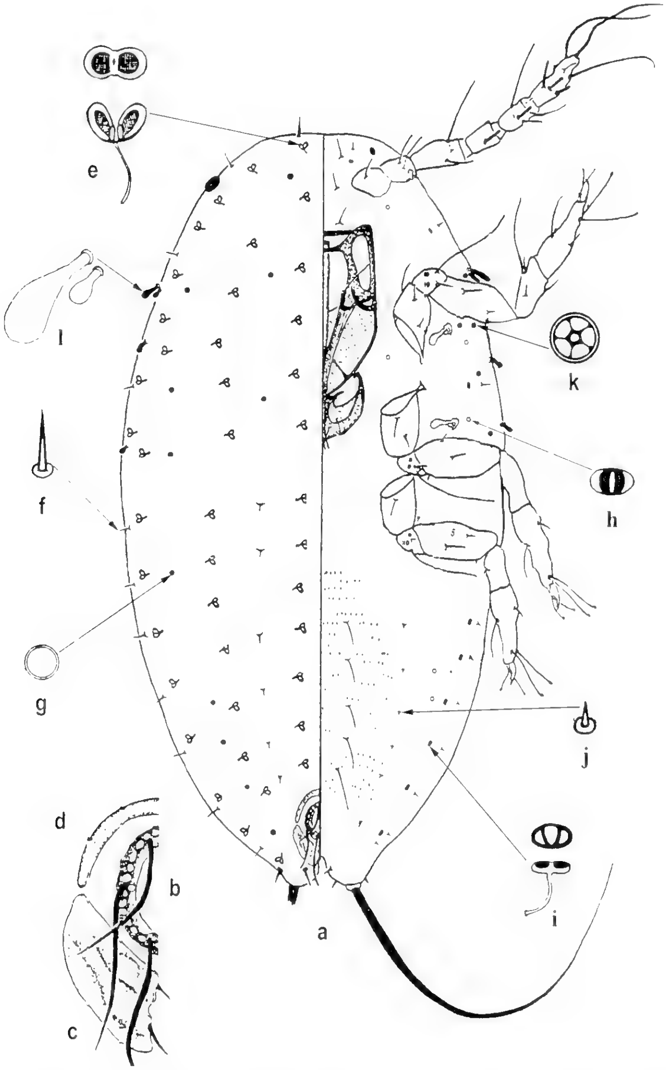

Fig. 1. *Lecanodiaspis brookesae* Lambdin and Kosztarab, First Instar (sex undetermined): (a) dorsoventral view; (b) anal ring; (c) anal plate; (d) arched plate; (e) figure 8-shaped pore; (f) dorsal spine-like seta; (g) simple pore; (h) bilocular pore; (i) flat 8-shaped pore; (j) tack-like seta; (k) quinquelocular pore; (l) spiracular setae.

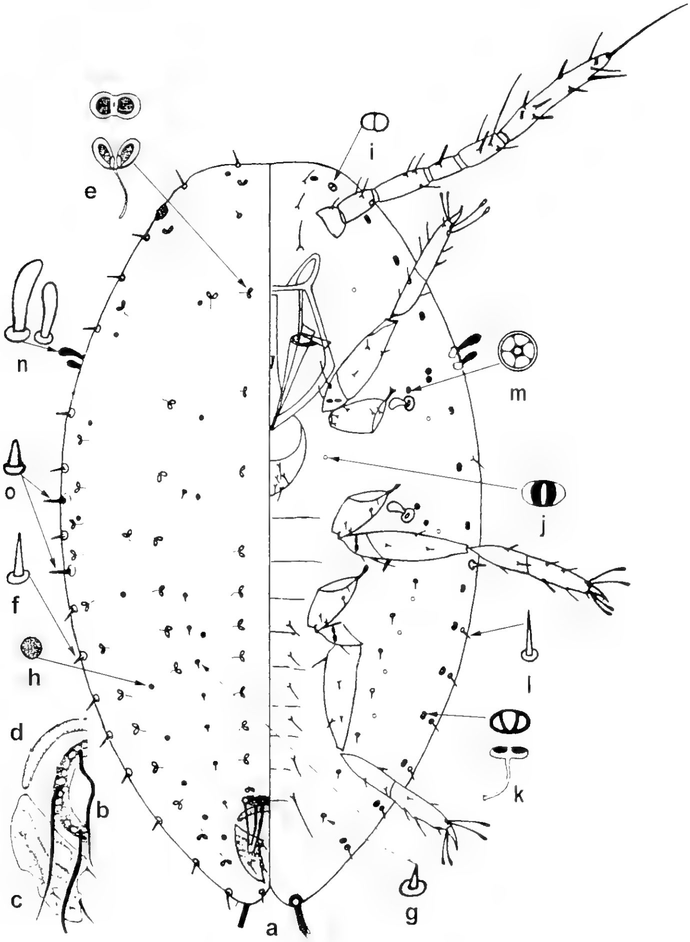

Fig. 2. *Lecanodiaspis crassispina* Howell and Kosztarab, First Instar (sex undetermined): (a) dorsoventral view; (b) anal ring; (c) anal plate; (d), arched plate; (e) figure 8-shaped pore; (f) dorsal spine-like seta; (g) tack-like seta; (h) simple pore; (i) bilocular pore; (j) dark rimmed bilocular pore; (k) flat 8-shaped pore; (l) needle-like seta; (m) quinquelocular pore; (n) anterior fleshy spiracular setae; (o) posterior spine-like spiracular seta.

without denticle, a pair of tarsal digitules 37 (36-38) long, and a pair of claw digitules 24 (23-25) long. Setae on body arranged in 3 longitudinal rows. Margin with 8 needle-like setae (Fig. 2l), with 1 on meso, 1 on meta, 0 on 1st abdominal segment, and 1 on each of abdominal segments 2-7; each 4.5 (4.0-7.0) long. Submarginal region with 7 tack-like setae (Fig. 2g), restricted to abdominal segments 1-7, each 2.2 (2.0-3.0) long. Submedial region with 9 setae arranged: 3 on head and 6 on abdomen; 1st and 2nd cephalic setae needle-like, each 4.2 (3-5) long; 3rd one hairlike, 15.5 (14.0-17,0) long; with 1 hairlike seta on each of the abdominal segments 2-7. Occasionally, a seta found on one side of the 1st or 2nd abdominal segments, but missing on the other side; each abdominal seta 8.5 (6.0-10.0) long, the last one (prevulvar seta) 49.5 (45.0-53.0) long. Spiracles on submargin, each 15.0 (14.0-16.0) long, peritreme 9.7 (9.0-10.0) in diam., aperture 4.9 (4.0-6.0) in diam.; with 1 quinquelocular pore (Fig. 2m) adjacent anterior spiracle and 2-3 pores near anterior spiracular fleshy setae; posterior spiracle with 1 adjacent quinquelocular pore and none near posterior spiracular setae, each quinquelocular pore 3.4 (3.0-3.6) in diam. Spiracular setae represented by 2 fleshy anterior setae (Fig. 2n), unequal in size, 14.2 (12.5-15.0) and 9.2 (8.5-11.0) long, respectively; two spine-like posterior setae (Fig. 2o), each 3.8 (3.0-5.0) long, rather variable in shape, either rounded or pointed apically, different from or resembling the marginal setae.

Material Studied: on *Eucalyptus* sp. (Myrtaceae), 186 specimens on 16 slides, 25 Oct. 1928, Euston, New South Wales, Australia, Coll. W.W. Froggatt.

DISCUSSION

The first instars may be distinguished from other instars by the possession of 5-segmented legs and 6-segmented antennae. In both species, segmentation of the cephalothorax is indistinct. Ventrally, the thoracic segments may be indicated by the attachment of the legs and the location of two pairs of the thoracic spiracles. The head and prothorax are fused, so the anterior of prothorax is difficult to demarcate. The posterior of the prothorax is distinguished by the attachment of the prothoracic legs. The anterior of the mesothorax is indicated by the position of the mesothoracic spiracles that are located within the intersegmental furrow between pro- and mesothorax. The anterior of the metathorax is indicated by the position of the metathoracic spiracles located adjacent to the intersegmental furrow between meso- and metathorax. The posterior of the metathorax is demarcated by the attachment of the metathoracic legs. Marginally, the thoracic segments may be delineated by the location of the spiracular setae. The two species have two anterior fleshy setae located in the intersegmental furrow between pro- and mesothorax. The posterior spiracular setae are represented by a single setae on each of the meso- and metathoraic furrows. The posterior spiracular furrows are bifid and delimited on the margin by a seta.

The most noticeable differences between *L. brookesae* and *L. crassispina* are the bifid posterior spiracular furrows, each furrow with one fleshy seta in *L. brookesae* and one spine-like seta in *L. crassispina*, the presence of a single row of simple pores between submarginal and medial 8-shaped rows in *L. brookesae* compared with two rows in *L. crassispina*, and the claws on each leg with a distinct denticle in *L. brookesae*, but no denticle is present on the claw of *L. crassispina*. The most distinctive similarities among the two species are body size, type and arrangement of the dorsal 8-shaped in 3 longitudinal rows, shape of the anal plate, number of marginal setae, and labium with 5 pairs of setae.

Earlier, Howell and Kosztarab (1972) reported that the adults of both *L. brookesae* and *L. crassispina* were morphologically similar *to L. convexa* Froggatt. We also found the first instars of *L. brookesae* to be similar in appearance to those of *L. convexa*, especially in the arrangement of pores and ducts. However, *L. brookesae* is easily separated by the location of setae on the anal plates, having five pairs of submedial setae on the abdomen rather than two, and with five rather than three pairs of labial setae.

This species is also similar to first instars of *L. acaciae* (Maskell), but may be separated from the latter by having five rather than three pairs of labial setae. In addition, the first instars are close to those of *L. anomala* (Green), but distinguished by having two rather than three setae on anal plate, five rather than three pairs of labial setae, and five rather than two pairs of ventral medial setae on abdominal segments. *Lecanodiaspis crassispina* is also similar to *L. convexa*, but separated by having five rather than three pairs of labial setae, the position and number of setae on the anal plates, and six rather than two pairs of ventral submedial setae on the abdominal segments.

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ADULT DESCRIPTIONS AND COMMENTARY FOR TWO SPECIES OF SOUTHEASTERN NEARCTIC *EPHEMERELLA* (EPHEMEROPTERA: EPHEMERELLIDAE)[1]

Luke M. Jacobus, W. P. McCafferty[2]

ABSTRACT: Reared and associated materials from Florida and the Great Smoky Mountains provide the bases for the first adult descriptions of *Ephemerella choctawhatchee* and *E. rossi*. Male adults of the two species are shown to be morphologically distinctive among congeners, based on characters associated with the male genitalia. The relatively similar larvae of *E. choctawhatchee* and *E. invaria* are possibly ecologically and geographically distinct. The first records of *E. rossi* from Georgia are provided.

Recent studies of Nearctic Ephemerellinae (Ephemerellidae) have led to the discovery of reared material of two southeastern species previously undescribed in the adult stage. Manny Pescador (Tallahassee, FL) kindly provided us with adults of *Ephemerella choctawhatchee* Berner from Florida that had been reared by J. Jones (Tallahassee, FL). *Ephemerella choctawhatchee* had been reported in the adult stage, but was not described (Berner and Pescador 1988). Adults of *Ephemerella rossi* Allen and Edmunds from Great Smoky Mountains National Park (GSMNP) were kindly provided to us by Chuck Parker (Gatlinburg, TN). John Cooper (Durham, NC) reared this material as part of the current All Taxa Biodiversity Inventory project underway in the Park (Kaiser 1999, Pedersen 1999). Based on these newly available adults, we herein provide the first formal adult descriptions of *E. choctawhatchee* and *E. rossi*. We have included commentary on adult diagnosis, various notes on the larvae, and distributional data.

Ephemerella choctawhatchee Berner

Male adult.–Length: body 7.2 mm, forewings 7.5 mm. Head light brown, dark spots on vertex; postfrontal and frontal sutures pale margined. Antennae with scape and pedicel brown. Ocelli white with black base. Upper portion of dioptic compound eyes pale orange, lower portion black. Thorax brown, with darker lateral areas; pronotum dark brown. Wings hyaline; costa and subcosta brown; most veins, intercalaries, and crossveins light brown; stigmatic area lightly clouded in white. Mid- and hindlegs uniformly pale; forelegs light brown, paler distally. Length of segments of foreleg in millimeters: trochanter = 0.3, femur = 1.5, tibia = 2.0, tarsus I = 0.1, tarsus II = 0.9, tarsus III = 1.0, tarsus IV = 0.8, tarsus V = 0.4. Abdomen brown, shaded with gray; middle segments slightly translucent. Each tergum with pale medial stripe and single pair dark brown sublateral dashes. Pleural margins dark gray. Sterna with pair of submedial dark brown small spots; angled brown dash present between spot and pleural margin. Genitalia (Fig. 1) with four to six lateral, stout spines and no ventral stout spines on penes; mesoapical lobe present on

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ENT. NEWS 112(5): 294-298, November & December 2001

forceps segment 2. Caudal filaments light brown with dark brown annulations at apex of segments, moderately covered with short, intersegmental setae.

Female adult.–Length: body 7.0 mm; forewings 7.5 mm. Body coloration much lighter than male, but otherwise very similar.

Adult diagnosis. The male adult of *E. choctawhatchee* appears most similar to those of the North American species *E. invaria* (Walker) and *E. rotunda* Morgan. This observation was previously noted by Berner and Pescador (1988). Allen and Edmunds (1965) even suggested that *E. choctawhatchee* and *E. invaria* might be synonymous; however, the two species differ in the number and placement of the spines on the penes. *Ephemerella choctawhatchee* has fewer dorsal spines on the penes than *E. invaria* or *E. rotunda*, and lacks ventral spines.

Ephemerella choctawhatchee male adults could have previously been identified as either *E. catawba* Traver or *E. inconstans* Traver, because of the sequence of characters used in the adult key to *Ephemerella* species by Allen and Edmunds (1965). Also, use of the key to Florida *Ephemerella* species by Berner and Pescador (1988) could have led to misidentification of *E. choctawhatchee* male adults as *E. dorothea* Needham. In light of these observations, certain southeastern North American *Ephemerella* male adults may require re-identification, particularly in light of the observed absence of ventral penes spines in *E. choctawhatchee* male adults.

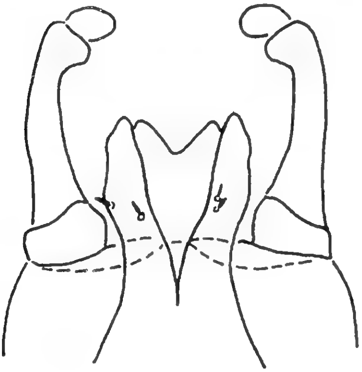
Larval diagnosis. Allen and Edmunds (1965) separated mature larvae of *E. choctawhatchee* from *E. invaria* based on body length and geographic distribution, with *E. choctawhatchee* indicated as the smaller and more southern of the two species. It has been shown that size differences can be unreliable when making species identifications in *Ephemerella* (Berner and Pescador 1988). It is therefore conceivable that some small mature larvae of *E. invaria* have been previously misidentified as *E. choctawhatchee*. Our preliminary studies of the larvae of the two species have as of yet not revealed any consistent morphological differences. The more widespread *E. invaria* is generally considered a cool water species throughout its eastern and midwestern range (Randolph and McCafferty 1998), whereas *E. choctawhatchee* has not been reported from such streams, at least in Florida. Larvae from Georgia and South Carolina (see below) may be ecologically segregated, but this can be demonstrated only if additional specimens of the two species from varied habitats are reared and associated.

Distribution. *Ephemerella choctawhatchee* is apparently restricted in distribution to the extreme southeastern United States. It has only been reported from Florida (Berner 1946, Berner 1950, Berner 1958, Allen and Edmunds 1965, Schneider 1967, Pescador and Peters 1974, Berner 1977, Berner and Pescador 1988), Georgia (Berner 1958, Berner 1977), and South Carolina (Berner 1977, Unzicker and Carlson 1982, Pescador et al. 1999). Some Georgia and South Carolina records may be questionable (see remarks above) and will require re-evaluation in the future.

Material examined. One male adult, associated exuviae, Florida, Gadsden Co., Flat Cr. at Co. Rd. 270A, 8 km south of Chattahoochee, 5-IV-1996, J. Jones [Florida A&M Univeristy (FAMU)]; one female adult, associated exuviae, Florida, Gadsden Co., Monroe Cr. at Co. Rd. 268, 6 km west of Midway, 14-II-1996, J. Jones [FAMU]; one male adult (genitalia on slide), associated exuviae, same data, except 8-II-1996 [FAMU]; twelve larvae, Florida, Gadsden Co., Monroe Cr., 12-II-1997, J. Jones [FAMU]; three larvae, Florida, Gadsden Co., L. Berner.

Ephemerella rossi Allen and Edmunds

Male adult.–Length: body 6.5 mm, forewings 6.2 mm. Head brown; postfrontal and frontal sutures pale margined. Antennae with scape and pedicel brown; scape pale margined; flagella brown. Ocelli white with dark brown base. Upper portion of dioptic compound eyes orange, lower portion black. Thorax dark brown, with lighter lateral areas. Wings hyaline, wing base and most veins brown; intercalaries and crossveins pale; stigmatic area lightly clouded in white. Mid- and hindlegs uniformly pale; forelegs uniformly light brown. Length of segments of foreleg in millimeters: trochanter = 0.2, femur = 1.1, tibia = 1.9, tarsus I = 0.1, tarsus II = 0.8, tarsus III = 0.8, tarsus IV = 0.7, tarsus V = 0.3. Abdomen light brown, with middle segments translucent. Each tergum stained with brown; posterior margin with dark brown crossband. Pleural margins pale. Sterna with pair of brown submedian spots. Genitalia (Fig. 2) with four to six, middorsal, stout spines and no ventral, stout spines on penes; no mesoapical lobe on forceps segment 2. Caudal filaments light brown with brown annulations at apex of segments, relatively densely covered with short, intersegmental setae.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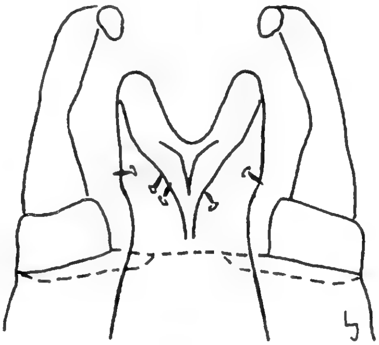
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Fig. 1. *Ephemerella choctawhatchee*, male genitalia (dorsal view).
Fig. 2. *Ephemerella rossi*, male genitalia (dorsal view).

Female adult.–Length: body 6.5 mm; forewings 7.1 mm. Coloration lighter than male, otherwise very similar.

Adult diagnosis. The male adult of *E. rossi* appears superficially similar to the male adult of *E. excrucians* Walsh. If using the key of Allen and Edmunds (1965), *E. rossi* will be misidentified as *E. excrucians*. However, the shape of the penes and the absence of an apical expansion on forceps segment 2 (Fig. 2) will distinguish *E. rossi* from *E. excrucians* and other known *Ephemerella* adults in North America.

Distribution. *Ephemerella rossi* was described from larvae collected in the Great Smoky Mountains of Tennessee (Allen and Edmunds 1965), and had been previously referred to as *Ephemerella* sp. No. 5 by Traver (1937). There have been subsequent published reports from Tennessee (Berner 1977, Long and Kondratieff 1996) and North Carolina (Berner 1977, Stoneburner 1977, Penrose et al. 1982, Unzicker and Carlson 1982). We have not been able to substantiate reports from South Carolina (Unzicker and Carlson 1982, Pescador et al. 1999), because the authors did not include any accompanying data. Our material examined, however, does provide the first records of this species from Georgia.

Material examined. Five larvae, Georgia, Rabun Co., Becky Branch in Warwoman Dell Picnic Area, 3 mi. east of Clayton on S 884, elev. 574 m., 02-V-1969, J. B. Wallace, et al.[Purdue Entomological Research Collection (PERC)]; two larvae, Georgia, Rabun Co., Chattooga R. at Forest Service Rd. 646, elev. 579 m., 02-V-1969, J. B. Wallace et al.[PERC]; six larvae, Georgia, Rabun Co., Reed Cr. at Forest Service Rd. 646, elev. 518 m., 11-V-1969, J. B. Wallace, et al. [PERC]; two male adults, one female adult, associated exuviae, North Carolina, Swain Co., GSMNP, Taywa Cr., 14-VI-1999 (emerged 16-VI-1999), D. Noon, A. Sekeres, L. Shugart (male genitalia on slides) [PERC]; one male adult (genitalia on slide), one female adult, one male subimago, associated exuviae, Tennessee, Sevier Co., GSMNP, LeConte Cr. at Twin Creeks, from Apple Barn upstream 55 m to old mill dam, 35°41'11"N, 83°30'02"W, 590 m, LCLC0101, 9-VI-1999, NPS Crew [GSMNP Museum, Gatlinburg, TN].

ACKNOWLEDGMENTS

This study has been funded in part by NSF Grant DEB-9901577 to WPM. This paper has been assigned Purdue ARP Journal Number 16479.

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BOOK RECEIVED AND BRIEFLY NOTED

FROGS, FLIES, AND DANDELIONS. The Making of Species . M. Schilthuizen. 2001. Oxford University Press. 245 pp. Hard. $25.00.

Possibly the most long standing question in evolutionary biology concerns the origin of species. From looking at how we define a species, to exploring how geographical isolation and sexual selection contribute to the making of new species, to showing how new species may appear either gradually or instantaneously, this small volume offers a comprehensive account of this evolutionary drama, and we get a clearer picture of some of the conditions that are necessary for one species to evolve into another. A major emphasis of the book is a discussion of how speciation occurs other than by geographical isolation. The author reviews the voluminous scientific literature on evolution, reduces it to a manageable size, and presents it in a form that is easily accessible for the non-specialist.

A NEW SPECIES OF *SPANGBERGIELLA* FROM PANAMA (HOMOPTERA: CICADELLIDAE: DELTOCEPHALINAE)[1, 2]

Paul H. Freytag[3]

ABSTRACT; A new species of *Spangbergiella* is described from Panama. This species closely resembles *S. mexicana*, but is smaller and the male aedeagus has longer apical processes.

A new species of *Spangbergiella* is described from Panama. Ma (1988) revised the genus *Spangbergiella* and included five valid species for the New World. Hamilton (2000) reviewed the genus again, reinstating one species that Ma had placed in synonymy but synonymizing one other species ending up also with five valid species. Niether worker listed or mentioned any specimens from Panama for the genus. I have examined one series of Panama specimens and found that these specimens represent an additional species, which is described at this time.

Spangbergiella abdita, NEW SPECIES

(Figs. 3-4)

Length of male 4.4 - 4.5mm., female 5.0mm. General color the same as *mexicana*, but with the reddish orange stripes on the forewings of both sexes narrower.

Male genitalia: Aedeagus (figs. 3 and 4) with shaft bent dorsally from base and narrowing to apex, with three apical processes. Lateral processes strongly divergent (forming obtuse angle in posterior view), longer than medial process, all narrow throughout and pointed. Remainder of genitalia similar to *mexicana*.

Holotype male from Panama, Pan., Los Cumbres, 16 Jan. 1975, at night, light, O'Brien and H. Wolda. Paratypes - female same data as holotype; male same data except 8 Jan. 1975, W. Wolda.

Holotype and female paratype deposited in the Ohio State University Collection, and the male paratype in the University of Kentucky Collection.

Notes: This species is similar to *mexicana* but smaller in size, and with the reddish bands on the forewings narrower than in *mexicana* (0.1mm in *abdita* and 0.15-0.2mm in *mexicana*). The processes of the aedeagus are not the same length as in *mexicana*, or thicker near the base of each lateral process (figs. 1 and 2). Some specimens of *mexicana*, from Mexico, have the reddish bands narrow as in this new species, but they are normally much wider. The male genitalia should be looked at to be sure of one's identification. So far this

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[1] Received March 24, 2001, Accepted April 24, 2001.

[2] This paper is published with approval of the Director of the Experiment Station as journal no. 00-08-59.

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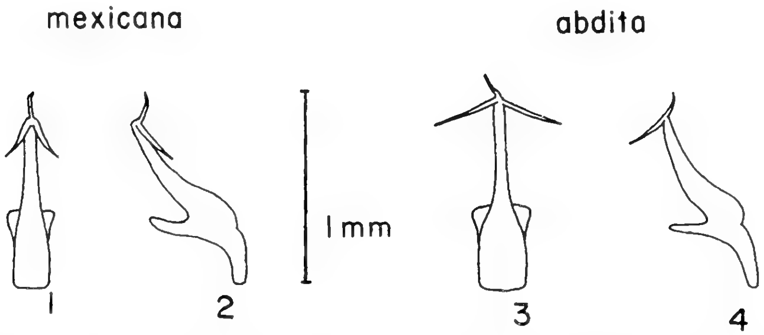

Figures 1 and 2, *Spangbergiella mexicana* Baker; Figures 3 and 4, *S. abdita* n. sp. Fig. 1, 3, ventral view of aedeagus. Fig. 2, 4, lateral view of aedeagus. All drawn to the same scale.

species is only known from Panama, and all specimens from Costa Rica north to the United States have been *mexicana*.

ACKNOWEDGMENTS

I wish to thank Lois O'Brien for the gift of these specimens. I also wish to thank Charles A. Triplehorn of the Ohio State University and Chen W. Young of the Carnegie Museum for permission to examine the specimens of this genus in their collections.

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ASIOPLAX NUMINUH, A NEW SPECIES OF EPHEMEROPTERA (LEPTOHYPHIDAE) FROM TEXAS AND MEXICO[1]

N. A. Wiersema[2], W. P. McCafferty[3], D. E. Baumgardner[4]

ABSTRACT: *Asioplax numinuh*, new species, is described from larvae and male and female adults from south central Texas and Mexico. The new species is evidently most closely related to *A. edmundsi*. Habitat and ecological information associated with the new species are discussed.

During the fall of 1996 one of us (NAW) was shown some very unusual larvae from the South Llano River in central Texas. Based on a detailed examination of these specimens in light of the recent descriptions of two similar species from Costa Rica and Ecuador (Lugo-Ortiz and McCafferty 1995; Wang et al. 1998), it became evident that these three species would be more appropriately placed into a new genus. As a result, Wiersema and McCafferty (2000) established the genus *Asioplax* to accommodate a small number of North, Central and South American species, including the above, that were previously considered within the genera *Leptohyphes* Eaton or *Tricorythodes* Ulmer.

Two of us (NAW and WPM) continued to find additional specimens of the unusual larval form mentioned above in Texas and Mexico; however, a formal species description was postponed because of what was considered a strong possibility that these larvae represented that stage of *Asioplax texana* (Traver), a southwestern species that had been known only in the adult stage. We are now able to describe the new species herein because one of us (DEB) reared the larvae in the spring of 2000, and this showed that indeed a new species, not *A. texana*, was involved.

Asioplax numinuh, NEW SPECIES

(Figs. 1-4)

Larva. Body robust and dorsoventrally flattened. Body length: 2.6-3.2 mm (male), 3.2-3.8 mm (female, largest size with egg expanded abdomen); caudal filaments length: 1.2-2.4 mm. Head: Coloration pale brown with black markings and head capsule fringed with numerous fine setae. Antennae yellow with length subequal to head capsule width. Mouthparts as shown in Figures 41-45 (Wiersema and McCafferty 2000). Thorax: Coloration pale brown to yellow with black-grey markings. Legs pale yellow with black markings on femora and tibiae. Tarsal claws strongly curved, with five to six small denticles and two to three preapical, fine setae. Abdomen: Tergal patterning as in Figure 1. Posterolat-

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[1] Received February 16, 2001. Accepted March 16, 2001.

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ENT. NEWS 112(5): 301-304, November & December 2001

eral projections of segments 7-9 very well developed; projections of segment 9 (Fig. 2) extending well beyond posterior margin of ninth sternum. Posterior margin of ninth sternum weakly to moderately concave in female larvae (Fig. 2). Gill 2 broadly rounded, nearly subtriangulate and pale yellow with black markings; inner ventral lamellae present and reduced. Caudal filaments light brown with whorls of short setae.

Male adult. Body length: 2.8-3.0 mm. Forewings: 3.8-4.0 mm. Body red-brown with sparse black markings. Head: Dorsally shaded with red-brown. Eyes small, widely separated; diameter approximately equal to basal width of lateral ocelli. Ocelli encircled with black basally. Thorax: Nota deep red-brown with pale areas adjacent to sutures. Forelegs approximately one and one-half times length of body. Hindlegs with pattern as in Figure 3; femora approximately equal in length to that of tibiae and tarsi combined. Abdomen: Tergal patterning similar to that of larvae (Fig. 1). Sublateral muscle insertion marks of sterna without pigment. Genitalia as in Figure 4, with subgenital plate narrowly and deeply emarginate. Caudal filaments grey-white in color with basal segments deeply shaded grey.

Female adult. Body length: 3.6-3.8 (with eggs). Forewings: 4.2-4.6 mm. Coloration similar to males except abdominal ground color paler.

Etymology. The specific epithet is a noun in apposition and is the name that the Native Americans (commonly known as Comanches), who lived throughout much of the new species range, called themselves.

Material examined. HOLOTYPE: male larva, TEXAS, Kerr Co., Guadalupe River off Hwy 27, near Center Point, March 14, 2000, D.E. Baumgardner, deposited in Purdue Entomological Research Collection (PERC). PARATYPES: five male and two female larvae, same data and deposition as holotype, except one male larva deposited at Texas A&M University; one adult male and two adult females, same data and deposition as holotype. Additional material: TEXAS: locale unknown/unclear (male adult, genitalia and hindleg on slide, medium euparal, solvent absolute ethanol, NAW); Kimble Co., South Llano River at low water crossing off Hwy 377, 30°28'44N, 099°46'41W, April 14, 1998, N.A. Wiersema (4 larvae deposited in personal collection of NAW); Kimble Co., Junction South Llano River, October 13, 1996, R. Waugaman (4 larvae, 3 deposited in PERC, 1 deposited with NAW); Kimble Co., South Llano River, Junction May 12, 1994, R.W. Sites (larva, PERC); Kendall Co., Guadalupe River 1 mi S. of Sisterdale at Ranch Road 1376, May 7, 1977, W.P. McCafferty and A.V. Provonsha (larva, PERC). MEXICO: Tamaulipas, Rio Guyayalejo, December 22, 1939, L. Berner (larval paratypes misidentified as *Tricorythodes edmundsi* Allen, multiple slides with various larval parts, deposited at Florida A&M University); Queretaro, 1 km NW Adjuntax, Rio Concá, July 13, 2000, W.D. Shepard (four larvae, PERC).

Remarks. Examination of the paratype material designated by Allen (1967) for *A. edmundsi* (Allen), from Rio Guyayalejo in Tamaulipas, Mexico, showed that they are referable to *A. numinuh*. Additionally, those larvae initially presumed to be the undescribed larvae of *A. texana* by Wiersema and McCafferty (2000) are also referable to *A. numinuh*.

The larvae and adults of *A. numinuh* are easily distinguished from those of *A. edmundsi* by less extensive tergal coloration (see Figure 1 herein and Figure 1 Wiersema and McCafferty) and tarsi without basal blue-black pigmentation. *Asioplax numinuh* larvae are additionally separable from those of *A.*

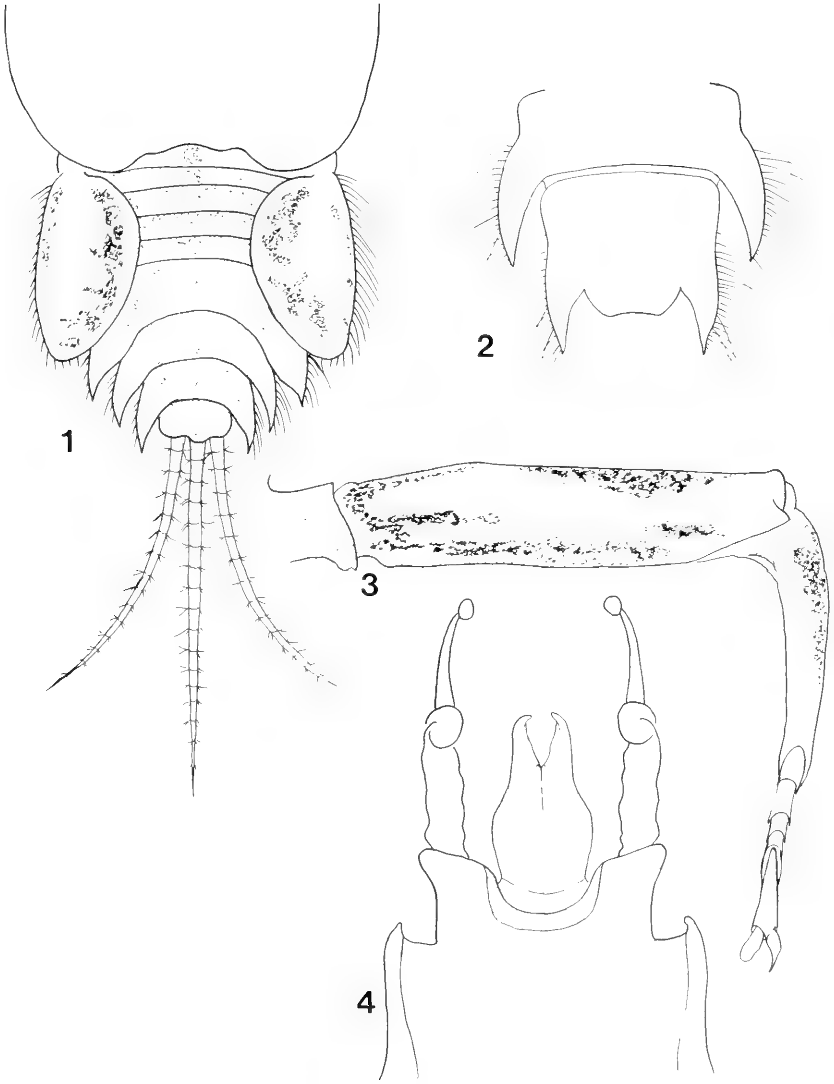

Fig. 1-4. *Asioplax numinuh.* 1. Female larval abdomen, dorsal. 2. Female larval 8th and 9th sterna. 3. Male adult hindleg. 4. Male adult genitalia, ventral.

edmundsi by having claws without subapical denticles, lateral projection of segment 9 extending well beyond the mid-posterior margin of the ninth sternum (Fig. 2), and a concave mid-posterior margin of the ninth sternum in female larvae (Fig. 2). *Asioplax edmundsi* larvae have claws with subapical denticles (these denticles are sometimes broken or worn off), lateral projection of segment 9 extending approximately equal to or slightly longer than the mid-posterior margin of the ninth sternum, and a truncate ninth sternum in female larvae.

Larvae of *A. numinuh* were collected from the surface of large, relatively flat-topped cobble with heavy periphyton and silt cover within river sections characterized by rapid, nonturbulent bank to bank flow. Gut contents of two examined larvae were composed primarily of fine mineral debris, along with sparse filamentous algae, diatoms, and detritus.

ACKNOWLEDGMENTS

We would like to thank R. P. Randolph and L. Sun (West Lafayette, Indiana) for their preliminary examination of some of the material used in this study and for their helpful critiques of the manuscript. Research was supported in part by NSF grant DEB-9901577 to WPM.

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REVISIONS TO *PLAUDITUS CESTUS* AND *P. GLOVERI* (EPHEMEROPTERA: BAETIDAE)[1,2,3]

W. P. McCafferty, Luke M. Jacobus[4]

ABSTRACT: Two species of the North American genus *Plauditus* (Ephemeroptera: Baetidae), *P. cestus* and *P. gloveri*, are shown to be apotypic sister species. All type specimens associated with both species were re-examined. Certain published larval character descriptions and figures are corrected; for example, mouthpart morphology is shown to be essentially similar in both species. Intraspecific variability is discussed based on previously reported variants and new variants of *P. cestus*, especially from New York and Wisconsin. Consistently reliable characteristics for diagnosing larvae of the two species are given, including both structural and color pattern differences. Species distributional ranges are updated.

The baetid genus *Plauditus* Lugo-Ortiz and McCafferty (1998a) includes several North American species that had been considered either in the original but incorrect American concept of *Pseudocloeon* Klapálek (e.g., Traver 1935), or as certain *Baetis* Leach species without hindwings and lacking a developed median caudal filament as larvae (McCafferty and Waltz 1990). *Plauditus* is closely related to the genera *Acentrella* Bengtsson and *Heterocloeon* McDunnough (R. D. Waltz, pers. comm.). The essential differentiation of the type of *Plauditus* from other North American *Baetis* complex genera, including *Acentrella*, *Baetis*, *Barbaetis* Waltz and McCafferty, *Heterocloeon*, and *Pseudocloeon* (as *Labiobaetis* Novikova and Kluge) can be found in Lugo-Ortiz and McCafferty (1998a). Several species of *Plauditus* are among the most poorly documented Baetidae in North America at this time.

Two species of *Plauditus*, *P. cestus* (Provonsha and McCafferty) and *P. gloveri* McCafferty and Waltz, form a relatively apotypic species pair, which is apparent from their common possession of a combination of relatively apomorphic character states in the larval stage. These character states include antennae that are shortened to one to two times the length of the head capsule (highly unusual for Baetidae in general); a labial palp segment 3 that is distinctly broadened apically (Fig. 5 [Lugo-Ortiz and McCafferty 1998b] and Fig. 6 [McCafferty and Waltz 1998]); and a tarsal claw with an outer, convex margin that is somewhat straight basally and medially, combined with the absence of a distinct distal curvature (see Fig. 8 [Lugo-Ortiz and McCafferty 1998b] and Fig. 7 [McCafferty and Waltz 1998]).

When using the most recent comprehensive North American generic key to mayflies (Edmunds and Waltz 1996), *P. cestus* larvae will key to *Barbaetis*

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[1] Received March 26, 2001. Accepted April 12, 2001.

[2] Purdue ARP Journal No. 16463.

[3] Research was supported in part by NSF grant DEB-9901577.

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because of their very short antennae (about the same length as the head capsule); however, key users should keep in mind that *P. cestus* significantly differs from *Barbaetis benfieldi* Kennedy because the median caudal filament of the latter is well developed. Also when using this key, *Plauditus gloveri* larvae, which have somewhat longer antennae (up to twice the head capsule), along with larvae of other *Plauditus* species, could alternatively be placed as *Acentrella* or *Baetis* lacking hindwingpads and developed median caudal filament.

Examinations of newly available larval samples of *P. cestus* as well as a careful re-examination of both of the holotypes and all paratypes associated with *P. cestus* and *P. gloveri* have shed new light on some similarities, differences, and variability regarding the two species. These data are important to note for workers needing to identify these species because the two species are now known to be sympatric in at least the Appalachian area of eastern North America and can be shown to be morphologically cryptic to a significant degree. With respect to adults, only those of *P. cestus* are described (Provonsha and McCafferty 1982), and therefore that stage does not contribute to analyses herein.

INTRASPECIFIC VARIABILITY

It has generally been considered that the presence of a dark band encompassing abdominal segment 5 in *P. cestus* was diagnostic (Provonsha and McCafferty 1982, McCafferty and Waltz 1998). Indeed, the vast majority of *P. cestus* larvae that have been examined fit this typical pattern; however, there are significant variants. Lugo-Ortiz and McCafferty (1998b) described an additional color pattern variant of *P. cestus* from South Carolina that had only a poorly developed segment 5 band, which was especially weak on the sternum. The latter authors also indicated the existence of an immature larval variant of *P. cestus* from South Carolina that almost entirely lacked the segment 5 band but possessed a well-developed band on segment 9. Besides color pattern variability in *P. cestus*, these observations established that *P. cestus* and *P. gloveri* are both present in South Carolina. Actually, the two variants of *P. cestus* mentioned above were taken in the same sample from South Carolina (Edgefield Co., Double Branch of Horn Cr., VI-3-1997, deposited in the Purdue Entomological Research Collection [PERC]). Although this was not made apparent in the previous work, it is significant. In addition, the variant of *P. cestus* that was referred to as immature by Lugo-Ortiz and McCafferty (1998b) is actually quite mature, with well-developed but light wingpads.

We have recently examined mature larvae of *P. cestus* from New York (Catskill Mountains, lot #667, deposited with EcoAnalysts collections, Moscow, ID—no other data readily available) that had both a moderately developed segment 5 band and a well-developed segment 9 band. This observation adds another color pattern variant for *P. cestus* in a state where both typical *P.*

cestus larvae and *P. gloveri* larvae had already been found (Jacobus and McCafferty 2001).

Finally, with respect to abdominal tergal color variants of *P. cestus*, we have recently examined mature larvae of *P. cestus* from Wisconsin (Dunn Co., Hay R., X-6-1998, deposited in PERC] that show a well-developed segment 5 band in addition to a somewhat less developed segment 9 band. This represents one more pattern variant of *P. cestus* larvae.

Medial abdominal tergal dots that are present in *P. gloveri* (Fig. 9 [McCafferty and Waltz 1998]) are not typical of *P. cestus* larvae; however, as indicated by Lugo-Ortiz and McCafferty (1998b), they are present in some larvae of *P. cestus*.

The maxillary palps of *P. cestus* were described as not reaching the apex of the galealaciniae (Fig. 5 [Lugo-Ortiz and McCafferty 1998b]), and this was previously considered to be a notable difference between *P. cestus* and *P. gloveri*, whose maxillary palps extend markedly beyond that apex of the galealaciniae in specimens examined (Fig. 2 [McCafferty and Waltz 1998]). One of the Indiana paratypes of *P. cestus* has maxillae with palps as long as those typical of *P. gloveri*. Amongst numerous other larval specimens of *P. cestus* from various localities in North America, we have observed an entire range of intermediate palp lengths.

In Figure 6 of Lugo-Ortiz and McCafferty (1998b), the apical margin of labial palp segment 3 is shown as truncate. After examining additional labia of this species, however, we discovered that the apex of this palp varies from strictly truncate to slightly pointed apicolaterally and slightly rounded apicomedially, as has been shown for the labial palps of *P. gloveri* (Fig. 5 [McCafferty and Waltz 1998]). This would apparently preclude the use of the labial palp for differentiating between the two species.

The antennal length in *P. gloveri* has been observed to vary roughly from about one and one-half the head capsule to approximately twice the head capsule. Because we have had only a limited number of specimens of *P. gloveri* to examine, however, the variation may turn out to be greater than here reported, and we can not be sure that antennal length is relatively consistent through larval development.

INTERSPECIFIC SIMILARITIES

Plauditus cestus and *P. gloveri* are similar in generic characteristics as well as those that differentiate the pair from other *Plauditus* as discussed above. In addition, the current study has revealed that certain morphological traits that previously would have been considered differences between the two species, based on published figures and descriptions, are not in fact valid.

With respect to the labrum, it may have been assumed from Figure 1 of *P. cestus* by Lugo-Ortiz and McCafferty (1998b) compared to Figure 1 of *P. gloveri* by McCafferty and Waltz (1998) that the shape of the labrum and the dorsal labral setal pattern differ in the two species. The shape differences in the labra figured are to a large degree related to slide mounting differences, and the true shape of the labrum of either species is essentially similar to that shown for *P. gloveri* by McCafferty and Waltz (1998). In Figure 1 of Lugo-Ortiz and McCafferty (1998b), the pair of long submarginal setae that occur about midway between the midline and lateral margin of the labrum were not drawn. In Figure 1 of McCafferty and Waltz (1998), the pair of submedian setae were not drawn. Re-examination of the slides upon which the latter two figures were based indicated that the setal pattern is the same in the two species and that both mentioned sets of submarginal setae are present. Because of the dorsal convexity of the labrum, it is difficult if not impossible to have both sets or even one seta of each set in focus simultaneously under the high magnification that is required. Also, the length of the submarginal setae nearest the midline is variable among individuals of both species. In some labra these submedian setae reach beyond the anterior labral margin, but in other labra they are shorter and therefore more difficult to detect.

In Figure 4 of Lugo-Ortiz and McCafferty (1998b) of the planate mandible of *P. cestus*, the medial margin of the fused incisor is smooth. This may have been interpreted as a significant difference from the comparative margin shown for *P. gloveri* (Fig. 4 [McCafferty and Waltz 1998]), which is serrate. However, close examination of the planate mandibles of material of *P. cestus*, including the types, has indicated that this margin is indeed also consistently serrate. This is apparently characteristic of most or all *Plauditus*.

McCafferty and Waltz (1998) figured the midleg of *P. gloveri*, showing a dorsal femoral setal row that was weakly developed in the basal half of the femur. Lugo-Ortiz and McCafferty (1998b) figured the non-comparative foreleg of *P. cestus*, showing a well-developed dorsal femoral setal row for the entire length of the femur. The midleg feature mentioned is essentially consistent for the mid- and hindlegs of both species, with only some variability in the degree of development of the basal armature. The foreleg feature mentioned is also consistent for both species.

INTERSPECIFIC DIFFERENCES

Certain of the characters discussed above and with which previous attempts have been made to diagnose *P. cestus* from *P. gloveri* cannot be used as such because we have herein demonstrated their similarity in both species. In the same respect, those characters that we have shown to be variable in *P. cestus* may not be used consistently for species diagnosis, although some of these latter characteristics can be used with some lesser degree of confidence as ancillary diagnostic characteristics, such as the common presence of segment 5 banding in *P. cestus* and the presumed common lack of such in *P. gloveri*. There are, however, certain characteristics that appear to be consistently useful at least for the diagnosis of relatively mature larvae, and especially unbleached specimens of such.

Relative antennal length of *P. cestus* has been found to be consistently shorter than that of *P. gloveri* (about subequal with head capsule compared to one and one-half to two times the head capsule, respectively). The sub-basal cross-band shading on at least the fore- and midfemora of *P. cestus* (Fig. 8 [Provonsha and McCafferty 1982] and Fig. 7 [Lugo-Ortiz and McCafferty 1998b]) compared with the dark dot/dash pattern found on at least the fore- and midfemora of *P. gloveri* (Fig. 6 [McCafferty and Waltz 1998]) has proven consistent. The short, somewhat thick, median V-shaped shading on the abdominal tergum 2 of *P. gloveri* (Fig. 8 [McCafferty and Waltz 1998]) compared to the lack of such a mark on *P. cestus* (Fig. 8 [Provonsha and McCafferty 1982] and Figs. 9-11 [Lugo-Ortiz and McCafferty 1998b]) has proven consistent but may be subject to fading. Abdominal segment 7 of *P. gloveri* is at least somewhat shaded compared to adjacent segments but this may be difficult to detect, as pointed out by McCafferty and Waltz (1998), whereas *Plauditus cestus* lacks shading or banding on segment 7. *Plauditus cestus* consistently has a distinctive, dark, wide band in the distal half of the cerci (Fig. 8 [Provonsha and McCafferty 1982]), whereas *P. gloveri* lacks such a band, instead either having three, lighter, narrower bands or having no banding apparent on the cerci (probably due to rapid fading in preserved material).

As suggested by Fig. 8 (Provonsha and McCafferty 1982) and Figs. 9-11 (Lugo-Ortiz and McCafferty 1998b) compared to Figs. 8-9 (McCafferty and Waltz 1998), the reduced median caudal filament of *P. cestus* is more attenuate than that of *P. gloveri*. After examining numerous specimens of *P. cestus*, however, we do not recommend that the median caudal filament be used for diagnosis; any specific differences possibly associated with this structure are very subtle and therefore too easily misinterpreted much of the time.

SPECIFIC RANGES

Plauditus cestus is herein reported from Wisconsin for the first time (see above, under Intraspecific Variability) and it had been previously reported from Colorado, Idaho, Illinois, Indiana, Iowa, Kentucky, Missouri, North Carolina, New York, Ontario, South Carolina, and Vermont (Provonsha and McCafferty 1982, McCafferty et al. 1993, Klubertanz 1995, Sarver and Kondratieff 1997, Lugo-Ortiz and McCafferty 1998b, Randolph and McCafferty 1998, Pescador et al. 1999, and Jacobus and McCafferty 2001). *Plauditus gloveri* is currently known from New York, South Carolina, and Texas (McCafferty and Waltz 1998, Jacobus and McCafferty 2001). We expect the latter species to occur in at least certain areas intermediate between these latter three states.

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NOTES ON THE LIFE CYCLE OF THE MILLIPED *ORINISOBATES NIGRIOR* (JULIDA: NEMASOMATIDAE)[1]

Will K. Reeves[2]

ABSTRACT: *Orinisobates nigrior* lives under bark of dead fir trees in the Great Smoky Mountains National Park, USA. Millipeds can be found under the bark year-round except during freezing weather. *O. nigrior* appears to have a multiyear life cycle in the Great Smoky Mountains National Park.

Millipeds are one of the most diverse groups of terrestrial animals (Shear 1999), and species of Nemasomatidae are physically among the smallest Julida. Because of their small size (length: 4-10 mm), unstable taxonomy, and cryptic habitats, nemasomatids have been poorly studied (Enghoff 1981, 1985). The only known nemasomatid in the Appalachian Mountains is *Orinisobates nigrior* (Chamberlin, 1943) (Enghoff 1985, Hoffman 1966, 1999). *Orinisobates nigrior* was initially described from specimens collected in Gatlinburg, Tennessee, but populations are known from Florida, southern Illinois, Kentucky, and the southern Appalachian Mountains (Enghoff 1985, Hoffman 1999, Shelley 2000). The only biological information published about this species is a single sentence by Enghoff (1985), which stated *O. nigrior* was "associated with logs (bark)". Hopkin and Read (1992) indicated that millipeds in nutrient-poor situations or at high altitudes often have a multiyear life cycle.

In 1998, I discovered *O. nigrior* living under the bark of dead standing fir trees, *Abies fraseri* (Pursh), on both the North Carolina and Tennessee sides of Clingmans Dome, Great Smoky Mountains National Park. *Orinisobates nigrior* was the only diplopod under the fir bark. From October 1999 through November 2000, I made monthly collections and biological observations of *O. nigrior* on Clingmans Dome. Collections were not made during January or February.

I collected adult and immature life stages on all sampling dates until 18 November 2000. *Orinisobates nigrior* was found only on trees with moisture trapped between the dead wood and loose bark. Loose, dry bark did not support populations of *O. nigrior*. Trees, which had previously supported populations of *O. nigrior* during wet months, were devoid of millipeds when the area beneath the bark became dry. Adults were present during all months except November and December when the bark was frozen. Mating was observed under moist bark on 14 September 2000. On 2 August 2000, I collected three first-stadium *O. nigrior* with adults under fir bark. No eggs were discovered, but they are small and would be difficult to detect. On 18 November 2000, the

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air temperature on Clingmans Dome was below 0° C and the water under the fir tree bark had frozen. No frozen millipeds were under the bark, and I hypothesize they migrate into the soil around the trees or move inside the dead trees via insect holes prior to freezing. Overlapping stadia, including adults in October, suggest *O. nigrior* has a multiyear life cycle. A multiyear life cycle would be similar to that observed by Meyer (1990) for *Ochogona* spp. (Chordeumatida: Craspedosomatidae) at high elevations in the Alps. An unidentified scolopendromorph centipede was collected under the bark with *O. nigrior*. The role of this predator in the life history of *O. nigrior* was undetermined. Predation was not observed.

Voucher specimens of *O. nigrior* were deposited in the Virginia Museum of Natural History and the Field Museum of Natural History. I thank H. Enghoff for identifying my initial collection of *O. nigrior*; and P.H. Adler, J.W. Chapin, and W.C. Reeves for reviewing this manuscript. This project was partially supported by an E.W. King Grant, Clemson University, Entomology Department. Research and collecting was conducted under United States Department of Interior National Park Service Permit GRSM-00-012.

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NEW RECORDS OF PARASITIC WASPS (HYMENOPTERA) FROM THE INTERIOR HIGHLANDS OF ARKANSAS[1]

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ABSTRACT: New records of parasitic hymenopterans are presented from Arkansas including 50 new state records and 14 significant range extensions into the state. Twenty-three parasitic wasp species were discovered in nine seeps/springs in the Ouachita National Forest while 21 parasitic species were found in eight springs in the Ozark National Forest. The findings from these Arkansas seeps and springs based on pan-trapping demonstrate the importance of these unique habitats.

Recent collections from yellow and white pan traps in the Ozark and Ouachita Mountains in Arkansas have yielded many new state and regional records of hymenopteran parasitic wasps, in addition to several new species unknown previously to science. Relatively little is known concerning the parasitic wasps inhabiting Arkansas. Earlier, Masner (1990) had commented that the faunal exploration of Hymenoptera of America north of Mexico was far from complete and recommended field work in underexplored or unexplored areas of the Ozark Plateau, among other areas. This study was conducted to collect more information concerning the biodiversity of the Ozark and Ouachita Mountains and the distributional ranges of those hymenopteran species inhabiting these upland areas of the state.

It has long been known that the Ozarks and Ouachita Highlands in Arkansas represent areas of biogeographic significance. These regions represent considerable endemism and refugia for disjunct populations of organisms particularly those with faunal affinities to the southern Appalachian Mountains (Ross and Ricker, 1971; Mayden, 1985; Carlton and Cox, 1989; Poulton and Stewart, 1991; Mohlenbrock, 1993; Robison and Allen, 1995; Carlton and Nobles, 1996; Moulton and Stewart, 1996; Robison et al., 1997; and Carlton and Robison, 1998). With this in mind, a systematic collecting effort was initiated in 1993 to survey the parasitic hymenopteran fauna in the Interior Highlands region of Arkansas. Collecting efforts were concentrated primarily in seep and spring areas, which are known to be preferred habitat for certain parasitic wasps.

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METHODS AND MATERIALS

Wasps were collected using yellow and white pan traps. After capture, wasps were rinsed in freshwater and subsequently placed in 70 percent isopropyl alcohol or 95 percent ethanol for storage and forwarded to LM for positive identification. This study was an offshoot of a larger project on the biodiversity of the springs and seeps of the Ouachita Mountains in Arkansas by H. W. Robison and Betty G. Crump. Specimens remain in the care of LM in the Canadian National Collection of Insects (CNCI, Ottawa).

RESULTS

Collection localities, dates of capture, and brief notes on habitat or rarity relating to each species are included below by family.

Scelionidae

Baryconus bidentatus Ritchie and Masner. AR: Johnson Co.: Baker Spring, ca. 5 mi. N. of Oark, Sec. 27, T13N, R24W. 6 Sept. 1994. Rare species; second record from AR.

Baryconus floridanus Ashmead. AR: Johnson Co.: Baker Spring, ca. 5 mi. N. of Oark, Sec. 27, T13N, R24W. 6 Sept. 1994. Montgomery Co.: Blue Springs, 7 mi. NW Bonnerdale, S of Rd. 44, Sec. 15, T3S, R23W. 5 July 1998. Rare eastern species.

Cremastobaeus sp. AR.: Johnson Co.: Little Piney Creek at St. Hwy. 123, 5 mi. NE. of Hagarville, Sec. 26, T11N, R22W. 15-28 July 1994. One male. This undescribed species is known from other states. **New state record for the genus**.

Gryon floridanum (Ashmead). AR: Montgomery Co.: Singing Springs, 7 mi. NE of Norman, Sec. 22, T3S, R24W. 25 June 1998. Blue Springs, 7 mi. NW of Bonnerdale, S. of Rd. 44, Sec. 15, T3S, R23W. 5 June 1998; 10 July 1998. **New state record**.

Gryon insulare (Ashmead). AR: Montgomery Co.: Boxx Springs, 4.5 mi. SW of Black Springs, E of Rd. 11, Sec. 33, T3S, R26W. 25 June 1998. Rare eastern species.

Holoteleia coracea Masner. AR: Montgomery Co.: Boxx Springs, 4.5 mi. SW of Black Springs, E. of Rd. 11, Sec. 33, T3S, R26W. 14 Nov. 1995. Blue Springs, 7 mi. NW Bonnerdale, south of Rd. 44, Sec. 15, T3S, R23W. 8 October 1998. **New state record**.

Holoteleia laticeps Masner. AR: Johnson Co.: Baker Flats Springs, ca. 5 mi. N. of Oark, Sec. 27, T13N, R24W. 11 September 1995. **New state record**. Significant extension of range to the west in distribution.

Holoteleia polita Masner. AR: Johnson Co.: Baker Flats Springs, ca. 5 mi. N. of Oark, Sec. 27, T13N, R24W. 11 Sept. 1995. One female. Montgomery Co.: Singing Springs, 7 mi. E. of Norman, Sec. 22, T3S, R24W. **New state record**. Significant extension to the west in distribution.

Idris castaneus Masner and Denis. AR: Johnson Co.: Gilliam Bog, Sec.11, T11N, R23W. 6 Sept. 1994. Montgomery Co.: Blue Springs, 7 mi. NW of Bonnerdale, Sec. 15, T3S, R23W, S. of Rd. 14. 22 Nov. 1995. **New state record**.

Idris cornutus (Ashmead). AR: Montgomery Co.: Singing Springs, 7 mi. N Norman, Sec. 22, T3S, R24W. 25 June 1998. Rare eastern species. **New state record**.

Idris leedsi Masner and Denis. AR: Johnson Co.: Baker Spring, ca. 5 mi. N. of Oark, Sec. 27, T13N, R24W. 6 Sept. 1994. **New state record.**

Idris sp. A. **Undescribed species**. AR: Johnson Co.: Little Piney Creek at St. Hwy. 123, ca. 5 mi. E. of Hagarville, Sec. 26, T11N, R22W. 15-28 Sept. 1994. **New state record.**

Idris sp. B. **Undescribed Species**. AR: Johnson Co.: White Road Spring, ca. 12 mi. NE Clarksville, Sec.28, T11N, R22W. 6 Sept. 1994. One male. **New state record**.

Inostemma sp. AR: **Undescribed species**. Johnson Co.: Little Piney Creek at St. Hwy. 123, ca. 5 mi. E. of Hagarville, Sec. 26, T11N, R22W. 6 Sept. 1994. Known from elsewhere. **New state record**.

Macroteleia carinata Ashmead. AR: Johnson Co.: Baker Spring, ca. 5 mi. N. of Oark, Sec. 27, T13N, R24W. 6 Sept. 1994. One female. Rare species. **New state record**.

Paridris laeviceps (Ashmead). AR: Montgomery Co.: Singing Springs, 7 mi. NE of Norman, Sec. 22, T3S, R24W. 25 June 1998. **New state record**.

Probaryconus striatus (Ashmead). AR: Montgomery Co.: Blue Springs, 7 mi. NW Bonnerdale (Sec. 15, T3S, R23W) S. of Rd. 44. 14 Nov. 1995. One male; two females. Slatington Spring, 5.2 mi. SE of Big Fork, west of Rd. 1, Sec. 33, T3S, R27W. 22 Sept. 1995. **New state record**. Rarely collected across transitional and austral zones in US.

Scelio incertus Muesebeck. AR: Johnson Co.: Gilliam Bog, Sec. 11, T11N, R23W. 6 Sept. 1994. Female; first discovery since the original description in 1972. Known previously only from type series in TX. **New state record**.

Spiniteleia sp. **Undescribed species.** AR. Johnson Co.: Baker Spring, sec. 27, T13N, R24W. 11 Aug.-6 Sept. 1994. Two females. Dick Johnson Spring, Sec. 29, T11N, R22W. 3 males. Wood Mountain Spring, ca. 12 mi. NE of Clarksville, Sec. 34, T11N, R22W. 11 Aug.-24 Sept. 1994. One male. **New state record.**

Spiniteleia campbelli Masner. AR: Johnson Co.: Wood Mountain Spring, ca. 12 mi. NE of Clarksville, Sec. 34, T11N, R22W. 6 Sept. 1994. Baker Spring, ca. 5 Mi. N. of Oark, Sec. 27, T13N, R24W. 6 Sept. 1994. Dick Johnson Spring, Sec. 29, T11N, R22W. 6 Sept. 1994. Numerous males and females. Previously known only from Kentucky. **New state record**.

Telenomus sp. **Undescribed species**. Johnson Co.: Baker Spring, ca. 5 mi. N. of Oark, Sec. 27, T13N, R24W. 6 Sept. 1994. Known from elsewhere. **New state record**.

Telenomus longicornis Ashmead. AR: Montgomery Co.: Blue Springs, 7 mi. NW Bonnerdale south of Rd. 44, Sec. 15, T3S, R23W. 10 July 1998. **New state record**. Presumed parasitoid in gerrid eggs.

Thoronella sp. **Undescribed species**. AR: Johnson Co.: Upper Mulberry River, 21 mi. N. of Clarksville. 15-28 July 1994. Two males. **New state record for the genus**. Widespread eastern species ranging from Florida to Canada (Quebec); phoretic on dragonflies (e.g. ***Aeschna***).

Thoronidea sp. **Undescribed species**. AR: Montgomery Co.: Boxx Springs, 4.5 mi. SW Black Springs, E of Rd. 11, Sec. 33, T3S, R26W. 10 July 1998. Rattlesnake Springs, 4 mi. NE Caddo Gap N of Rd. C52, Sec.33, T3S, R24W. 10 July 1998. Rare eastern species (MD, MS, VA), presumed parasitoid of gelastocorid eggs. **New state record for the genus**.

Tiphodytes sp. **Undescribed species**. AR: Polk Co.: Bard Springs, 20 mi. SE of Mena, AR, Sec. 20, T4S, R28W. 7-11 Oct. 1995. Members of ***Tiphodytes*** are parasitoids of the eggs of Gerridae. **New state record**.

Trimorus annulicornis (Ashmead). AR: Montgomery Co.: Tea Creek Springs, 6.5 mi. NW Bonnerdale S of Rd. 476, Sec. 23, T3S, R23W. 25 June; 10 July, and 8 August 1998. Rattlesnake Springs, 4 mi. NE Caddo Gap, N of Rd. C52, Sec. 33, T3S, R24W. 10 July 1998. Boxx Springs, 4.5 mi. SW Black Springs E of Rd. 11, Sec. 33, T3S, R26W. 25 June 1998. Slatington Spring, 5.2 mi. SE Big Fork W of Rd. 1, Sec. 33, T3S, R27W. 25 June, 3 July, and 10 July 1997. Rare eastern species.

Diapriidae

Auxopaedeutes sp. **Undescribed species**. AR: Montgomery Co.: Brier Creek Spring, 25 mi. W. of Glenwood, Sec. 20, T4S, R27W. 19 July 1994. Johnson Co.: Dick Johnson Spring, Sec. 29, T11N, R22W. 6 Sept. 1994. This undescribed species is recorded from other localities. Members associated with ***Solenopsis*** ants. **New state record for the genus**.

Basalys sp. **Undescribed species**. AR: Montgomery Co.: Powell Creek Seeps, Sec. 35, T3S, R24W. 5-21 May 1998. Boxx Springs, 4.5 mi. SW Black Springs E of Rd. 11, Sec. 33, T3S, R26W. 25 June 1998. **New state record.** Also known from Florida, Georgia (Sapelo Island), and Canada (Ontario).

Belyta longicollis Fouts. AR: Montgomery Co.: Slatington Spring, 5.2 mi. SE Big Fork W of Rd. 1, Sec. 33, T3S, R27W. 25 June, 3 July, 10 July 1997. Distinct eastern species. **New state record.**

Entomacis ambigua Brues. AR: Johnson Co.: Baker Spring, ca. 5 mi. N. of Oark, Sec. 27, T13N, R24W. Rare species; this marks the southernmost record of this species. **New state record.**

Entomacis sp. **Undescribed species**. AR: Montgomery Co.: Tea Spring, 6.5 mi. NW Bonnerdale, S of Rd. 476, Sec. 23, T3S, R23W. 8 October 1997. **New state record.**

Idiotypa sp. Johnson Co.: Woods Mountain Spring, ca. 12 mi. NE of Clarksville, Sec. 34, T11N, R22W. 6 Sept. 1994. Many females. **First record of this genus from Arkansas**.

Ismarus gibsoni Masner. AR: Johnson Co.: Dick Johnson Spring, Sec. 29, T11N, R22W. Fall, 1993. **New state record.**

Paramesius sp. A. AR: Johnson Co.: Gilliam Bog, Sec. 11, T11N, R23W. 6 Sept. 1994. **Undescribed species**. **New state record for the genus**; known from other states.

Paramesius sp. B. AR: Johnson Co.: Gilliam Bog, Sec. 11, T11N, R23W. 6 Sept. 1994. Large series collected. **New state record.** Rare species known from elsewhere.

Spilomicrus antennatus (Jurine). AR: Montgomery Co.: Slatington Spring, 5.2 mi. SE of Big Fork, Sec. 33, T3S, R27W, W. of Rd. 1. 14 Nov. and 5 Dec. 1995. Two males. Widespread Holarctic species; fall-winter species which is very rarely collected; transcontinental in US. **New state record.**

Spilomicrus brevicornis (Ashmead). AR: Montgomery Co.: Tea Spring, 6.5 mi. NW of Bonnerdale, Sec. 23, T3S, R23W, S. of FSR 76. 5 Dec. 1995. One male. **New state record**. Widespread, but very rarely collected; late fall-winter species.

Spilomicrus exul Masner. AR: Montgomery Co.: Rattlesnake Spring, 4 mi. NE Caddo Gap, N of Rd. C52, Sec. 33, T3S, R24W. 10 July 1997. **New state record.**

Spilomicrus flavicornis Ashmead. AR: Montgomery Co.: Tea Creek Spring, 6.5 mi. NW Bonnerdale, Sec. 23, T3S, R23W. 8 October 1997. Blue Spring, 7 mi. NW Bonnerdale, S. of Rd. 44, Sec. 15, T3S, R23W. 5 July 1998. **New state record.**

Spilomicrus ruficornis (Provancher). AR: Montgomery Co.: Blue Spring, 7 mi. NW Bonnerdale, S. of Rd. 44, Sec. 15, T3S, R23W. 8 October 1997. Rattlesnake Springs, 4 mi. NE of Caddo Gap, N of Rd. C52., Sec. 33, T3S, R24W. 10 July 1998. **New state record.**

Spilomicrus stepheni Masner. AR: Montgomery Co.: Boxx Spring, 4.5 mi. SW of Black springs, Sec. 33, T3S, R26W. 10 June 1998. **New state record**; major range extension southwestward as VA is the closest known locality.

Spilomicrus sylvicola Masner. AR: Montgomery Co.: Blue Springs, 7 mi. NW of Bonnerdale, S of Rd. 44, Sec. 15, T3S, R23W. 5 July 1998. **New state record** and major range extension southwestward as VA is the closest known locality.

Synbelyta sp. **Undescribed species**. AR: Montgomery Co.: Tea Spring, 6.5 mi. NW of Bonnerdale, S. of Rd. 476 , Sec. 23, T3S, R23W. 14 Nov. 1995. One female. **New state record for the genus**. Several females known from more northern states in North America.

Trichopria sp. **Undescribed species**. AR: Montgomery Co.: Brier Creek Spring, Sec. 20, T4S, R27W. **New state record.** Known only from Arkansas.

Platygastridae

Acerotella acerina Masner. AR: Johnson Co.: Baker Spring, ca. 5 mi. N. of Oark, Sec. 27, T13N, R24W. 6 Sept. 1994 Arbaugh Springs, Sec. 24, T13N, R24W. 6 Sept. 1994 **New state record**. Known only from Ontario, Quebec, and New Brunswick in Canada and MD. These specimens represent a major extension southward.

Eritrissomerus cecidomyiae Ashmead. AR: Johnson Co.: Baker Spring, ca. 5 mi. N. of Oark, Sec. 27, T13N, R24W. 6 Sept. 1994. Arbaugh Spring, Sec. 24, T13N, R24W. 6 Sept. 1994. Associated with hickories. **New state record.**

Inostemma caryae (Ashmead). AR: Johnson Co. Baker Spring, ca. 5 mi. N. of Oark, Sec. 27, T13N, R24W. 6 Sept. 1994. Arbaugh Spring, Sec. 24, T13N, R24W. 6 Sept. 1994. Associated with hickories. **New state record.**

Inostemma sp. **Undescribed species**. AR: Newton Co.: Arbaugh Spring, 3 km SW of Arbaugh, Sec. 24, T13N, R24W. 27 May 1995. One female. Johnson Co.: Baker Spring, ca. 5 mi. N. of Oark, Sec. 27, T13N, R24W. 27 May 1995. One male. Known from other states. **New state record.**

Iphitrachelus foutsi Jackson. AR: Montgomery Co.: Singing Springs, 7 mi. NE Norman, N. of Rd. 208, Sec. 22, T3S, R24W. 25 June 1997. **New state record**. Major extension westward.

Platygaster caryae Ashmead. AR: Johnson Co.: Baker Spring, ca. 5 mi. N. of Oark, Sec. 27, T13N, R24W. 6 Sept. 1994. Arbaugh Spring, Sec. 24, T13N, R24W. 6 Sept. 1994. Associated with hickories. **New state record.**

Chrysididae

Amisega floridensis (Krombein). AR: Johnson Co.: Baker Spring, ca. 5 mi. N. of Oark, Sec. 27, T13N, R24W. 6 Sept. 1994. Numerous males and females. Dick Johnson Spring, 10 mi. NE of Clarksville, Sec. 29, T11N, R22W. 20 Aug.-24 Sept. 1994. Ninety-two males and females. Parasitoid in walking stick eggs. **New state record.**

Microsega bella Krombein. AR: Johnson Co.: Gillian Bog, Sec. 11, T11N, R23W. One female. Rare species, known previously from only TX and OK. **New state record**. Parasitoid in walking stick eggs.

Rhopalosomatidae

Olixon banksii (Brues). AR: Johnson Co.: Little Piney Creek at St. Hwy. 123, 5 mi. E. of Hagarville, Sec. 26, T11N, R22W. 15-28 July 1994. One male. **New state record.**

DISCUSSION

A total of 50 new state records of parasitic wasps was documented from Arkansas during the study period 1993-1998 as well as 14 significant range extensions into the state. Twenty-three parasitic wasp species were discovered in collections from nine different seeps/springs in the Ouachita National Forest while 21 parasitic wasp species were found in eight springs in the Ozark National Forest areas. Only four parasitic wasp species were shared by the two national forests. In the Ouachita NF, Blue Springs had the highest number of parasitic wasp species with eight, while Singing Springs and Boxx Springs had five species, and Slatington and Tea springs were inhabited by four species. In the Ozark NF, twelve species of parasitic wasps were collected from Baker Spring, while Gilliam Spring had five species collected from its environs and Arbaugh Spring had only four species. In addition, four species of parasitic wasps (*Idris leedsi*, *Idris* sp., *Trichopria* sp., and *Spiniteleia* sp.) new to science were discovered during this study of hymenopteran biodiversity in the Interior Highlands of Arkansas.

These 50 new state records and 14 records of significant range extension collected primarily from seeps and springs on national forests lands demonstrate the importance of these unique habitats and their attributes, and supports the USDA Forest Service efforts to conserve and manage these areas.

This study was not intended to be an exhaustive study of the hymenopteran biodiversity of Arkansas, but rather to shed light on the poorly known parasitic hymenopteran fauna of Arkansas and provide a basis from which future studies may be initiated. The study does however, provide another proof that an intensive focus on a targeted microhabitat (seeps and springs) using specialized collecting techniques to penetrate the microhabitat will yield good results.

ACKNOWLEDGMENTS

Travel funds for Henry W. Robison were graciously provided by the USDA Forest Service, Caddo Ranger District, Ouachita National Forest. Special thanks are extended to Wes Stone, Brian Pounds, Joey Powell, and Terry McKay for their assistance in the field. SAU students helping in this study were Jan Rader and Nick Covington. Appreciation is expressed to two SAU colleagues, Drs. Dan England and James Rasmussen, for reviewing this paper.

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NEW RECORDS OF FIVE GROUND BEETLES (COLEOPTERA: CARABIDAE) FROM TALLGRASS PRAIRIE REMNANTS IN WESTERN MINNESOTA[1,2]

P. P. Tinerella, D. A. Rider[3]

ABSTRACT: Five species of ground beetles (Coleoptera: Carabidae), *Poecilus corvus*, *Chlaenius p. purpuricollis*, *Diplocheila undulata*, *Agonum nutans*, and *Cymindis (Pinacodera) platicollis*, are reported from Minnesota for the first time.

The family Carabidae, or ground beetles, is one of the largest of all the coleopteran families. A recent world catalogue (Lorenz 1998) lists 32,561 extant species. The most recent North American carabid catalogue (Bousquet and Larochelle 1993) lists 323 species from Minnesota. Additional records for Minnesota have been recently reported by Tinerella (2000) and Tinerella and Rider (2000).

Poecilus corvus (LeConte) (Pterostichini), *Chlaenius p. purpuricollis* Randall (Chlaeniini), *Diplocheila undulata* Carr (Licinini), *Agonum nutans* (Say) (Platynini), and *Cymindis (Pinacodera) platicollis* (Say) (Lebiini) are reported for the first time from western Minnesota. All of the species were collected from tallgrass prairie remnants.

MATERIALS AND METHODS

All specimens were collected using pitfall traps, similar to the design of Reeves (1980). No covers or apron-type devices were used. During 1995-1999, pitfall trapping was conducted from early spring to late fall on Bluestem Prairie Complex near Glyndon, (Clay Co.) Minnesota [46° 50' 45"N, 96° 27' 45"W]; Felton Prairie Complex, near Felton, (Clay Co.) Minnesota [47° 03' 20"N, 96° 25' 45"W]; and Agassiz Dunes State Natural Area near Fertile, (Norman and Polk Counties) Minnesota [47° 30' 32"N, 96° 17' 84"W].

The Bluestem Prairie Complex is a 5000-acre (2023 ha) tallgrass prairie preserve which encompasses dry, mesic, and wet prairie remnants. It is managed primarily by periodic burning, but alternate management techniques (annual haying and rotational grazing) are being investigated on adjacent lands. The Felton Prairie Complex is a 4500-acre (1821 ha) site maintained by various management techniques. Within this tallgrass prairie complex are: 1) the Blazing Star Prairie and Bicentennial Prairie State Natural Areas, managed by periodic burning; 2) the Clay County Trust Lands, managed by annual haying; 3) state-owned lands (not recently managed); and 4) privately owned

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[1] Received December 12, 2000, Accepted February 26, 2001

[2] Approved as North Dakota Insects Publication No. 19 Schafer-Post Series.

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ENT. NEWS 112(5): 319-322, November & December 2001

ranch lands, which are periodically grazed. Vegetation on these complexes was composed of typical tallgrass prairie graminoids and forbs, and included: big bluestem [*Andropogon gerardii* Vitman], little bluestem [*Schizachrium scoparium* (Michx)], porcupine grass [*Stipa spartea* Trin.], purple coneflower [*Echinacea angustifolia* DC.], torch flower [*Geum triflorum* Pursh], purple prairie clover [*Dalea purpurea* Vent.], blazing star [*Liatris* spp.], and lead plant [*Amorpha canescens* Pursh]. Adventive species present included: Kentucky bluegrass [*Poa pratensis* L.], smooth brome [*Bromus inermis* Leyss.] and white sweet clover [*Melilotus alba* Medic.]. Vegetation seen typically on wet prairie transects included: blazing star [*Liatris pychnostachya* Michx.] water hemlock [*Cicuta* spp.], and wild lily [*Lilium philidelphicum* L.].

The Agassiz Dunes State Natural Area is a 2000-acre (809 ha) tallgrass prairie/oak savannah complex, managed by periodic burning. Typical vegetation on this site included: big bluestem, little bluestem, purple coneflower, and torch flower. Abundant adventive species included Kentucky bluegrass and smooth brome. Also occurring on this complex were creeping juniper [*Juniperus horizontalis* Moench], stands of quaking aspen [*Populus tremuloides* Michx.] and bur oak [*Quercus macrocarpa* Michx.].

In 1995, a total of 26 transects was established over these complexes as part of a large-scale tallgrass prairie arthropod study. Ground beetle specimens reported here have been deposited in the North Dakota State Insect Reference Collection, Department of Entomology, NDSU.

SPECIES ACCOUNTS

Poecilus corvus (Leconte): Three individuals of *P. corvus* were collected in 1996 (June 27, July 3, & September 24). Two individuals were collected from wet prairie in Bluestem Prairie Complex, one from a hayed transect and one from a non-managed transect. A single individual was collected from a non-managed transect of dry prairie on the Agassiz Dunes State Natural Area. In the Minnesota vicinity, this species has been reported previously from Manitoba, North Dakota, and South Dakota (Bousquet and Larochelle 1993). Lindroth (1966) recorded *P. corvus* as a prairie species, occurring on dry, often clayish soil, in the vicinity of alkaline water.

Chlaenius p. purpuricollis Randall: One hundred twenty-three individuals were collected throughout the season, on each of the three prairie sites from 1995 to 1998. Sixty-eight individuals were collected from the Felton Prairie Complex on two burned transects of mesic prairie, on two hayed transects of dry to mesic prairie, and on one non-managed transect of mesic prairie. Twenty-nine individuals were collected from the Bluestem Prairie Complex on four burned transects of dry, mesic, and wet prairie, and one on a hayed transect of wet prairie. One individual was collected on a burned transect of dry prairie from the Agassiz Dunes State Natural Area in 1996. This species is transamerican in distribution, although regarded as locally rare (Lindroth 1969). Near Minnesota, it has been reported from Iowa and Manitoba (Bousquet and Larochelle 1993). In Ontario, Bouchard, et al. (1998) have taken many specimens in alvar habitats (dry, sparsely vegetated limestone plains).

Diplocheila undulata Carr: Seven individuals were collected from the Bluestem Prairie Complex on June 3, 13 & 25, 1996, and July 14 & 31, 1997. These were collected from two burned transects of dry prairie and mesic prairie, two hayed transects of wet prairie, and one non-managed transect of wet prairie. This species has been previously reported only from Illinois, Alberta and Manitoba (Bousquet and Larochelle 1993). The ecology of this species is unknown (Lindroth 1969). Five species of *Diplocheila* Brullé were collected during this survey, all in wet areas.

Agonum nutans (Say): Thirty-one individuals were collected during 1996 and 1997 on the Bluestem Prairie Complex. Individuals were collected from all months of the season (spring thaw to killing frost), with the highest abundance in June. Specimens were collected on a grazed transect of mesic to wet prairie and on three burned transects of mesic prairie and wet prairie. This species is widespread east of the Rocky Mountains (Lindroth 1966) and has been reported near Minnesota from South Dakota, Iowa, and Wisconsin (Bousquet and Larochelle 1993). Lindroth (1966) reported examples of Canadian specimens from drift material, stating that the true habitat association for this species was unknown. Bouchard, et al. (1998) collected hundreds of specimens in alvar grasslands in Ontario.

Cymindis (Pinacodera) platicollis (Say): Two individuals were collected on the Agassiz Dunes State Natural Area on October 13, 1997. Both specimens were in traps on a non-managed transect of dry prairie. This species is distributed throughout eastern North America and has been reported near Minnesota from Iowa and Wisconsin (Bousquet and Larochelle 1993). This lebiine has been reported from under bark and various cover in sandy areas (Lindroth 1969). Similar vegetation exists on the non-managed transect where this species was collected. It is primarily an arboricolous species (Davidson personal comm., Krinsky and Godwin 1990).

ACKNOWLEDGMENTS

We wish to thank Donald Schwert, Quaternary Entomology Laboratory, Dept. of Geosciences, NDSU, for his confirmation of the identifications and review of the manuscript. We also wish to thank Allan Ashworth, Quaternary Entomology Laboratory, Dept. of Geosciences, NDSU, and Robert Carlson, Dept. of Entomology, NDSU for their review of the manuscript. Appreciation is extended to Darren Pollock, Texas Agricultural Experiment Station, Bushland, TX, for confirming the identification of *Agonum nutans* (Say). The personal communication of Robert Davidson, Carnegie Museum of Natural History, is likewise acknowledged and served to add important information to the manuscript. Special thanks also to Brian Winter, The Nature Conservancy– Minnesota Chapter, for coordination and access to the prairie study sites. Financial support for this research was provided by the Minnesota Chapter of the Nature Conservancy, the Wisconsin Department of Natural Resources, and the Minnesota Department of Natural Resources, Non-game Wildlife Fund.

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SOCIETY MEETING OF FEBRUARY 28, 2001

BIOKO ISLAND: RESEARCH AND ADVENTURE IN WEST AFRICA

Jason Weintraub and Lauren Spearman
Philadelphia Academy of Natural Sciences

Jason Weintraub and Lauren Spearman gave a travelogue with a brief overview of their research project involving the Lepidoptera fauna of Bioko, an island off the coast of central Africa.

Bioko is part of the country of Equatorial Guinea, and was formerly known as "Fernando Po". Bioko has a Portuguese, British, and Spanish colonial history. The largest island in the volcanic chain that extends south from Nigeria's Mt. Cameroon, Bioko lies in the Gulf of Guinea ca. 32km from mainland Cameroon. Bioko's geologic history has left it as part of a band of tropical rainforest vegetation that extends from Sierra Leone east to southwestern Uganda and Rwanda. Bioko is ranked as one of the wettest places on earth, with over 200 cm of precipitation recorded annually. The island is characterized by a mosaic of different forest types over a very steep elevation gradient and this has undoubtedly played an important role in the genesis of extraordinary insect species diversity.

(Continued on page 325)

STONEFLY NAIADS (PLECOPTERA: PERLIDAE) ENCRUSTED BY DIATOMS

N. J. Pamperin[2], G. S. Paulson[3]

ABSTRACT: We report the first instance of diatoms (*Cocconeis* sp.) found encrusting Perlidae nymphs (*Acroneuria* sp.). Scanning electron micrographs of the diatoms *in situ* are presented.

Diatoms are extremely abundant in the plankton and sediments of marine and freshwater ecosystems. They have an extensive fossil history that includes massive deposits, known as diatomaceous earth, which is mined for commercial usage. Many species encrust objects found in their aquatic environment. They are commonly found on plants and rocks, but also live on molluscs and crustaceans, and will even form thick crusts on the skins of whales (Round et al, 1990, Vinyard 1979). Kondratieff and Kirchner (1982) reported that nymphs of *Taeniopteryx nelsoni* Kondratieff and Kirchner (Plecoptera: Taeniopterygidae) have a cryptic covering composed of algae, fungi, detrital material, sand, and four genera of diatoms. This paper provides an additional record of diatoms encrusting insects including the first scanning electron micrographs of this phenomenon.

Acroneuria sp. nymphs (Plecoptera: Perlidae) collected in the Taylor River, Gunnison Co., CO in the summer of 1996, were prepared for examination with a scanning electron microscope (SEM) by gradual dehydration in ethanol, critical point drying and sputter coating with gold. Upon examination diatoms (*Cocconeis* sp.) were found to be encrusting the exoskeleton of the insects. Six specimens of *Acroneuria* sp. were examined; all of them had a large number of diatoms especially on the cerci, antennae, and thorax (Figure 1). This is the first record of diatom encrustation in the Perlidae as well as the first report of *Cocconeis* sp. encrusting insects.

It is unclear if the nymphs were adversely affected by the presence of the diatoms. In *T. nelsoni* encrustations of diatoms and other materials provide camouflage for the nymph but that does not seem to be the case in *Acroneuria* sp. While there are a large number of diatoms present on the exoskeleton of *Acroneuria* sp. there do not seem to be enough to make the nymphs cryptic. Conversely it seems that such large encrustations could interfere with the functions of sensory structures on the antennae and cerci. Due to the nature of diatoms it is not surprising that they are found encrusting aquatic insects. It is

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[1] Received June 2, 2001. Accepted July 16, 2001.

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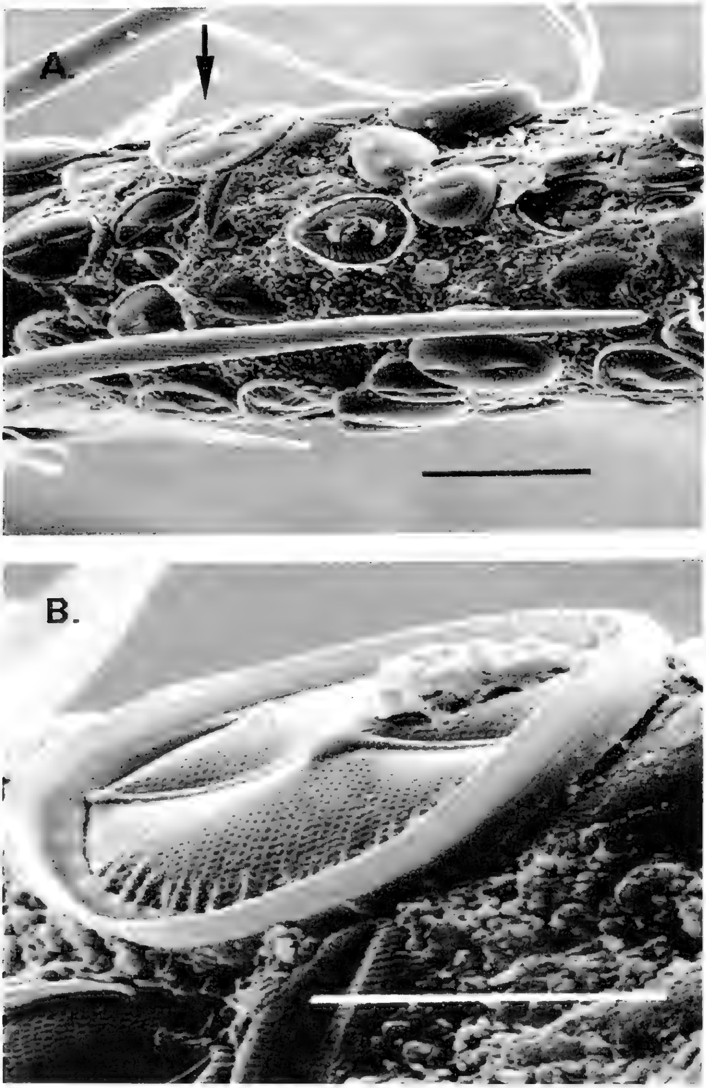

Figure 1. A. Diatoms (*Cocconeis* sp.) encrusting the cercus of *Acroneuria* sp. (Plecoptera: Perlidae). Scale bar equals 20 microns. B. Higher magnification of organism marked by arrow above. Scale bar equals 10 microns.

perhaps more interesting that this behavior has not been more widely reported previously and we wonder how commonly this occurs and the range of insect taxa that might be utilized.

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(Continued from page 322)

The presenters discussed their field surveys in the various habitats on Bioko including a volcanic crater, lowland rainforest, and montane rainforest on the second highest peak in West Africa, Pico Basile. Jason, Lauren and their colleague Nathan Orfe photographed, videotaped and used several methods of collection to document the broad range of different groups of insects with a special emphasis on the Lepidoptera fauna.

Specimens collected in the field were brought back to the Academy of Natural Sciences for preparation and identification. The process of identifying and incorporating the specimens has been ongoing and laborious because of the lack of literature addressing the Lepidoptera of Bioko Island. The presenters have had to construct a database that contains hundreds of scanned images from the primary scientific literature linked to a large list of potential species known to occur on or near Bioko. The ultimate destination of the identified material is the Academy's collection and other major museum repositories. Jason and Lauren anticipate that future study of the collections from the 1998 and 1999 trips to Bioko will yield additional new records, and possibly undescribed taxa.

At the business meeting, the slate of candidates for society offices was accepted unanimously. In notes of entomological interest, Susan Whitney showed items with a cicada motif from southern France and Dr. Ken Frank (M.D.) reported finding six orders of insects (winter stoneflies, caddisflies, crickets, ants, beetles and spiders) on the snow near a spring-fed stream in Tyler Arboretum on January 6. Dr. D. R. Kasparian of the Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia, who is visiting the Academy's Cresson type collection of Ichneumonidae, was introduced.

William J. Cromartie
Corresponding Secretary

NEW RECORDS OF THE GENUS *BUENOA* (HEMIPTERA: NOTONECTIDAE) FROM OHIO[1]

Stephen W. Chordas III[2]

ABSTRACT: Three *Buenoa* species were recently collected from nine Ohio wildlife areas. *Buenoa margaritacea* was collected in black light traps and dip-net samples. Two other species, *B. confusa* and *B. scimitra*, were collected solely by dip-nets. Both *B. confusa* and *B. margaritacea* have been reported from states bordering Ohio, and were expected for Ohio. *Buenoa scimitra*, historically known as a southern species, was not anticipated for Ohio.

There are about 80 wildlife areas in Ohio managed by the Ohio Department of Natural Resources, Division of Wildlife (DOW) for a variety of hunting, fishing, recreational, and watchable wildlife functions. The aquatic insect fauna of these areas is relatively unknown. The DOW provided funds for the Ohio Biological Survey to conduct a three-year study of state-listed, special category species for Killdeer Plains Wildlife Area (Wyandot County). The Ohio Biological Survey is concurrently conducting a multi-year comprehensive survey of adult aquatic insects in Ohio co-funded by DOW, Partnerships for Wildlife Foundation of the U.S. Fish and Wildlife Service, and the Proctor and Gamble Co., Inc. As relatively undisturbed areas, Ohio's wildlife areas make good candidates for investigation of biological diversity. As a result of these projects, several uncommon and/or rare taxa have been found.

Fifteen *Buenoa* species are known from the United States. However, many are restricted to the south and southwest (Polhemus and Polhemus, 1988; Polhemus, 1997). Five *Buenoa* species are known from the Great Lakes region. Prior to this paper, the only *Buenoa* reported for Ohio was *Buenoa platycnemis* (Fieber, 1851) (Osborn and Drake, 1915). This was a misidentification as this species is a southern species (Mexico, Florida, Texas) (see Truxal, 1953). Further, the author examined the Notonectidae in the C.J. Drake collection (National Museum of Natural History, Washington D.C.) in 1996 and found no *B. platycnemis* from Ohio.

Buenoa species have hemoglobin-filled abdominal chambers which are believed to act, in part, as a buoyancy compensation unit. With these, the insect has the ability to inhabit deeper water than many other aquatic insects. This ability and their small size make them somewhat elusive and are often under-represented in insect collections (Hilsenhoff, 1984). It is not surprising they had been generally overlooked by Ohio collectors.

The purpose of this paper is to report the occurrence of three *Buenoa* species as new state records for Ohio. This is one of a series of papers on this

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[1] Received May 2, 2000. Accepted December 16, 2000.

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order which will culminate in comprehensive diagnostic atlases of aquatic Hemiptera of Ohio.

METHODS

Adult *Buenoa* were collected in either black light trap or dip net samples, preserved in 70% ethanol, and identified using Truxal (1953). Chordas and Harp (1991), Chordas et al. (1999), Polhemus (1997), Polhemus and Polhemus (1988), Truxal (1953), Yeakel and Larsen (1997), and Zack (1990) were used as distribution references. Voucher specimens were deposited into the Ohio Biological Survey's Aquatic Insect Collection (OBS) (Museum of Biological Diversity, The Ohio State University, Columbus, Ohio) and into the author's personal collection (SWACC) (Columbus, Ohio). Examination of Ohio museum collections failed to add additional *Buenoa* species or wildlife area records to this study.

RESULTS

Three *Buenoa* species were identified from collections obtained at nine wildlife areas throughout Ohio (Table 1; Figure 1). Each species was collected

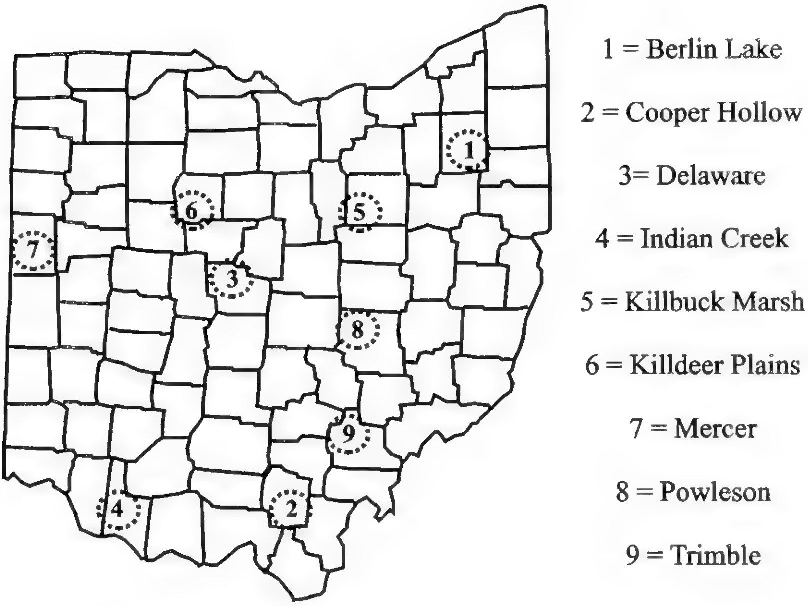

Figure 1. Location of Wildlife Areas where *Buenoa* species were collected.

at several wildlife areas (Table 1). *Buenoa margaritacea* Torre-Bueno, 1908 was collected in both dip-net samples and black light traps. *Buenoa confusa* Truxal, 1953 and *Buenoa scimitra* Bare, 1925, were obtained solely in dip-net samples. Adults obtained by dip-net sampling were collected between April and October while sampling lentic, fish-less habitats. Black light traps were set from May through October, but only July & August samples contained *Buenoa*.

Table 1. Occurrence of *Buenoa* species from various wildlife areas in Ohio.

		Species	
Wildlife Area, Collection Site & Specimen Repository	*Buenoa confusa*	*Buenoa margaritacea*	*Buenoa scimitra*
Berlin Lake W.A. Portage County; large marsh off State Route 225, Steve Chordas III [N41.00 : W-81.09] 24 June 1996 (SWACC)	X 10♂-17♀		
Cooper Hollow W.A. Jackson County; pond at headquarters, Steve Chordas III, [N38.93 : W-82.52] 24 September 1995 (SWACC)	X 1♂-2♀	X 1♂-5♀	X 24♂-13♀
Delaware W.A. Marion County; pond off State Route 98/near U.S. Route 23, Steve Chordas III [N40.46 : W-83.07] 3 August 1995 (SWACC)	X 32♂-33♀	X 15♂-6♀	X 1♂
Indian Creek W.A. Brown County; swamp near Archery range, Steve Chordas III [N39.18 : W-82.89] 7 April 1996 (SWACC)			X 2♂-9♀
Killbuck Marsh W.A. Wayne County; Kimber pond on Kimber Road, Steve Chordas III [N40.71 : W-81.98] 14 September 1996 (SWACC)	X 40♂-25♀	X 4♂-6♀	X 2♂
Killdeer Plains W.A. Wyandot County; Black light trap, M. Ballard [N40.71 : W-83.28] 22 July 1997 & 31 August 1997 (OBS)		X 4♂	
Mercer W.A. Mercer County; pond at headquarters, Steve Chordas III [N40.49 : W-84.56] 18 July 1997 (SWACC)		X 10♂	
Powelson W.A. Muskingum County; shallow lake off State Route 60, Steve Chordas III [N40.04 : W-82.03] 24 October 1996 (SWACC)	X 16♂-14♀		
Trimble W.A. Athens County; pond off of road T-314, Steve Chordas III [N39.52 : W-82.12] 3 October 1996 (SWACC)	X 26♂-25♀		

DISCUSSION

The genus *Buenoa* has now been reported for every state east of the Mississippi River except Kentucky, New Hampshire, and Rhode Island. In Ohio, *Buenoa* were found only in fish-less lentic habitats. This is consistent with the idea of fish being the primary limiting factor with respect to *Buenoa* distribution (Bendell, 1986).

The species reported here are the three most common *Buenoa* species in North America (Polhemus and Polhemus, 1988; Truxal, 1953). Two additional, less common, *Buenoa* species (*Buenoa limnocastoris* Hungerford, 1923 and *Buenoa macrotibialis* Hungerford, 1924) may also occur in Ohio. A more comprehensive collecting effort is needed to establish the presence of these species.

***Buenoa confusa*:** This species has the widest distribution of all *Buenoa* species in the United States and Canada. In Canada, it has been reported for every province between British Columbia and Nova Scotia (Polhemus and Polhemus, 1988). In the United States it has now been reported for 22 states and ranges from Idaho and Washington, to Maine, Florida, and Texas. It had been reported for three states (Michigan, Indiana, Pennsylvania) bordering Ohio and was expected for Ohio.

Buenoa confusa was found in clear ponds or small lakes containing abundant aquatic vegetation (often *Elodea* sp.). Chordas and Harp (1991) and Hilsenhoff (1984) found it in similar habitats in Arkansas and Wisconsin, respectively.

***Buenoa margaritacea*:** This is a common species in the United States and eastern Canada. It has been reported from three provinces in Canada and is now known from 32 states in the United States. This species was expected for Ohio as it had been reported for all states bordering Ohio, except Kentucky.

This was the only species taken in black light traps. Four specimens from two separate black light samples were taken at Killdeer Plains Wildlife Area (Figure 1; Table 1). Interestingly, Chordas and Harp (1991) reported that, of the three species known for Arkansas (which are the same three known for Ohio) this was the only *Buenoa* species not taken in black light traps.

***Buenoa scimitra*:** This species is common throughout the southern United States. Until recently, it had not been reported north of about the 38th parallel and was not anticipated for Ohio. Yeakel and Larsen (1997) reported this species from Pennsylvania, the first record of it north of the 40th parallel. Pennsylvania is the only state bordering Ohio with records of this species. The Ohio records further confirm its presence in the southern Great Lakes region (Table 1; Figure 1). It is the least common *Buenoa* in Ohio and is generally restricted to the southern half of the State (Table 1).

ACKNOWLEDGMENTS

Funding for projects from which part of this work is derived came from the Ohio Division of Wildlife's "Do Something Wild!" Income Tax Check-off Program, U.S. Fish & Wildlife Service's Partner for Wildlife Program, and the Proctor & Gamble Co., Inc. Thanks is extended to all the wildlife area managers for allowing unrestricted access to the wildlife areas. Also many thanks to Benjamin A. Foote (Kent State University) and Veda M. Cafazzo (Ohio Biological Survey) for reviewing early drafts of this manuscript.

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FIRST RECORD OF *DIBOLOCELUS OVATUS* (COLEOPTERA: HYDROPHILIDAE) IN NEW HAMPSHIRE[1]

Tracy L. Tarr, Kimberly J. Babbitt[2,3]

ABSTRACT: We report the first record of *Dibolocelus ovatus*, a water scavenger beetle, in New Hampshire and provide habitat data for this location.

The genus *Dibolocelus* has a New World distribution (Jasper and Vogtsberger 1996); however it is represented by only a single species, *D. ovatus*, in North America (Smetana 1988). Although the distribution of *D. ovatus* has been described as transcontinental (Smetana 1988), published records to date indicate a spotty distribution. Recent reports have extended the known range of *D. ovatus* into Canada (Laliberté 1980, Smetana 1988, Roughley 1991, LapLante 1992), Mississippi (Testa and Lago 1994), and Texas (Jasper and Vogtsberger 1996), but until now, no records existed for New Hampshire.

The larval stage of *D. ovatus* was described only recently (Archangelsky and Durand 1992). *Dibolocelus ovatus* is predatory in the larval stage, and appears to eat only snails. In the adult stage this hydrophilid likely functions as a detritivore by scavenging on decomposing organic matter in aquatic systems (White and Brigham 1996).

Our observation of *D. ovatus* was the result of a field study examining the effects of hydroperiod on predatory insect composition and larval amphibian composition and abundance (Tarr 2000). We surveyed 54 wetlands of varying hydroperiod for predatory insects (larvae and adults) and larval amphibians twice during the summers of 1998 and 1999 in southern New Hampshire (Figure 1). Haphazard replicated 1 m^2 dipnet sampling was used to capture specimens in all available microhabitats within a wetland (shallow vegetation, shallow non-vegetation, deep vegetation, and deep non-vegetation). Shallow water was defined as a water depth less than 0.6 m. All major plant types (e.g., submerged, emersed, floating) were sampled within a wetland. In the field, specimens were preserved in 10% buffered formalin, and insects were transferred to 70% ethanol in the laboratory. Prior to dipnetting, pH was recorded at three haphazard locations in each microhabitat, between approximately 9:00 am and 3:00 pm using an Orion model 230A pH meter. Data are provided only for the *D. ovatus* location.

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One adult specimen of *D. ovatus* was found in a well-vegetated permanent pond in August 1998 in Lee, New Hampshire USA (43° 06.49' N, 70° 58.97' W, Strafford County, Figure 1). At the time of capture, the pond had little open water. The pond (0.2 ha, 200 ft above sea level) is part of an extensive area flooded by beaver (*Castor canadensis*) and is close to several ephemeral wetlands. The specimen was found in shallow water in dense mermaid-weed (*Proserpinaca palustris*). Other vegetation in the pond included bur-reed (*Sparganium spp.),* three-way sedge (*Dulichium arundinaceum*), mannagrass (*Glyceria spp.*), and bulrush (*Scirpus spp.*). The pH of the pond ranged from 6.31 to 6.62 in the shallow, vegetated sections.

Young (1954) and Smetana (1988) note that *D. ovatus* may prefer well-vegetated, large water bodies. However, *D. ovatus* may be found in other

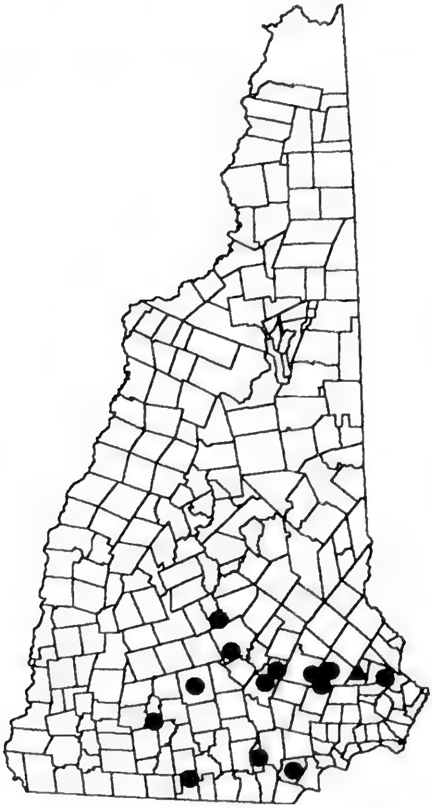

Figure 1. Approximate locations of study sites. At least three wetlands were sampled at each location (indicated by a black circle; n = 54 wetlands in 13 towns). The triangle indicates the *Dibolocelus ovatus* location.

habitats, such as vernal pools (pers. comm., K. Stein, Blacksburg, VA) which tend to be small and sparsely vegetated. As a result, more research is needed to determine habitat preference of this noteworthy beetle.

Because we did not capture any other individuals in New Hampshire in 1998 and 1999, the captured individual may be a migrant from another state and is not necessarily an indication of a breeding population (pers. comm., D. Chandler, Durham, NH). However, as with habitat preference, distribution of this beetle is poorly known, especially in the northeast. The poor state of knowledge of this species in terms of both habitat preference and distribution can only be addressed with future survey work and analysis of habitat associations. The fact that the larval stage was described only recently (Archangelsky and Durand 1992) raises the possibility that this species has been misidentified or unidentified in previous work of aquatic coleopteran larvae. This new record should alert researchers conducting surveys of aquatic taxa in the northeast to the possible occurrence of specimens of *D. ovatus*.

ACKNOWLEDGMENTS

This research was funded by the Environmental Protection Agency, N.H. Department of Environmental Services, and the N.H. Fish & Game Department. We thank Sara Callaghan, Becky Wright, and Tracy Ayer for assistance with data collection and Donald Chandler for confirming our identification and for access to the University of New Hampshire insect collection. We are also grateful to Philip Perkins for examining the Harvard University *Dibolocelus* collection for us. The specimen is stored at the University of New Hampshire insect collection. Two anonymous reviewers provided helpful comments on a previous draft of this manuscript.

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ADDITIONS AND CORRECTION TO THE LIST OF CERAMBYCIDAE (COLEOPTERA) OF MISSISSIPPI[1]

Terence L. Schiefer[2]

ABSTRACT: Seven species of Cerambycidae are added and one removed from records of Mississippi species.

Seven species of Cerambycidae need to be added to and one removed from the list of species that occur in Mississippi (Schiefer 1998). Records for these species are listed below. The known longhorned beetle fauna of Mississippi will now include 219 species and seven subspecies of Cerambycidae and one species of Disteniidae. As in my earlier list (Schiefer 1998), I have selected a specimen to serve as a voucher for the occurrence of each species in Mississippi and have listed its accompanying label data. All specimens are deposited in the Mississippi Entomological Museum, Mississippi State University, except as noted.

The following species is removed from the list of Mississippi Cerambycidae:

Brachysomida bivittata (Say). The record of this species in Mississippi (Schiefer 1988) was based on a misidentified specimen of the superficially similar *Gaurotes thoracica* (Haldeman). See below.

The following species are added to the list of Mississippi Cerambycidae:

Phymatodes aereus (Newman). New State Record. This eastern species has been recorded as far south as Georgia (Turnbow and Franklin 1980) and Missouri (MacRae 1993). The single Mississippi specimen is from the southwestern edge of the species' known distribution. Voucher: Winston Co., Tombigbee Natl. Forest, 33°11'50"N 89°03'20"W, 5 April 1999, D.M. Pollock, blacklight trap in mixed mesic forest.

Clytoleptus albofasciatus (Laporte and Gory). New State Record. The presence of this eastern species in Mississippi was anticipated since it has been recorded from Florida (Peck and Thomas 1998) and Oklahoma (Alexander 1958). Two specimens are known from Mississippi. Voucher: Sharkey Co., Delta Natl. Forest, 33°44'09"N 90°45'38"W, 17 June-1 July 1999, M.D. Warriner, Malaise trap in unthinned hardwood forest. Other specimen: same data except, 9-17 June 1999.

Xylotrechus aceris Fisher. New State Record. The distribution of this eastern species extends from Maine (Hopping 1932) south to Georgia (Turnbow and Franklin 1980) and west to Michigan (Gosling 1973). The single Mississippi specimen represents a southwesternmost record for the species. Voucher: Winston Co., Tombigbee Natl. Forest, 33°11'50"N 89°03'20"W, 12 July 1999, T. Schiefer, J. MacGown, on leaf near ground on ridge top trail in mixed mesic forest.

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ENT. NEWS 112(5): 334-336, November & December 2001

Gaurotes thoracica (Haldeman). New State Record. This species has long been considered to be rare (Leng 1890, Linsley and Chemsak 1972, Yanega 1996). It has been recorded from Massachusetts, Pennsylvania, and Virginia (Leng 1890, Linsley and Chemsak 1972), Michigan (Gosling and Gosling 1976), and Ohio (Knull 1946). However, based on Knull's published description, the Ohio records probably refer, at least in part, to *Brachysomida bivittata* (Say). Forty specimens of *G. thoracica* have been collected in Mississippi, 36 of which were collected 5 April 1999 at blacklight in Winston County, Tombigbee National Forest, 33°11'50"N 89°03'20"W. That night the blacklight attracted an unusually large number and diversity of insects, probably due to the unseasonably warm temperature which remained above 73° F (23°C) at midnight. The habitat at this locality is old-growth hardwood ravines with mixed pine/hardwoods on the ridges. Voucher: Tishomingo Co., Tishomingo St. Pk., 12 April 1986, D. Stout. This specimen was misidentified as *Brachysomida bivittata* (Say) in Schiefer (1998). Other specimens: Monroe Co., 5 mi. NNW Aberdeen, 33°53'58"N 88°34'49"W, 1-6 April 1998, Malaise trap in hardwood forest; same data except, 33°53'56"N 88°35'08"W; Winston Co., Tombigbee Natl. Forest, 33°13'01"N 89°05'42"W, 26 April-3 May 1999, Malaise trap in deciduous forest.

Typocerus deceptus Knull. New State Record. It was expected that this eastern species would be found in Mississippi since it has been recorded from Florida (Peck and Thomas 1998) and Oklahoma (Alexander 1958). Three specimens are known from Mississippi. Voucher: Tishomingo Co., Tishomingo St. Pk., 16 June 1991, T.L. Schiefer, on flowering *Hydrangea arborescens*. Other specimens: Webster Co., The Cove, T20N, R8E, Sec.12, 7 mi. W. Walthall, 25 June 1988, sweeping; Winston Co., Tombigbee Natl. Forest, 33°13'01"N 89°05'42"W, 31 May-7 June 1999, Malaise trap in deciduous forest.

Microgoes oculatus (LeConte). New State Record. This eastern species has been recorded as far south as Alabama and as far west as Illinois (Linsley and Chemsak 1984). The two Mississippi specimens are at the southwestern edge of the known distribution of this species. Voucher: Winston Co., Tombigbee Natl. Forest, 33°13'01"N 89°05'42"W, 7-21 June 1999, T. Schiefer, J. MacGown, Malaise trap in deciduous forest. Other specimen: Monroe Co., 5 mi. NNW Aberdeen, 33°53'58"N 88°34'49"W, 11-18 May 1998, Malaise trap in hardwood forest.

Astylopsis fascipennis Schiefer. This species was recently described from Mississippi (Schiefer 2000). The type specimen, deposited in the National Museum of Natural History, will serve as a voucher.

ACKNOWLEDGMENTS

I thank Richard Brown, William Jones, Joe MacGown, David Pollock, Beverly Smith, Daniel Stout, and Michael Warriner for their efforts in collecting specimens mentioned in this paper. Wendell Ladner supplied the temperature data.

Approved for publication as Journal Article No. J9853 of the Mississippi Agricultural and Forestry Experiment Station, Mississippi State University, with support from State Project MIS-311020. Study of Cerambycidae in Tombigbee National Forest was made possible through a Mississippi Natural Heritage Program Research Grant and USDA Forest Service Agreement No. 08-99-07-CCS-010.

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SOCIETY MEETING OF APRIL 25, 2001

CATERPILLAR SURVIVAL STRATEGIES

David L. Wagner
University of Connecticut

Butterflies and moths lay hundreds of eggs, only a few of which on the average survive to become adults. Birds, wasps, and other natural enemies daily thin the ranks. Birds, stained hemolymph green in claw and bill, harvest huge numbers of caterpillars. Songbirds in particular are ravenous predators, which feed each of their nestlings dozens of caterpillars daily. Caterpillars in turn have amassed an impressive repertoire of gimmicks and strategies to thwart their would be predators. Dr. Wagner provided an overview of many of these tactics, particularly those employed by local species. He contrasted those species that rely on crypsis, trying not to be seen, often with amazing resemblances to other objects in the environment, with those that advertise their noxious or unpalatable qualities through color, ornament and odor. His talk was infused with enormous collection of slides of caterpillar, many of which have appeared in his two caterpillar identification guides.

William J. Cromartie
Corresponding Secretary

NEW DISTRIBUTIONAL RECORD OF *LUTZOMYIA CRUCIATA* (DIPTERA: PSYCHODIDAE) IN THE STATE OF YUCATAN, MEXICO[1]

Eduardo A. Rebollar-Téllez[2], Pablo Manrique-Saide[3]

ABSTRACT: Fortuitous collections of female sand fly *Lutzomyia cruciata* were carried out in "Sudzal chico", Tzucacab and Xmatkuil, Yucatan. This represents the first report of the anthropophilic sand fly *L. cruciata* in the state of Yucatán. The importance of this finding in relation to transmission of *Leishmania mexicana* in the area is yet unknown.

Cutaneous leishmaniasis caused by *Leishmania mexicana* (Biagi) is endemic in the Yucatán Peninsula. The sand fly *Lutzomyia olmeca olmeca* (Vargas & Diaz-Nájera) has hitherto been incriminated as a proven vector of *Leishmania* parasite (Biagi et al. 1965). Nonetheless, more recent evidence (Rebollar-Téllez et al. 1996a) suggests that *L. cruciata* (Coquillett) may play an important role in parasite transmission as well. *L. cruciata* females are highly anthropophilic, this species being by far the most often collected man-biting species caught in the states of Campeche (Rebollar-Téllez et al. 1996 b & c) and Quintana Roo (Cruz-Ruiz et al. 1994). In the state of Yucatán, no collections of sand flies have been undertaken for many years. This paper reports on recent fortuitous catches of *L. cruciata* in the state of Yucatan.

MATERIALS AND METHODS

L. cruciata females were collected on a human subject (PMS) as they alighted on the subject's forearm and ears whilst feeding. Collections were made on 12/I/1999 (Sudzal Chico, Tzucacab) and on 8/XI/2000 (Km 15.5 Merida-Xmatkuil). Flies were captured with a mouth aspirator and killed in ethanol (70%). Specimens were dissected and mounted on microscope slides using Berlese mounting medium (Harris Chemical, Shenstone, England). Identification of flies was carried out according to Young & Duncan's (1994) species keys. Voucher specimens have been deposited in the collection of phlebotomine sand flies of the Autonomous University of Yucatan (UADY). Accesion numbers: slides UADY 350 through UADY 359.

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[1] Received March 24, 2001. Accepted May 21, 2001.

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RESULTS AND DISCUSSION

Ten specimens were collected at both locations (nine in Sudzal Chico, Tzucacab and the one in Merida-Xmatkuil). *Lutzomyia cruciata* (Coquillett) has been reported previously in the Mexican states of Campeche, Chiapas, Hidalgo, Michoacán, Nuevo León, Puebla, San Luis Potosí and Tamaulipas (Vargas & Diaz-Nájera 1953, Fairchild & Hertig 1959), and a single specimen in Yucatan (Ibañez-Bernal 1999). Female *L. cruciata* are morphologically similar to those of *L. gomezi* (Nitzulescu). They can be distinguished from each other by the darker coloration of the pronotum and paratergites in *L. cruciata* than that which is seen in *L. gomezi* (Young & Duncan 1994). Furthermore the ninth abdominal tergite in *L. cruciata* shows a papillate area in the lateral anterior margin, which is absent in the female of *L. gomezi* (Fairchild & Hertig 1948, 1953). Unpublished observations of one of us (EART) has shown that *L. cruciata* and *L. gomezi* can be sympatric in the state of Campeche. This is important when considering biting habits in areas of transmission of *L. mexicana*. Traditionally *L. cruciata* has been reported as a keen human-biter (Zeledón & Murillo 1983, Cruz-Ruiz et al. 1994, Rebollar-Téllez et al. 1996a, b & c). *L. cruciata* is considered at the present time to be a suspicious vector species in the Peninsula of Yucatan and perhaps in Belize as well (Williams 1970, Rebollar-Téllez et al. 1996a). Biting rhythm has been reported to peak after dusk (1900 to 2000 h) (Williams 1970, Rebollar-Téllez et al. 1996b), however females can be active throughout the day, biting opportunistically at light-hours (Williams 1966, 1970). All the specimens reported herein were captured at noon while biting, and interestingly one specimen was caught indoors in an air-conditioned room. An important point to highlight is the fact that female *L. cruciata* have been shown capable of transmission of *L. mexicana* to human volunteers during blood-feeding (Williams 1966). The real potential of *L. cruciata* as a vector of *L. mexicana* in the Peninsula of Yucatán should be assessed in future studies. Only two other sand fly species have been reported in the state of Yucatan, these being *L. trinidadensis* (Newstead) and *L. longipalpis* (Lutz & Neiva) (Vargas & Diaz-Nájera 1953). We advance a suggestion for undertaking more sand fly catches in the state of Yucatan to evaluate the potential risk for *Leishmania* transmission to the inhabitants of this area.

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STATEMENT OF OWNERSHIP, MANAGEMENT & CIRCULATION

1. Title of publication: ENTOMOLOGICAL NEWS
2. Date of filing October 1, 2001.
3. Frequency of issue: Bimonthly (every other month) except July and August
4. Location of known office of publication: 232 Oak Shade Rd., Tabernacle Twp., Vincentown PO, New Jersey 08088
5. Location of the headquarters or general business offices of the publishers: 1900 Benjamin Franklin Parkway, Philadelphia, PA 19103-1195
6. Name and address of publisher, editor and managing editor:
   Publisher: American Entomological Society, 1900 Benjamin Franklin Parkway, Philadelphia. PA. 19103-1195. Editor; Howard P. Boyd, 232 Oak Shade Rd Tabernacle Twp, Vincentown PO, New Jersey, 08088
7. Owner: American Entomological Society, 1900 Benjamin Franklin Parkway, Philadelphia. PA 19103-1195
8. Known bondholders. mortgagees and other security holders owning or holding one percent or more of total amount of bonds, mortgages and other securities: None
9. For optional completion by publishers mailing at the regular rates: signed
10. For completion by nonprofit organizations authorized to mail at special rates: The purpose, function and nonprofit status of this organization and the exempt status for Federal income tax purposes:
    Have not changed during preceding 12 months (checked)

11. EXTENT AND NATURE OF CIRCULATION	Average No. Copies Each Issue During Preceding 12 Months	Actual Number of Copies of Single Issue Published Nearest to Filing Date
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1. SALES THROUGH DEALERS AND CARRIERS. STREET VENDORS AND COUNTER SALES	0	0
2. MAIL SUBSCRIPTIONS	608	632
C. TOTAL PAID CIRCULATION	608	632
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E. TOTAL DISTRIBUTION	608	632
F. OFFICE USE. LEFTOVER. UNACCOUNTED, SPOILED AFTER PRINTING.	192	168
G. TOTAL	800	800

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MAILING DATES
VOLUME 112, 2001

No.	Date of issue	Pages	Mailing Date
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2	Mar.& Apr.	73-144	May 31, 2001
3	May & June	145-220	August 13, 2001
4	Sept. & Oct.	221-284	October 31. 2001
5	Nov. & Dec.	285-344	December 28, 2001

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