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(Continued on inside of back cover)

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LARVAL AND PUPAL DESCRIPTIONS OF *MARILIA FUSCA* (TRICHOPTERA: ODONTOCERIDAE)[1]

H. Gene Drecktrah[2]

ABSTRACT: The larva and pupa of *Marilia fusca* from Australia are described and illustrated.

The genus *Marilia* is composed of two species in Australia: *M. fusca* Kimmins and *M. bola* Mosely (Neboiss 1983, 1986). Additional species of *Marilia* have been recorded from Oriental regions, China and South and North America (Wiggins 1977). Both Australian species were reported to have the same distribution: New South Wales and the southeast coastal ranges of Australia (Neboiss 1983). *M. fusca* was described by Kimmins (Mosely and Kimmins 1953) from adults taken at Epping, NSW, but no descriptions of the immature stages were included. This is the first recorded association of the immature stages of *M. fusca* with that of the adult. Identification and association of the immature stages, based on two pharate males, were made by Dr. A. Neboiss, Curator of the Entomology Department, Museum of Victoria, Melbourne, Australia.

Ulmer (1955) described and illustrated the larvae and pupae of *M. sumatrana* Ulmer from Sumatra and Java (Sunda Islands). Wiggins (1977) provided generic characteristics and the description of *M. flexuosa* from North America. The other North American *Marilia*, *M. nobsca* Milne, has been associated with the adult (Wiggins 1977) but apparently no descriptions nor illustrations were published. The pupae of *M. major* Muller and *M. minor* Muller from South America were described by Thienemann (1905). Unfortunately, the larva of the other Australian species, *M. bola*, is not known. The larvae of *M. fusca*, *M. flexuosa* and *M. sumatrana* share several characteristics: metanotal setal area 1 (=*sa*1) sclerites large and rectangular; metanotal *sa*3 sclerites small and rectangular; fore tibia approximately same length as tarsus; labrum with 6 long setae across central part; anal claw lacking dorsal accessory hook; and lateral sclerite of anal proleg edged mesially with stout spines.

There are, however, several characteristics that can be used to differentiate these three species. In *M. fusca* and *M. flexuosa*, the mesonotal plate is subdivided into 3 sclerites, whereas in *M. sumatrana* the mesonotal plate is not subdivided. The ventral apotome of *M. flexuosa* and *M. sumatrana* completely separates the genae, but in *M. fusca*, the ventral

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apotome separates the genae to approximately the midpoint of the ecdysial line. The anterolateral corner of the pronotum of *M. flexousa* and *M. sumatrana* is rounded; in *M. fusca* it is slightly pointed but not produced into a sharp point as in two other genera (*Parthina* and *Psilotreta*) of North American odontocerids (Wiggins 1977). In *M. fusca* and *M. flexuosa*, the lateral sclerite of the anal proleg possesses 3 very long setae on the mesial margin, whereas *M. sumatrana* possesses a dense cluster of setae at the apex of the hind tarsus; this cluster of setae is lacking in *M. flexuosa* and *M. fusca*.

The pupae of *M. fusca*, *M. sumatrana*, *M. major* and *M. minor* can be separated on the basis of the teeth (serrations) of the anal processes. In *M. sumatrana*, several prominent teeth are located on the hooked apex of the anal process. In *M. fusca*, a few low teeth are found just proximad of the apical hook with one small tooth on the inner margin of the hook. The anal process of *M. major* has several prominent teeth ending considerably proximad of the apical hook. In *M. minor* prominent teeth extend to the base of the apical hook. The pupal mandibles of these four species are basically similar, i.e. thick basally with a flattened bladelike distal portion which is strongly attenuated. In *M. fusca* the attenuated portion is approximately equal in length to the distal bladelike portion; in *M. major* and *M. minor*, the attenuated portion is less than half the length of the bladelike portion. The tip of the attenuated portion of the mandible of *M. sumatrana* is subdivided into several small points (or teeth), whereas, in *M. fusca*, the tip of the mandible is simply pointed.

MATERIALS AND METHODS

The specimens of *M. fusca* used to describe the immature stages were collected in the Yarra River near Reefton, Victoria, Australia. Illustrations were prepared from specimens preserved in 80% ethanol using a squared ocular grid in a stereo binocular microscope. For greater detail, larval and pupal structures were dissected, mounted in Hoyers mounting medium on a microscope slide, and examined using a compound microscope at 100X-400X magnifications. Measurements were made with a calibrated ocular micrometer or the squared ocular grid.

LARVA

Overall length of final instar 10-12.5 mm.; body creamy-white (Figure 1).

Head (Figures 2-4): Head capsule (measured from anterior margin of frontoclypeus to posterior margin of capsule) slightly longer (1.165 mm) than wide (1.0 mm), sides subparallel. Color pattern distinct: very dark brown bands extending from anterior margin on either side and mostly parallel to frontoclypeal and coronal sutures; mesal portions of frontoclypeus lighter brown; lateral areas light yellow-brown or tan; ventral and lateroventral areas very dark brown with a few paler muscle scars on posteroventral areas. Eyes surrounded by pale areas. Very weak lateral carina extending posteriad from near base of mandibles just dorsad of eye and slightly beyond. Antennae small, just posteriad of dorsal articulations of mandibles. Ventral apotome elongated, triangular, separating genae for approximtely one-half their length. Mandibles (Figure 5) stout, pointed, with a few low subapical teeth on dorsal cutting edge; setae and mesal brush lacking. Labrum (Figure 6) slightly rounded anteriorly and narrowed posteriorly; 4 pairs of setae arising from dorsal surface; 2 pairs of curved, pale setae arising from anterior margin.

Thorax (Figures 7-8): Pronotal plates heavily scerotized; dark brown band on either side of mesal suture forming a distinct mid-dorsal stripe; each plate light brown with dark brown margins; anterior margin of each plate with 2 long, dark setae and a few short, pale setae; anterolateral margins slightly pointed, each with a long, dark seta; ventrolateral margins each with 5-7 setae; a group of 7-9 setae just dorsad of mid-ventrolateral margin arising from area slightly darker brown than ground-color; an oblique row of 4 long, dark setae dorsad to this row; posterolateral margin very dark brown and somewhat sinuate.

Each mesonotal plate subdivided into 3 sclerites (anterior, posterior and lateral) separated by distinct sutures. Anterior plates subquadrate, light brown with dark brown mesal bands; each plate with several short, pale setae along anterior margin and 4 long, dark setae just posteriad. Posterior plates rectangular, light brown with dark brown mesal bands; anterolateral corners dark brown and discontinuous with dark brown posterolateral corners of anterior plates; posterior margins very dark brown, somewhat serrated; each plate with 5 long, dark setae just posteriad of anterior margin. Lateral plates elongated, dark brown, each with a few long, dark setae and several shorter, pale setae on anterior half.

Metanotum with 2 pairs of heavily sclerotized plates. Larger, mesal plates subrectangular, each with pale brown margin and lighter central area; each with 10-15 short, pale setae along anterior margin, 4 long, dark setae just posteriad of anterior margin, and 6 long, dark setae along posterior margin. Smaller, lateral plates elongate, narrow, each with approximately 14 short setae.

Prosternite well-developed, brown and irregularly shaped: middle of anterior margin broadly truncated and produced anteriorly; anterolateral margins pointed; lateral margins oblique; and posterior margin slightly concave. Mesosternum with 2 pairs of light-brown, rectangular plates; anterior pair about 1.5X wider than long; posterior pair narrow, about 4X wider than long. Metasternum lacking sclerotized plates but with 2 pairs of lateral and 1 mesal lightly pigmented areas.

Legs (Figures 9-11): Anterior legs short, slightly robust, protrochantin poorly developed, bluntly rounded at apex from which arises a short seta. Middle legs slightly longer. Posterior legs longer, more slender. All legs with numerous setae. Claws slender, curved, each with a basal seta.

Abdomen (Figures 1,12): Creamy-white with distinct purple speckling on dorsum and sometimes fainter purple speckling along midventral line. Dorsal spacing hump of segment I moderately developed with a pair of setae (1 long, 1 short) on each side. Lateral spacing hump of I with well-developed, light-brown, irregular-shaped sclerite with about 10 vertical rows of filelike ridges; single setae dorsad and ventrad of sclerite. Segments II-VII with several pairs of very short, pale setae visible only at high magnification. Segments II-VII with mid-lateral, dense row of very fine, inconspicuous, pale hairs. Segment VIII with a row of 23-30 bifid lateral tubercles (also termed bifid spicules by Neboiss 1977) (Figure 12). Segment IX with a pair of short, lateroventral setae; dorsal sclerite weakly-developed with 2 long, dark and 3 short, pale pairs of setae along posterior margin. Lateral sclerite of anal proleg well-developed, slightly pigmented; 3 long, dark setae arising from posterior margin; a single shorter, dark seta dorsad of anal claw and a single, short pale seta dorsad of the 3 setae. Posterior margin of lateral sclerite distinctly serrated with approximately 10 very dark teeth. Ventral sole plate with two setae. Anal claw lacking dorsal accessory hook but

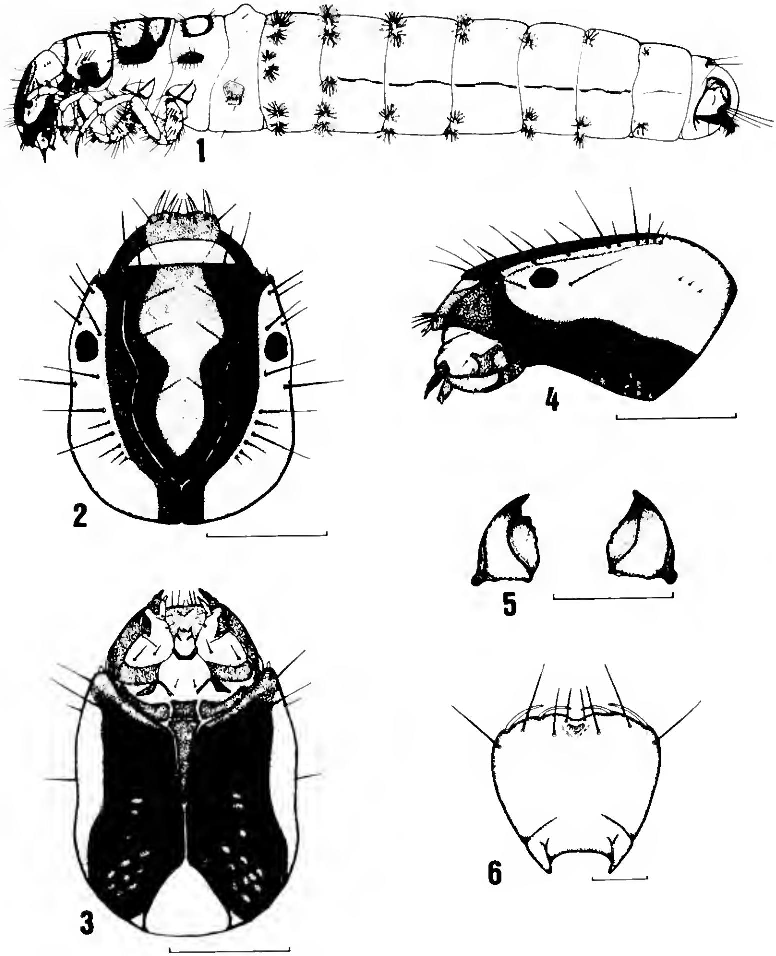
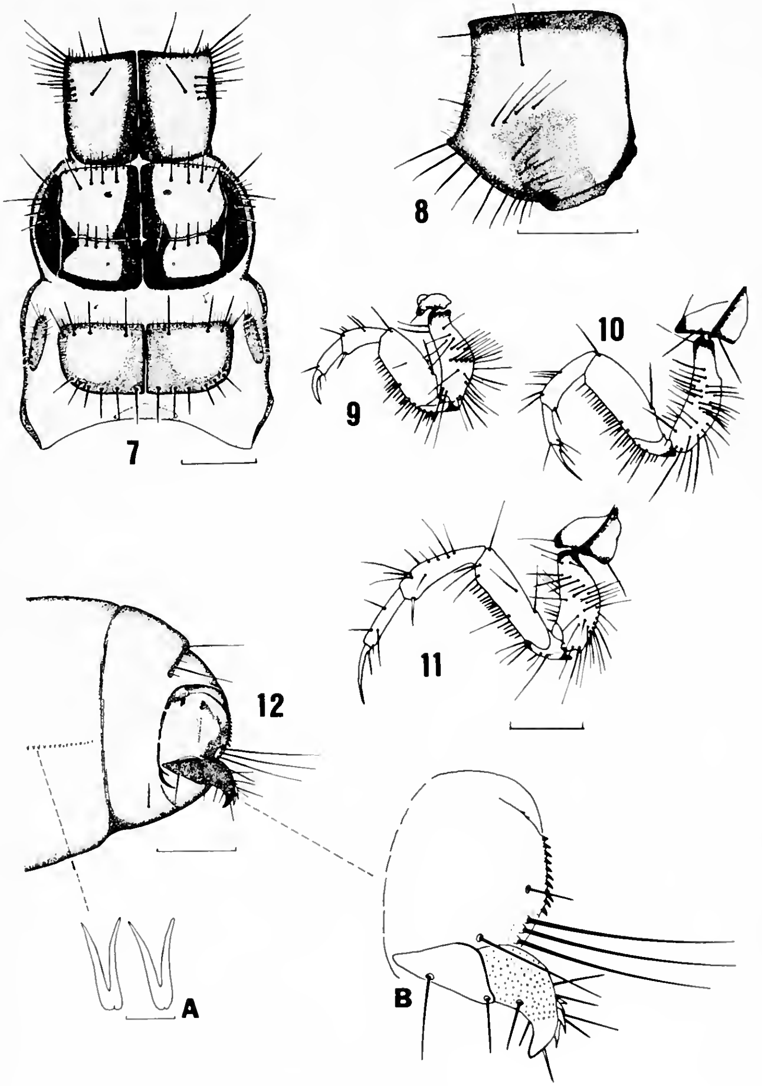


Figure 1. *Marilia fusca* larva, lateral. Figures 2-6: *M. fusca* larva. 2. head, dorsal; 3. head, ventral; 4. head, lateral; 5. mandibles, ventral; 6. labrum, dorsal. Scale lines: 0.5 mm (Figs. 2-5), 0.1 mm (Fig. 6).



Figures 7-12: *M. fusca* larva. 7. thorax, dorsal; 8. pronotum, lateral; 9-11. anterior, middle and posterior legs; 12. terminal abdomen, lateral, A - enlarged lateral tubercles of segment VIII; B - terminal segment enlarged. Scale lines: 0.5 mm (Figs. 7-12); 0.025 mm (Fig. 12A, lateral tubercles).

with 5-6 stout spines and 6 setae arising from mesal surface; basal two-thirds of claw with sparse, very tiny spines.

Gills: Paired abdominal gills on segments II-VIII (Figure 1); single or double gills (each gill arising independently) each with a few to several digitiform filaments, located at the anterodorsal (AD), anterolateral (AL) or anteroventral (AV) positions depending on the segment. Gill arrangement: segment II with double AD, AL and AV gills; segment III with double AD and AV and single AL gills; segments IV and V with double AD and AV gills; segments VI and VII with single AD and double AV gills (VII AD gill infrequently absent); segment VIII with single AD (sometimes absent) and AV gills. The number of digitiform filaments per gill is reduced on posterior segments.

Case (Figure 13): Maximum length 12 mm; anterior and posterior openings circular, diameters approximately 2 and 1 mm, respectively. Constructed of small sand grains; contour smooth, slightly curved and tapered posteriad. Posterior opening partially occluded by vertical, silkened projection from ventral margin. Line of transverse discontinuity (Figure 13, arrow) distinct in some cases, more frequently in cases of early instars.

PUPA

Head (Figure 14); Antennae very long, extending posteriad along body; distal portions coiled around abdominal apex 5 times. Vertex with paired setae. Frontoclypeus with 2 pairs of setae. Paired setae mesad of each eye. Labrum subquadrate, anterolateral angles somewhat rounded; 3 pairs of setae at each posterolateral angle, 1 setae along each lateral margin, and 4 pairs of setae at each anterolateral angle. Mandibles (Figure 15) broad, thick basally, each with a pair of setae; distally flattened and bladelike with strongly attenuated, hooked apex; proximal portion of blade with numerous minute serrations on outer margin.

Legs: Mesotibia and mesotarsi with fringe of long hairs. Fringe lacking on pro- and metathoracic legs.

Abdomen (Figure 16): Creamy-white with faint purple speckling along mid-dorsum of segments II-V (Figure 16, arrow, segment II). Dorsum of segment I with 4 pairs of setae and a narrow band of short, stout denticles along posterior margin. Dorsum of segments II-VI with 2 pairs of short setae; dorsum of segments VII-VIII each with a pair of short setae anteriorly and 3 pairs of long, dark setae near posterior margin. Segments II-VII each with a pair of dorsolateral, longitudinal, pigmented bars each with anteromesal projection; those of segment VIII connected by anteromesal projections. Ventrolateral longitudinal, pigmented bars similar but lacking anteromesal projections. Venter of segment VIII with 2 dense patches of hairs along posterolateral margins. Lateral abdominal fringe lacking. Anterior hookplates (Figure 16,A) on segments III-VII small, oval, each with single, caudally-directed hook; posterior hookplates (Figure 16,B) on segment V subrectangular, each with 2 anteriorly-directed hooks. Anal processes (Figure 16,C) long, narrow, slightly tapered and divergent distally; apices recurved and hooked; a few low serrations just proximad of apex; conspicuous setae lacking but with sparse, short setae along length of process.

Gills: Abdominal gills on segments II-VII similar to larval gills. Gill arrangements: segment II with double AD, AL, and AV gills; segment III with double AD and AV and single AL gills; segment IV with double AD and AV gills; segment V with double (sometimes single) AD and AV gills; segment VI with double AV gills; segment VII with double (sometimes single) AV gills. The number of digitiform filaments per gill is highest on anterior segments (e.g. 30 filaments on AD gill of segment II) and decreases on posterior segments (e.g. 10 on AV gill of segment VII).

Case: Similar to larval case but slightly less tapered and curved. Anterior margin

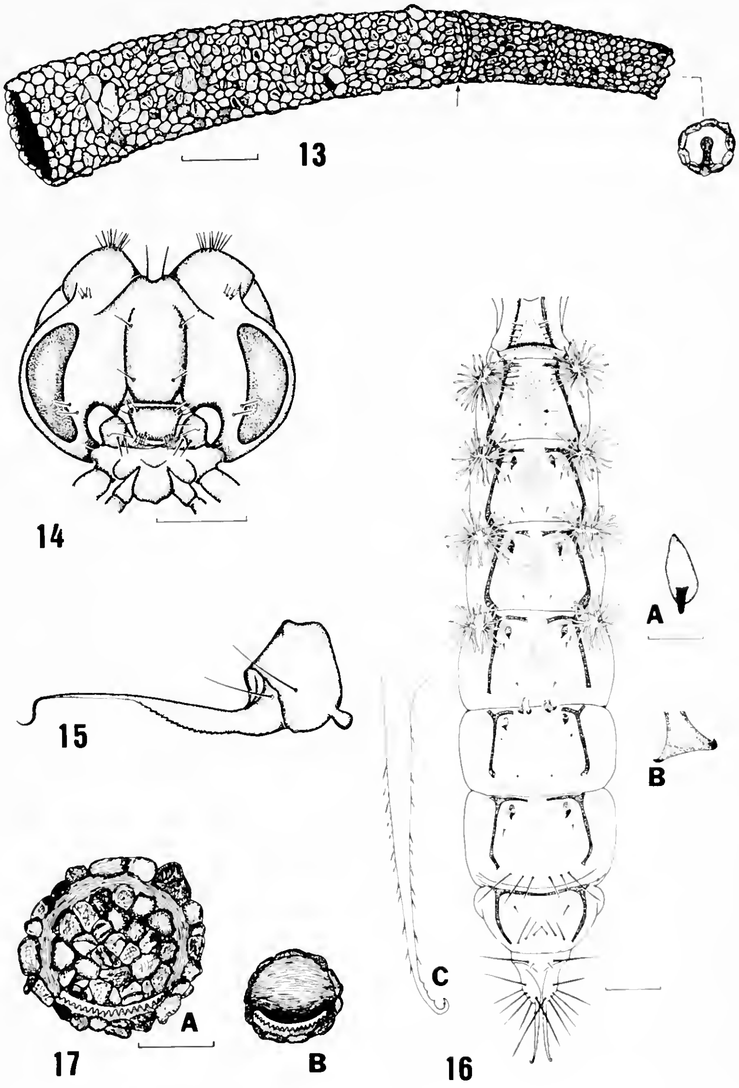


Figure 13: Larval case, lateral, with posterior opening; Figures 14-17; *M. fusca* pupa. 14. head, anterior; 15. left mandible; 16. abdomen, dorsal, A - anterior hookplate, B - posterior hookplate, C - anal process; 17. case, A - anterior opening, B - posterior opening. Scale lines: 1.4 mm (Fig. 13); 0.5 mm (Figs. 14, 16); 0.1 mm (Figs 14 A,B - hookplates); 1.0 mm (Figs. 17 A, B).

(Figure 17,A) slightly flared, with opening partially closed by slightly convex, silkened partition attached just inside opening; sand grains embedded in partition; partition not attached to case ventrally leaving a narrow, crescent-shaped opening; anteroventral margin of case with numerous teethlike projections. Posterior opening (Figure 17,B) partially closed by a silkened partition, the ventral margin of which is deflected inward and not attached to case leaving a narrow, crescent-shaped opening; posteroventral margin of case also with numerous, teethlike projections. Attachment of case by anterior and posterior silkened filaments. Pupae frequently encountered in cracks and crevices of submerged limbs or other objects.

SPECIMENS EXAMINED

Victoria: 8 larvae and 8 pupae, 8 Nov. 1980; 28 larvae, 13 Nov. 1980; 21 larvae and 29 pupae, 27 Nov. 1980. All specimens collected in Yarra River near Reefton, Victoria, Australia by G. Drecktrah. Voucher specimens deposited in Department of Entomology, Museum of Victoria, Melbourne, Australia and Department of Biology/Microbiology, University of Wisconsin, Oshkosh, WI.

ACKNOWLEDGMENTS

I wish to thank Arturs Neboiss, Curator, Department of Entomology, Museum of Victoria, Melbourne, for his assistance and guidance in this study and for identifying the specimens. Appreciation is extended to the Board of the Museum of Victoria for providing me the opportunity to work in the Department of Entomology. I also wish to thank John Morse, Clemsen University, and Glenn Wiggins, Royal Ontario Museum, for providing suggestions in preparing this manuscript.

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A NEW *XYELA* (HYMENOPTERA: XYELIDAE) FROM WESTERN UNITED STATES[1]

David R. Smith[2]

ABSTRACT: *Xyela lata*, n. sp., is described from Colorado, Nevada, and Oregon. Adults were collected from *Pinus flexilis* and *Pinus monophylla*.

Larvae of *Xyela* feed on the developing pollen of the male strobili of pines. Species of the genus probably occur wherever pines are found. Adults are small and short-lived and may be found on the larval host plant or on nearby pollen sources such as the catkins of willow, alder, or birch. Because of their small size and habits, there are undoubtedly a number of species yet to be discovered. One unusual new species has recently come to my attention and is described here.

Burdick's (1961) revision of *Xyela* included 15 species in the North American fauna and notes on the biology of some. Since then, two species have been added (Smith, 1979). Smith (1978) listed 32 world species.

Xyela lata Smith, new species

Figs. 1-4

Female. — Body length, 2.6-3.3 mm; sheath length, 2.1-2.3 mm; forewing length 4.0-4.3 mm. Antenna yellowish with 1st segment, inner surface of 3rd segment, and apical filament usually more brownish. Background color of head yellow with interocellar area, postocellar area, spot between postocellar area and eye, lines from anterior ocellus to each antennal socket, line extending from anterior ocellus to interantennal area, clypeal suture, and apical margin of clypeus black to dark brownish. Background color of thorax yellow with blackish to dark brown on mesosternum, cervical sclerities, and most of dorsum; usually yellowish spots on mesonotal lateral lobes and anterior portion of mesoscutellum. Abdomen blackish with narrow apical margins of segments yellow; ventrally and laterally dark brownish to partly or mostly yellowish. Legs with coxae, trochanters and most of femora dark brownish; extreme apices of femora, tibiae and tarsi yellowish. Wings hyaline; veins and stigma amber. Third segment of maxillary palpus longer than 1st antennal segment (as 1.3:0.7) and as broad or slightly broader than 3rd antennal segment. Sheath broad, laterally flattened, with lateral, longitudinal ridge; in lateral view narrow at extreme base but immediately broadening, ventral margin straight, apex with dorsal margin curving downward to rounded apex near ventral margin (Figs. 1, 2). Lance and lancet without teeth; apex of lancet with apico-ventral notch, extreme apex narrowed and pointed at apex, with about 7 distinct annuli (Figs. 3, 4).

Male. — Unknown.

Holotype. — Female, Nederland, Boulder Col., Colorado, labeled "Nederland, Colo., Science Lodge, 9500', 27-VI-61, W.R.M. Mason, *Pinus flexilis*." In the Canadian National

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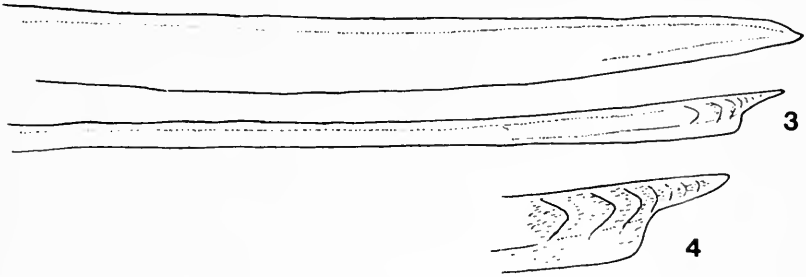
[2] Systematic Entomology Laboratory, PSI, Agricultural Research Service, U.S. Department of Agriculture, c/o National Museum of Natural History, Washington, D.C. 20560.

Figs. 1, 2. *Xyela lata*. 1, Lateral view. 2, Apex of abdomen and sheath.



Figs. 3, 4. *Xyela lata*. 3, Lance and lancet. 4, Apex of lancet.

Collection, Ottawa.

Paratypes. — COLORADO: Same data as holotype (1 ♀); same data as holotype except date, 29-VI-61 (one without host data) (2 ♀); Nederland, 8500', 18-VI-61, W.R.M. Mason (1 ♀); Estes Park, 7500', 19-VI-61, B.H. Poole (1 ♀). NEVADA: Mt. Springs summit, Clark Co., V-26-1961, elev. 5400', *Pinus monophylla*, R.C. Bechtel (1 ♀). OREGON: Mt. Washington [Linn Co.], July 13, 1963 (1 ♀). In the Canadian National Collection and National Museum of Natural History, Washington, D.C.

Hosts. — Adults were collected from *Pinus flexilis* James and *P. monophylla* Torr. & Frém. Hosts may include several species of pine, as is the case for some other *Xyela* species.

DISCUSSION

In Burdick's (1961) key, this species runs to *bakeri* Konow, but *bakeri* is commonly mostly black, the lancet has no apical notch or distinct annuli, and the sawsheath is less than 2 mm long. The extremely broad, straight, laterally flattened sheath and the constricted apex of the lancet are unique to *X. lata* and are not known in any other *Xyela*. These unusual characteristics will immediately distinguish this new species.

Some variation occurs in the amount of yellow, especially on the dorsum of the thorax and venter of the abdomen. The mesonotum may be almost all black to dark brown, or the yellow spots on the lateral lobes and scutellum may be extensive; the abdomen may be mostly black ventrally and laterally, or mostly yellowish.

Collections are from high elevations, as indicated by label data about 5400' or above.

The specific name is from the Latin "*latus*", referring to the unusually broad sawsheath.

ACKNOWLEDGMENTS

My appreciation is extended to Henri Goulet, Biosystematics Research Centre, Agriculture Canada, Ottawa, for allowing study of the specimens and for reviewing the manuscript, and to the following for reviewing the manuscript: H. R. Wong, Canadian Forestry Service, Edmonton, Alberta; R. E. White and E. E. Grissell, Systematic Entomology Laboratory, U.S. Department of Agriculture, Washington, D.C.

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SOCIETY MEETING OF NOVEMBER 29, 1989
NORTH AMERICAN BIRD BLOW FLIES AND MAGGOTS (*PROTOCALLIPHORA*)

Dr. Curtis W. Sabrosky, Speaker

About a quarter of all species of North American perching birds have been found infested with maggots of blow flies. These blood sucking parasites feed on nestling birds, engorging themselves two or three times before pupating in the bottom of the nest or falling to the ground to pupate. Although the iridescent blue-black or coppery-colored adults are rarely seen except when reared, they have a very long life span and probably overwinter in this stage even in the north of Canada and Greenland. Dr. Curtis W. Sabrosky, retired from the USDA Systematic Entomology Laboratory and former president of the Entomological Society of America, described these little known flies at the society meeting at the Academy of Natural Sciences of Philadelphia. He has recently coauthored a book on the taxonomy, biology and ecology of the *Protocalliphora*.

Twenty-six species of bird blow flies are recognized in North America; however, subtile key characters make their identification difficult. While the different species are somewhat stratified vertically in a woodland habitat and have distinctive geographical distributions, there is little host specialization. For example, one species, *P. braueri* (Hendel), has been found in the nests of 42 bird species and nine *Protocalliphora* have been found in robin nests. Once 1200 maggots were found in a single hawk nest. Only ground nesting, shore birds and birds of the lower Mississippi Valley and Gulf Coast seem to be spared from these parasites.

Dr. Sabrosky's lecture was attended by 19 members and 6 guests who came early and stayed late to talk about insects. Perhaps it was the mulled cider or refreshments that put everyone in a good mood. Among a number of topics discussed in the open forum before the featured talk was the preservation of habitats by Jane Ruffin. Cape May, New Jersey has long been recognized as a place where migrating birds and insects pause to feed before continuing their annual southward migration. The rapid development in Cape May County is reducing the cover and resources normally used by migrants such as the monarch butterfly. Mrs. Ruffin urged members to write letters supporting efforts to preserve existing old growth and to create new backyard habitats that will sustain migrant birds and insects in a residential setting.

(Continued on page 19)

A NEW *RHADINOCERAEA* (HYMENOPTERA: TENTHREDINIDAE) FEEDING ON *ZIGADENUS* (LILIACEAE) FROM SOUTHEASTERN UNITED STATES[1]

David R. Smith[2], Will McDearman[3]

ABSTRACT: *Rhadinoceraea (Veratra) zigadenusae*, n. sp., is described from the southeastern United States. Young larvae feed on the developing stamens and pistils and older larvae consume open flowers of *Zigadenus densus* and *Z. leimanthoides*. The species is described and illustrated and notes on its life history are given. Plants of the tribe Veratrae (Liliaceae) possess alkaloids toxic to many animals, and species of *Rhadinoceraea* (*Veratra*) are among the few herbivores of this tribe.

Sawfly larvae feeding on flowers of *Zigadenus densus* (Descr.) Fernald and *Z. leimanthoides* A. Gray were discovered by the junior author during studies on the relationship between plant fecundity and herbivores. Examination of the adults associated with these larvae revealed a new species of sawfly of the genus *Rhadinoceraea*. This new species resembles the only other eastern North American species of the genus, *Rhadinoceraea nubilipennis* (Norton).

Eight North American species of *Rhadinoceraea* were treated by Smith (1969), four in the typical subgenus and four in the subgenus *Veratra*. All occur west of the Rockies except for *R. nubilipennis*. Known hosts are *Calochortus* sp. for *R.* (*R.*) *nigra* (Rohwer) and *Veratrum* spp. for *R.* (*V.*) *aldrichi* (MacGillivray), *R.* (*V.*) *insularis* (Kincaid), and *R.* (*V.*) *nubilipennis*. *Zigadenus* represents a new host plant for sawflies. All hosts are in the family Liliaceae.

Rhadinoceraea (Veratra) zigadenusae Smith, new species

Figs. 2, 4, 6, 8, 10

Female. — Length, 7.0-8.0 mm. Black, only outer surfaces of forefemur and foretibia brownish. Wings uniformly, darkly, black infuscated; veins and stigma black. Third antennal segment slightly longer than 4th. Tarsal claw simple. Sheath as in Figs. 2, 4; 3rd valvula (sheath) only slightly longer than 2nd valvifer (basal plate). Lancet as in Figs. 2, 6, with about 10 serrulae, each serrula with 2 or 3 anterior and 5 or 6 posterior subbasal teeth.

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Male. — Length, 5.5-6.5 mm. Coloration as for female. Third antennal segment subequal in length to 4th. Genitalia as in Fig. 8.

Larva. — Very similar to that described for *R. nubilipennis* by Smith (1969), differing only by the shape of the body tubercles. The body tubercles are lower and more rounded (Fig. 10) than the higher and more conical tubercles of *R. nubilipennis* (Fig. 9).

Holotype. — ♀, "Mississippi, Jackson Co., ca. 11 mi. N. Pascagoula, on Big Point Road, 2 mi. E Hwy 63, 21 April 1987, Will McDearman"; mesic pine savanna, adult collected on *Zigadenus densus*. Deposited in the National Museum of Natural History, Washington, D.C. by permission of W. McDearman.

Paratypes. — MISSISSIPPI: Same data as for holotype (6 ♀, 6 ♂); Pearl River Co., Crosby Arboretum, Dead Tiger Creek Savanna, ca. 2.5 mi. E Picayune, 2 mi. S Hwy 43, 28 April 1987, Will McDearman, mesic pine savanna and pitcher plant bog, adults collected on *Zigadenus densus* (1 ♀, 5 ♂); Hancock Co., Crosby Arboretum, Hillside Bog, ca. 3.5 mi. E Picayune, 0.5 mi S Hwy 43, 28 April 1987, Will McDearman, hillside pitcher plant bog, adults collected on *Zigadenus densus* (1 ♀, 1 ♂). Deposited in the following collections; Mississippi Museum of Natural Science, Jackson; Mississippi Entomological Museum, Mississippi State University, Mississippi State; National Museum of Natural History, Washington, D.C.; and Canadian National Collection, Ottawa.

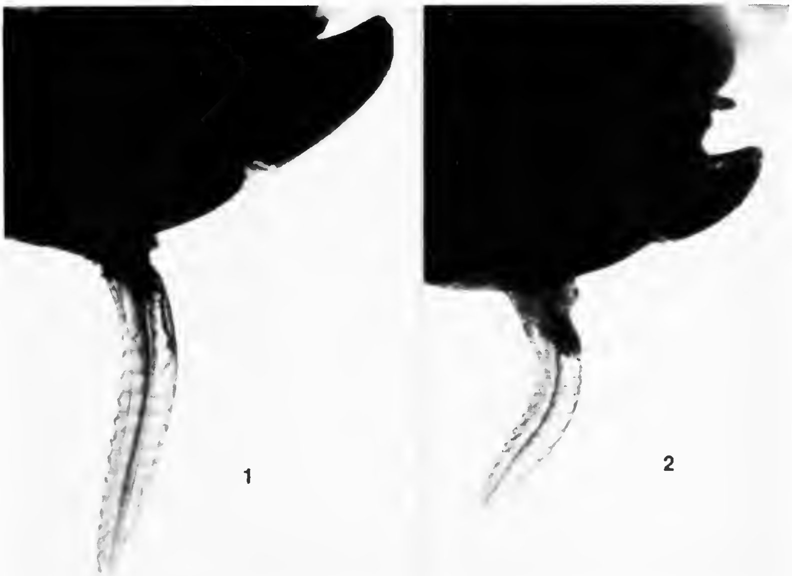
Distribution. — In addition to the above Mississippi localities based on adults, larvae have been collected from the following localities by WMcD: ALABAMA: Mobile Co., ca. 1 mi. E Hwy 193 and 1 mi N Hwy 193-163 junction on Old Rangeline Rd., 14 May 1987, on *Z. densus* in recently burned mesic longleaf pine savanna. NORTH CAROLINA: Caldwell Co., Grandfather Mtn., ca. 1/2 mi. N Grandfather Mtn. Visitor Center, on trail between McRae Peak and Attic Window Peak, 5,800 ft. elev., 7 August 1986, on *Z. leimanthoides* in heath barren, host plant populations small and widely scattered, ca. 300 plants. SOUTH CAROLINA: Jasper Co., ca. 1/2 mi. W of Hwy 17 at Switzerland, 17 May 1987, on *Z. densus* in recently burned longleaf pine savanna. WEST VIRGINIA: Tucker Co., Monongahela National Forest, Dolly Sods, ca. 1 mi. W Red Creek Campground, 3500 Ft. elev. 9 August 1986, on *Zigadenus leimanthoides* in heath barren and bog, extensive host plant population of over 2,000 plants.

Remarks. — This species runs to *R. nubilipennis* in Smith's (1969) key to North American *Rhadinoceraea.* In general habitus, color, and size it is similar to that species, but close examination reveals differences in the female sheath and ovipositor and the male genitalia. The female sheath is much smaller than that of *R. nubilipennis* (Figs. 1-4, photographs and drawings to same scale from similar sized individuals). This is difficult to compare without having representatives of both species, but valvula 3 (sheath) of *R. nubilipennis* is about 1.4 times the length of valvifer 2 (basal plate). Valvula 3 of *R. zigadenusae* is only slightly longer than the length of valvifer 2. The ovipositor of *R. zigadenusae* is much shorter than that of *R. nubilipennis*, the former having about 10 serrulae, the latter about 14 (Figs. 1, 2, 5, 6, photographs and drawings to same scale from similar sized individuals). The serrulae of each species are very similar. The male is somewhat more difficult to differentiate, and the only differences noted are in the genitalia. The harpe of *R. zigadenusae* has a more distinct indentation on its inner margin, the apex of the parapenis is somewhat flatter, and the penis valve is somewhat broader apically than in *R.*

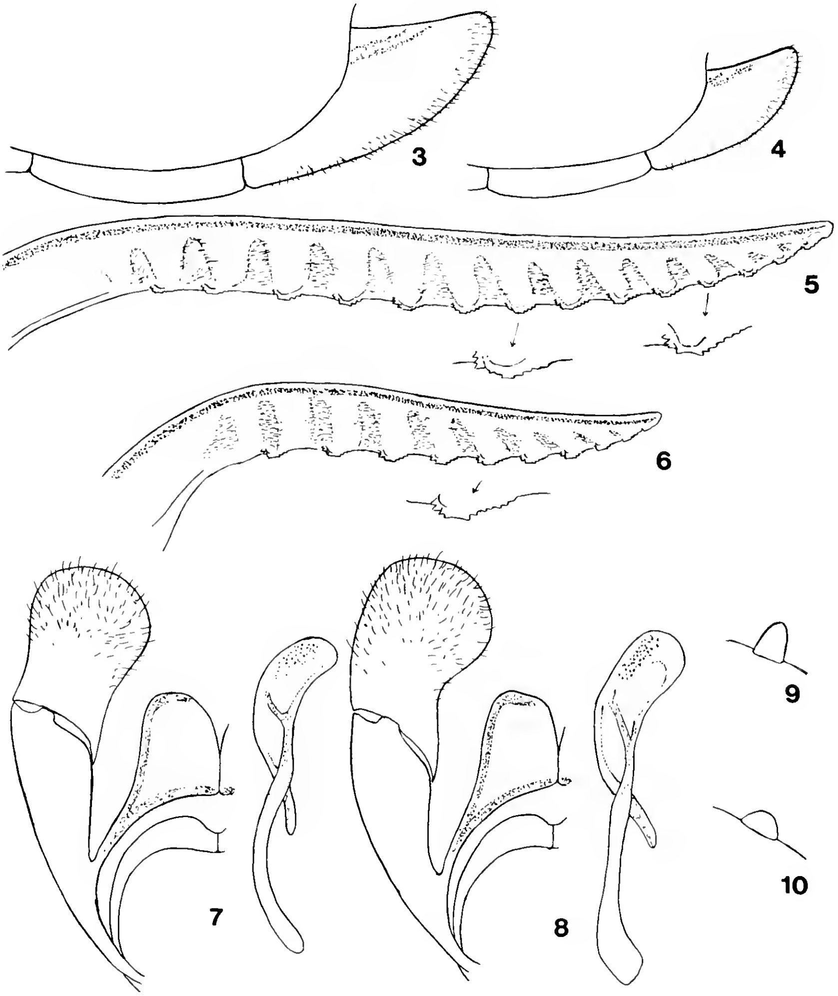
nubilipennis (compare Figs. 7, 8).
The specific name is based on the host plant genus.

Hosts and biological notes

Rhadinoceraea nubilipennis occurs only in the northeastern U.S. and southeastern Canada, south in the Appalachians to North Carolina. Its host, *Veratrum viride* Ait. is a northern plant and is found mostly at higher elevations further south. *Zigadenus densus* and *Z. leimanthoides* occur in bogs, flatwoods and mesic savanna primarily on the lower coastal plain from Louisiana east through Florida, and from southern peninsular Florida north through New Jersey. Disjunct populations are isolated in central Tennessee and the mountains of North Carolina and West Virginia. The junior author has collected larvae of *R. zigadenusae* on the coastal plain from Mississippi to South Carolina and from the disjunct host populations in North Carolina and West Virginia. Host populations in the Applachicola basin of Florida and surrounding vicinity



Figs. 1, 2. Apex of abdomen, sheath, and exerted saw of female. 1, *Rhadinoceraea nubilipennis*. 2, *R. zigadenusae*. Photographs of same magnification.



Figs. 3, 4, Female sheaths. 5, 6, Female ovipositors. 7, 8, Male genitalia. 9, 10, Body tubercles of larvae., 3, 5, 7, 9, *Rhadinoceraea nubilipennis*. 4, 6, 8, 10, *R. zigadenusae*.

were surveyed for two years without producing any evidence of sawflies. Peninsular Florida populations and those from North Carolina north to Delaware were not surveyed. Adult sawflies were collected only in Mississippi.

Nothing is known about the life history of *R. nubilipennis* except for its host. However, a related species, *R. aldrichi* (MacGillivray) in western North America, oviposits in and feeds on the foliage of *Veratrum* spp. This is very different from the habits of *R. zigadenusae* which oviposits in the inflorescence stalk and feeds on the developing stamens and pistils or open flowers of *Zigdenus*.

In southern Mississippi, *R. zigadenusae* emerged and flew in the spring, usually from late April to early May, which coincided with the period when the host plant was just beginning to flower. Females oviposited a single egg by inserting the ovipositor into subdermal and cortical plant tissues on the primary inflorescence stalk. Of 20 ovipositing females observed, all deposited one egg per plant visit and then flew to another plant. The position and number of eggs was identifiable by a nodule of swollen plant tissue. In Mississippi, 14 eggs was the maximum number observed on a single plant. Larvae hatched within 5 to 10 days and emerged by boring a small exit hole in the stalk. Young larvae typically moved up the inflorescence and entered a flower bud where they fed on the developing stamens and pistils. Older larve consumed open flowers, and secondarily fed on fruits. When all flowers were consumed, larvae ate the dermal tissue of the inflorescence stalk before dispersing. In plant populations where the period of ovipositing and hatching occurred before the inflorescence was fully developed, larvae consumed unopened flowers as well as most of the inflorescence stem. As a last resort, larvae would attempt to feed on basal leaves, but less than 1% of all observed infested plants displayed leaf damage and less than 5% of the leaf area was damaged. When mature, in mid to late May on the coastal plain, larvae burrowed shallowly into soil to pupate. Only one generation was produced each year.

Although larvae did not defoliate host plants or cause plant mortality, floral herbivory caused a direct reduction in plant fecundity. Sawfly larvae were observed in 12 of 17 host plant populations in southern Mississippi and literally all flowers were consumed in the majority of these host populations. *Zigadenus densus* and *Z. leimanthoides* often occur in the same habitat on the coastal plain with the sympatric *Z. glaberrimus* Michx. However, sawflies did not utilize *Z. glaberrimus* as a host. The flowering interval between the host species and *Z. glaberrimus* is about three months.

Rhadinoceraea zigadenusae cannot be described as a monophagous floral herbivore since two host species are known, but the taxonomic distinction between *Zigadenus densus* and *Z. leimanthoides* has recently been questioned (McDearman, 1984). The nature of character differentiation among these two species as well as whether *Z. leimanthoides* should be reduced to an infraspecific taxon or treated as a synonym is the subject of ongoing research. Nevertheless, the ecological specialization of *R. zigadenusae* is much more restricted than the current host plant nomenclature may suggest.

The alkaloids of the plant tribe Veratrae, which includes *Zigadenus*, *Veratrum*, and four other genera, are the subject of an extensive literature (e.g., Kupchan *et al.*, 1961; Tomko and Voticky, 1973). These compounds, commonly known as the "veratrum" akaloids, can physiologically act as neurotoxins (Narahashi, 1975; Jones *et al.*, 1970), as teratogens (Van Kampen *et al.*, 1969; Keeler, 1971), and as vaso-dilators (Anon, 1975; Page and Sidd, 1973). Crosby (1971) has reviewed the extremely poisonous group of ester-alkaloids, their toxicity to a wide variety of insects, and the history of their agricultural applications.

Considering the ecological implications of veratrum alkaloid research as well as the role of defensive alkaloids in other plants (Levin, 1976; Miller and Feeny, 1983; Zuniga *et al.*, 1985) it is remarkable that only a few of the 64 species of the Veratrae have been reported as hosts to herbivorous insects. Moreover, the known herbivores in North America consist of four species of *Rhadinoceraea*. The Veratrae-*Rhadinoceraea* (*Veratra*) association suggests that the distinctive alkaloid phytochemistry may be involved with sawfly speciation in *Rhadinoceraea*. Future studies are planned by the junior author to address fundamental questions regarding host plant phytochemistry.

ACKNOWLEDGMENTS

We extend our thanks to the following who reviewed the manuscript: H. Goulet, Biosystematics Research Centre, Agriculture Canada, Ottawa; H. R. Wong, Canadian Forestry Service, Edmonton, Alberta; and R. D. Gordon and E. E. Grissell, Systematic Entomology Laboratory, USDA, Washington, D.C.

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SOCIETY MEETING OF NOVEMBER 29, 1989

(Continued from page 12)

Kenneth Frank, M.D. commented on the dramatic increase in *Ixodes dammini*, the tick vector of Lyme disease. Nymphs of this species were uninvited guests at the AES Insect Field Day in the New Jersey Pine Barrens last June. A number of participants were unknowing hosts, although none developed the annular rash associated with Lyme disease. Dr. Frank cautioned that entomologists, who are frequently in the field, are more likely to contract the disease than the general public and should be aware of the prevention, recognition and treatment of the disease. He distributed copies of a recent review on Lyme disease that appeared in the August 31 issue of the *New England Journal of Medicine*.

Paula Haines described her observations on strepsipterans she had found parasitizing *Polistes* wasps. Her request for more information was answered by Dr. Paul Schaeffer who had worked with *Xenos peckii* in the past.

Mr. and Mrs. Chaiken, operators of the gift shop at the Academy of Natural Sciences, displayed a number of insect-related books and gifts with insect motifs. Also available for examination and purchase were beautifully mounted specimens of the large and showy insects of the world.

Harold B. White,
Corresponding Secretary

A NEW SPECIES OF *CURTARA* (HOMOPTERA: CICADELLIDAE) FROM BERMUDA [1,2]

Paul H. Freytag[3]

ABSTRACT: A new species of gyponine leafhopper, *Curtara bermudensis*, is described from Bermuda and compared with closely related species. This is the first gyponine known from these islands.

A new species of *Curtara* from Bermuda was sent to me for identification, and is described at this time and compared with the closely related species. I wish to thank M. R. Wilson, CAB International Institute of Entomology, London, for making this series available. This species belongs in the subgenus *Curtara*.

The Genus *Curtara* was described by DeLong and Freytag (1972), with 76 species included (1976). DeLong and others (DeLong 1977, 1979, 1980, 1983; DeLong and Foster 1982; Delong and Triplehorn 1978, 1979; and DeLong and Wolda 1978, 1982, 1984) have added an additional 67 species. This new species makes a total of 144 species known for this genus.

Curtara bermudensis n. sp.

(Figures 1-5)

Length of males 6.4-6.8 mm., females 7.8-8.6 mm. Crown broadly rounded, twice as wide between eyes at base as median length, margin foliaceous.

Color: Males brown with many dark brown spots on head and pronotum. Wings dark brown spotted with lighter brown. Females yellow brown with few spots of darker brown on head, pronotum and forewings.

Male genitalia: Pygofer bluntly pointed at apex. Plate four times as long as wide, truncate at apex. Style broad at base, narrowed to hatchet-shaped apex, ventral margin finely serrate. Aedeagus with shaft long, tubular, with pair of processes extending along shaft about half length of shaft, then curving dorsad; paraphysis broadened near middle, with dorsally hooked apex.

Female genitalia: Seventh sternum produced medially with very small median emargination.

Holotype male: Paget Parish, Paget Marsh, 14-22 VII 1988, M. R. Wilson & D. J. Hilburn, in the British Museum. Paratypes: one female, same data as holotype, in the British Museum; one male; same data as holotype, in the University of Kentucky Collection; one male, Devonshire Parish, Devonshire Marsh, 14-22 VII 1988, M. R. Wilson & D. J. Hilburn, in the Bermuda Collection; one male St. George's Parish, 4 VI 1987, D. J. Hilburn, Ferry Reach on G. Beating; one female, St. George's Parish, 16 II 1967, F. M. Collector, Non

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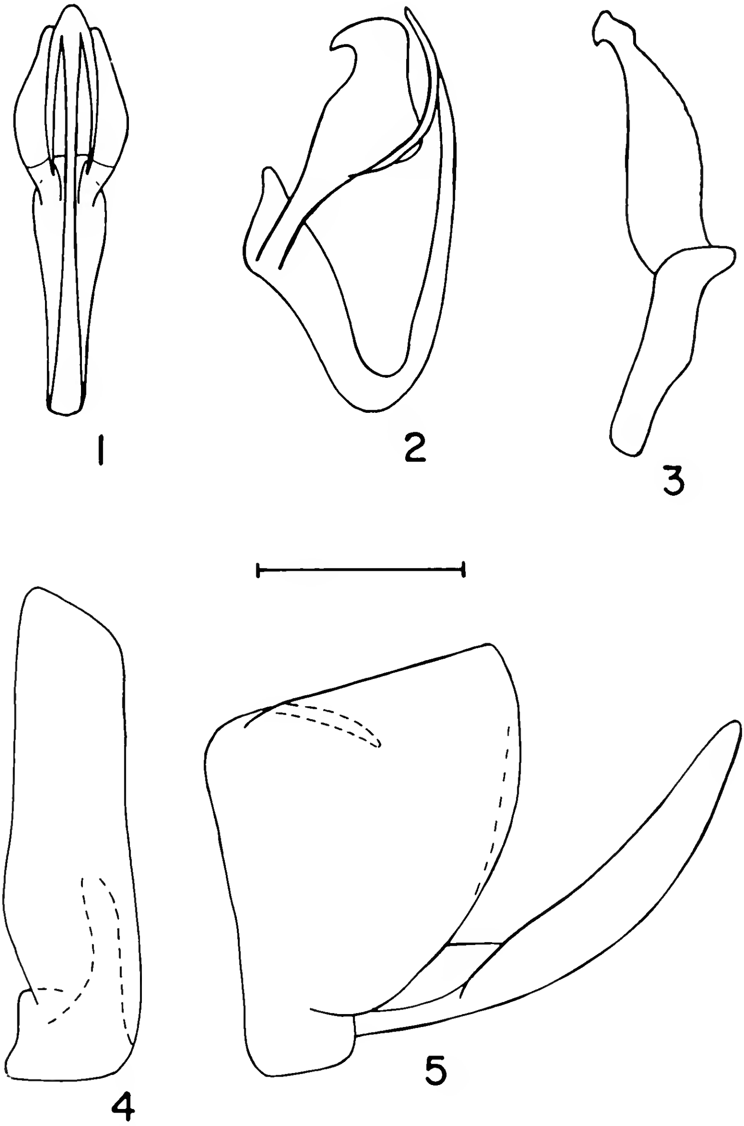

Figures 1-5, Male genital structures of *Curtara bermudensis* n. sp. 1, ventral view of aedeagus. 2, lateral view of aedeagus. 3, lateroventral view of style. 4, ventral view of plate. 5, lateral view of pygofer, plate and valve. All drawn to the same scale, which equals 0.5 mm.

Such Island, in grass, Bda. Dept. Agr. Coll. No. 323, both in the U.S. National Museum; one female, Non Such Island, 26 VIII 1966, F. M. Collector, collected on *Conocarpus erecta*, No. 323.; one female, Pembroke Parish, 22 IX 1966, F. M. Collector, Mount Hill, at light, No. 323; one male, Sandy's Parish, 19 IX 1987, D. Hilburn, General Beating; one male, Smith's Parish, 6 IX 1987, D. Hilburn, Spittal Pond, Sweeping, all in the Bermuda Collection.

Notes: This species is closely related to *samera* DeLong and Freytag but differs from it by having the males smaller, much darker in color and the aedeagus with longer processes which curve dorsally. Also, it resembles *compacta* DeLong but differs from this species by being larger and the male style being more robust near the middle.

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SPIDER (ARANEAE) TAXA ASSOCIATED WITH THE IMMATURE STAGES OF *MANTISPA INTERRUPTA* (NEUROPTERA: MANTISPIDAE)[1,2]

Kevin M. Hoffman[3], Jeffrey R. Brushwein[4]

ABSTRACT: The immature stages of *Mantispa interrupta* are associated with 10 species of spiders, not previously recorded as hosts, from the families Gnaphosidae, Lycosidae, Ctenidae, and Pisauridae. First-instar mantispids were found on adult and juvenile spiders of both genders, while later-instar mantispids were located inside spider egg sacs. Larvae on spiders were located on the edge of the carapace, on the dorsal, ventral, and lateral surfaces of the pedicel, and inside book lungs. The locations on spiders occupied by *M. interrupta* first instars are compared with those occupied by first instars of other mantispine species.

Adult Mantispinae have been reared exclusively from spider egg sacs (Redborg and MacLeod 1985, Brushwein 1986, Hoffman and Brushwein 1989). Mantispine larvae develop through three instars by feeding on spider eggs. Pupation occurs within the egg sac and pharate adults exit both their own cocoons and the spider egg sacs before adult eclosion occurs. First instars procure spider eggs either by locating and entering preexisting egg sacs or by locating and boarding female spiders and subsequently entering egg sacs as they are deposited by the spiders. Recent studies on the spiders associated with particular mantispine species suggest that these associations may be indicative of the egg procurement methods used by first instars of those mantispine species (Redborg and MacLeod 1985, Hoffman and Brushwein 1989).

Mantispa interrupta Say has been recorded throughout the eastern United States and westward into Texas and Arizona (Throne 1972), and adults have been reared from the egg sacs of three spider species. Smith (1934) reported the emergence of two pupae from two spider egg sacs, one of which was associated with a female *Eris militaris* (Hentz) [as *Philaeus militaris* (Hentz)]. Subsequently, adult emergence has been reported from egg sacs of *Gnaphosa muscorum* (L. Koch) and *Lycosa rabida* Walckenaer (Kaston 1940, Rice 1985). In addition to the above records, *M. interrupta* has been incorrectly reported as being associated with two other spider species, but both associations were actually based on species other than *M. interrupta*. Eason *et al.* (1967) associated *M. interrupta* with *Philodromus aureolus* (Clerck) and attributed the association to Auten

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(1925). However, Auten (1925) reported on the chrysopid *Chrysopa interrupta* Schneider, not *M. interrupta*. Killebrew (1982) reported that a mantispid which emerged from an egg sac of *Peucetia viridans* (Hentz) was possibly *M. interrupta*. However, this specimen was recently examined by one of us (KMH) and proved to be a pharate adult of *Mantispa sayi* Banks.

Viets (1941) supplied the only indication that *M. interrupta* larvae can board spiders in order to procure eggs. The laboratory boarding of an unidentified female lycosid by several first instars was followed by deposition of an egg sac by the spider and subsequent emergence of an adult mantispid. Both Redborg and MacLeod (1985) and Brushwein (1986) reported that *M. interrupta* has been reared using techniques developed for two other mantispine species, but no information on spider associations or boarding was supplied. The present paper reports further spider associations for *M. interrupta*, confirms larval boarding behavior in the field by documenting the presence of larvae on collected spiders, and compares the locations on spiders of *M. interrupta* larvae with those reported for other mantispine species.

METHODS

Eight of the 13 spiders associated with *M. interrupta* were collected in pitfall traps from 12 June to 1 August 1988, four were collected by visual searching, and the remaining association was based on museum specimens. The pitfall traps were located in the Clemson University Experimental Forest surrounding Lake Issaqueena, Pickens County, South Carolina. The traps were constructed of 2 or 3 liter soft drink bottles whose tops were cut off and inverted to form funnels. Holes were punched in the bottoms to aid in water drainage and a few curled leaves were supplied in each trap to provide harborage sites for trapped spiders. Forty-four traps were buried to ground level at six locations within a mixed hardwood-pine forest and checked one to three times each week. The female *Schizocosa saltatrix* (Hentz) and egg sac were collected in the vicinity of Lake Issaqueena on 14 May 1988, while the specimens of *Gladicosa gulosa* (Walckenaer) and *Varacosa avara* (Keyserling) were collected on 24 July 1988 along a tributary of Toxaway Creek at County Road 88, Oconee County, South Carolina. The female *Pisaurina brevipes* (Emerton) and egg sac were collected on 15 November 1988 near Corkscrew, Lee County, Florida. The association of *M. interrupta* with *Sosippus floridanus* Simon was based on specimens located in the entomological collections of the Museum of Comparative Zoology (MCZ), Harvard University. The spider and its egg sac had been collected by P. J.

Cone in Collier County, Florida, at the junction of 840A and 846, approximately 5 miles east of Immokalee. The pharate adult emerged on 16 April 1968, but collection date of the egg sac was unrecorded.

Identities of the immature stages of *M. interrupta* were confirmed by comparisons of first instars with those previously obtained from an adult female and by allowing later instars to complete development within the egg sacs in which they were found. Spider egg sacs were identified by determination of the particular female spider accompanying each sac. The specimen of *V. avara* was reared to maturity in order to facilitate a species-level identification. Spiders were identified both by the use of selected taxonomic references (Brady 1962, 1979, Carico 1972, Platnick and Shadab 1975, Dondale and Redner 1978, Peck 1981, Roth 1985) and with the assistance of A. R. Brady and C. D. Dondale. Voucher specimens of *M. interrupta* first instars, adults, and associated spiders are deposited in the Clemson University Arthropod Collection (CUAC), Department of Entomology.

RESULTS AND DISCUSSION

Eighteen *M. interrupta* immatures were associated with 13 spiders representing ten spider species from the Gnaphosidae, Lycosidae, Ctenidae, and Pisauridae, thereby bringing the total spider taxa associated with *M. interrupta* to 13 species in nine genera from five families (Table 1). These species are predominantly ground-wandering hunters, although both *P. brevipes* and *E. militaris* are somewhat more arboreal wanderers than the others and *S. floridanus* builds funnel webs near ground level.

First instars of *M. interrupta* were associated with adult and juvenile spiders of both genders, whereas later instars were found inside spider egg sacs (Table 1). The locations of first instars aboard spiders included the edge of the carapace, the dorsal, ventral, and lateral surfaces of the pedicel, and the book lungs. Two of the nine spiders boarded by first instars had more than one larva. Larvae on these spiders occupied either different regions of the same structure, e.g., opposite sides of a pedicel, or similar regions of separate structures, e.g., the left and right book lungs. Two first instars were dead when collected; one was found in a book lung along with a live larva and the other was alone in the book lung of a different spider. In the only previous report of *M. interrupta* first instars aboard a spider, Viets (1941) noted that larvae crawled over the body of the spider upon boarding and that the area between and around the spinnerets seemed to be preferred. However, the positions of the several larvae which remained on the spider after 15 days was not mentioned, and it is possible that some larvae resided in locations similar to those reported above. The presence of first-instar *M. interrupta* on spiders, coupled with the predominantly wandering-mode behavior of the associated spiders, supports the hypothesis of Hoffman and Brushwein (1989) that mantispine species which use spider boarding to gain access to spider eggs will be associated generally with wandering spiders.

Table 1. Spider taxa associated with the immature stages of *Mantispa interrupta*. Superfamilies and families are arranged according to the taxonomic list presented by Shear (1986). (juv. = juvenile).

SUPERFAMILY Family Species	Developmental stage & gender of spider	*M. interrupta* immatures			Reference
		Instar	Number	Location	
CLUBIONOIDEA					
Gnaphosidae					
Gnaphosa fontinalis Keyserling	female	1	1	pedicel	this report
Gnaphosa muscorum (C.L. Koch)	egg sac	pupa?	1	egg sac	Kaston 1940
LYCOSOIDEA					
Lycosidae					
Gladicosa gulosa (Walckenaer)	juv. male	1	1	book lung	this report
Lycosa acompa Chamberlin	male	1	1	book lung	this report
Lycosa georgicola Walckenaer	juv. male	1	5	pedicel & book lungs	this report
Lycosa rabida Walckenaer	egg sac	pupa	1	egg sac	Rice 1985
Lycosa sp., *helluo* group	juvenile	1	1	pedicel	this report
Schizocosa ocreata (Hentz)	egg sac	3	1	egg sac	this report
Schizocosa saltatrix (Hentz)	egg sac	3	1	egg sac	this report
Sosippus floridanus Simon	egg sac	?	1	egg sac	this report
Varacosa avara (Keyserling)	juv. female	1	1	carapace	this report
undetermined	juvenile	1	1	pedicel	this report
undetermined	juvenile	1	1	pedicel	this report
Ctenidae					
Anahita punctulata (Hentz)	male	1	2	pedicel	this report
Pisauridae					
Pisaurina brevipes (Emerton)	egg sac	pupa	1	egg sac	this report
SALTICOIDEA					
Salticidae					
Eris militaris (Hentz)	egg sac	pupa	1	egg sac	Smith 1934

Of the four other mantispine species known to board spiders, only first instars of *M. sayi* [as *Mantispa uhleri* Banks and *Mantispa fuscicornis* Banks, both recently synonymized with *M. sayi* by Hoffman (1989)] occupy a range of resting sites on spiders similar to that of *M. interrupta* first instars (Redborg and MacLeod 1985, Rice 1986). In contrast, first instars of the other three species occupy a more restricted range of sites. First instars of *Climaciella brunnea* (Say) have been found only on the sternum and the edge of the carapace (Redborg and MacLeod 1983, LaSalle 1986), while those of both *Perlamantispa perla* (Pallas) and *Mantispa pulchella* (Banks) occupy only the dorsal surface of the pedicel (Lucchese 1955, 1956, Hoffman and Brushwein 1989).

In previous reports of *M. interrupta* spider associations, the developmental stages of the mantispids at the time of egg sac collection were not known. However, some estimates can now be made by comparing the intervals between egg sac collections and emergences of adult mantispids with the durations of appropriate developmental stages of *M. interrupta* and other North American mantispines. During the present study, the two *M. interrupta* which were reared under ambient conditions from third instars to adult required 17 to 22 days from the onset of cocoon spinning to adult eclosion. Under standard laboratory conditions, *C. brunnea, M. sayi*, and *Mantispa viridis* Walker spend an average of 14 to 20 days as prepupae and pupae (Redborg and MacLeod 1983, 1985, Brushwein 1986). Both Smith (1934) and Rice (1985) reported the emergences of adult mantispids within four days of egg sac collections, and therefore these records surely represent field-collected pupae and are listed as such in Table 1. Because of the 17 day lag between egg sac collection and adult emergence, the mantispid collected by Kaston (1940) could have been either a late-instar larva or pupa. Unfortunately, the collection date of the *S. floridanus* egg sac was unrecorded, and therefore the developmental stage of the mantispid when initially collected can not be determined.

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THE RELATION BETWEEN HEARING AND FLYING IN CRICKETS[1]

Daniel Otte[2]

ABSTRACT: Hearing and flying are closely coupled functions in true crickets (Grylloidea). Although the auditory tympana have been lost many times independently in crickets, they are virtually never lost in species that can fly. Since crickets migrate at night it seems likely that tympana are retained to avoid bat predation.

The ancestor to modern crickets (Grylloidea) probably possessed tibial auditory tympana and tegminal stridulatory devices similar to those of modern species. Subsequently the stridulum (and therefore acoustical communication) has been lost many times. In Australia, for example, where 103 species (or 18.9% of the known fauna) lack a stridulum, the stridulum was lost at least 27 times. In Africa it was lost at least 17 times. It was lost a number of times on Pacific islands as well (i.e. New Caledonia, Hawaii, Fiji, and Lord Howe — Otte, Alexander and Cade 1988, Otte and Rentz 1985, Otte and Rice in prep.)

Although the stridulum has not been lost in any United States species, calling behavior has been lost in at least seven species *(Gryllus ovisopis* [Gryllinae], *Oligocanthropus prograptus* [Mogoplistinae], *Tafalisca lurida* and *Hapithus brevepennis* [Eneopterinae], *Falcicula hebardi* [Trigonidiinae], *Scapteriscus abbreviatus* [Gryllotalpinae] and northern populations of *Hapithus agitator* [Eneopterniae]) (Walker 1974). Absence of a calling song must be a precurser to the loss of the stridulum; therefore examination of these species should give one clues as to the selective forces causing muteness and deafness.

Walker (1974) notes also that *Gryllus fultoni* on Key Largo lacks a functional calling song. And in the sibling pair *Hapithus melodius* and *H. brevipennis,* the former species retains both calling and courtship songs, while the latter has never been heard to produce either song, even though it appears to have a functional stridulum.

The circumstances which cause non-acoustical methods of communication to entirely replace acoustical modes is open to speculation. Do acoustical signals lose their directionality, and therefore effectiveness, in certain situations (caves, burrows), or become ineffective in the presence of noise (sea shores), or less effective than other modes of signal transmission (pheromones, substrate vibration, visual signals) under certain circumstances (burrows, caves, or on grasses)?

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Walker (1974), noting that all U.S. mute species are flightless, speculates that muteness is associated with their higher degree of sedentariness: "Sedentary populations characteristically occupy relatively permanent habitats and are not subject to the extreme fluctuations in density of breeding adults characteristic of temporary habitats. Consequently, chance encounters or short-range signals become more dependable pair-forming techniques." He suggests two other possible causes: acoustically orienting predators could select against singing males; or the loss of song could evolve if it caused reduction in interbreeding with a closely related species possessing a nearly identical song (as may have happened to *Gryllus ovisopis* when it speciated from *G. fultoni*).

In Australia mute species are best represented among the following groups: a) burrowing crickets from rain-forests and open woodlands (most belong to the genus *Apterogryllus* [Brachytrupinae] and all probably derive from a single mute and wingless ancestor); b) crickets inhabiting lush grasses along water courses (all are small Trigonidiinae, but the stridulum may have been lost 3 or 4 times in this group); c) crickets inhabiting canopy foliage in rain forest or seasonally wet woodland (these belong to three groups: Trigonidiinae (*Amusurgus, Metiochodes, Cyrtoxiphoides*); Podoscirtinae (*Mundeicus, Aphonoides*); and Pentacentrinae; d) crickets inhabiting seasonally moist grasslands (Euscyrtinae — probably lost at least twice); e) crickets inhabiting ant nests (Myrmecophilinae — muteness probably evolved but once in this group, perhaps outside Australia); f) forest floor (leaf litter) species (Nemobiinae and Phalangopsinae — stridulum perhaps lost three times in the Nemobiinae and two or three times in the Phalangopsinae); g) shore-inhabiting species (Nemobiinae, *Apternonemobius* — since this genus is widespread over the Pacific ocean, the stridulum may have been lost outside Australia; (h) cave-inhabiting species (Nemobiinae, *Nambungia*).

A survey of the Australian crickets shows that auditory tympana are often retained *after* the tegminal stridulatory mechanism is lost, that is, they continue to hear after becoming mute (*Amusurgus, Metiochodes* [Trigonidiinae] *Pentacentrus* [Pentacentrinae] *Mundeicus, Umbulgaria, Aphonoides,* [Podoscirtinae], *Euscyrtus,* and *Patiscus* [Euscyrtinae]. Partial loss of the stridulum is seen in *Hemiphonus, Unka* (Podoscirtinae), *Trigonidomorpha* (Trigonidiinae) and *Merrinella* (Euscyrtinae). Since a loss of the sound producing mechanism is probably usually accompanied (or followed) by a loss in the listening mechanism, one must presume that some kind of selection pressure opposes the loss of a tympanum in these species.

In my survey of the Australian fauna (based on Otte and Alexander 1983) I noticed that *virtually all flying species* retain a tympanum, even those species that have lost the stridulum. The only non-hearing crickets are ones that cannot fly. We can look at the relation between singing[3], hearing[4], and flying[5] in the Australian fauna more closely. All the possible combinations of these three characters are shown in Figure 1 and next to them the number and the percentage of species possessing the condition. Two very common conditions occur in this fauna: A large number of species can sing, hear, and fly. But a much larger number of species can sing and hear, and are flightless (B). Of the remainder, 57 species (or 20% of the total) cannot fly, cannot hear and cannot sing (H); 46 species (10%) cannot sing but can both fly and hear (D). Notice that two of the possible combinations have no representative species: There are no species which can sing and fly but cannot hear (C) and there are no mute and deaf species which can fly (G). Condition C may be absent for two reasons: a) Perhaps a species which cannot hear will not retain its song mechanism. This is probably true in most cases, but rare instances do occur in which males continue to sing even though a stridulum is lost (as in condition F — Evans 1988). b) The condition is rare because flying species are selected against if they are deaf. The latter reason is probably true, given that there are no species which can fly *and* which cannot also hear (see also condition G).

Few species have conditions E and F; both conditions are probably transitional between B and H. Outside Australia I know of no species with either of these conditions. Of the four Australian species which have lost the stridulum but retain the tympanum, one species has a tiny, apparently rudimentary, organ; another species is geographically variable with western Australian specimens retaining a tympanum, and eastern Australian ones having lost it (perhaps in this species occasional individuals are macropterous).

Condition F, in which the stridulum is retained in a species that has lost its tympana, is also exceptional. Fortunately the acoustical behavior of one of these species is known. Males of *Balamaro gidya* have a peculiar mode of signalling (Evans 1988). In the presence of females they tap the grass on which they rest with the abdomen, presumably transmitting information to the females through vibration of the subtrate. Males tap in pairs, and during the first tap of each pair they stridulate. We do not know what *B. gidya*'s nearest relatives do. *B. marroo* possesses both a stridulum and well-developed tympana. *B. albovittata* from eastern Australia has no stridulum and no tympana; in western Australia this species has no stridulum but retains a small tympanum. We speculate that in the lineage leading to *B. gidya* males called females by stridulating; later, males began to vibrate the substratum (grass blades on which both were

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[3] have a tegminal stridulatory mechanism

[4] have a tibial auditory tympanum

[5] possess long hind wings

perched) during stridulation; gradually tapping began to predominate as the information carrier, and tympana were lost when the acoustical component of the signal disappeared; the stridulation now heard faintly during the first tap is perhaps a vestige of the original call. Once it disappears, as it may already have done in *B. albovittata*, the stridulum may also be lost.

One is led to conclude that hearing is important to flying crickets.

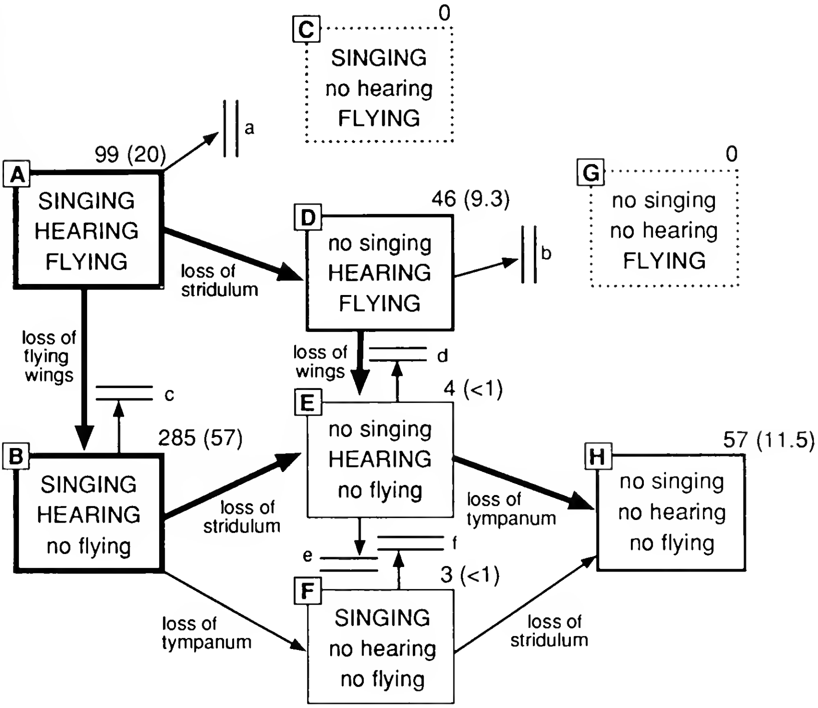

Figure 1. All possible combinations of singing, hearing, and flying in the known Australian cricket fauna. *Singing* means possession of a stridulatory mechanism; *hearing* means possession of a tibial auditory tympanum; *flying* means possession of hind wings long enough to make flight possible. Numbers in the upper right indicate the number (and percentage) of species possessing the condition. Arrows indicate the presumed direction of evolutionary change. Parallel lines indicate evolutionary transformations which have probably not occurred — *a* and *b* because absence of hearing in flying species is perhaps strongly selected against by bats or other predators; c, d, e, and f because once a particular complex mechanism is lost it is highly unlikely to evolve again. Conditions E and F are absent in African and other faunas, suggesting that the transition from B or D to H is rapid.

Africa and Pacific island crickets hold to this pattern precisely, though we have discovered a single species of *Adenopterus* (Loyalty Islands) which possesses long hind wings and lacks tympana (Otte, Alexander and Cade 1987).

The association between hearing and flying is also evident within some Australian species which show developmental flexibility in both characteristics — further confirming a functional coupling between them. *Euscyrtus hemelytrus* (Euscyrtinae) always possesses tympana, but the outer tympanum is sometimes obsolete in micropterous specimens. In general, macropterous individuals have larger tympana. We noted the following variation in this species (Otte and Alexander 1983): Micropterous individuals are quite variable, with the outer tympanum sometimes obsolete and represented only by a dimple. Macropterous males had very large and conspicous inner and outer tympana. A macropterous male and female from Upper Burma have very large inner and outer tympana, but a micropterous female has inner and outer tympana barely visible. A micropterous female from Manila, Philippines has an outer depression and a conspicuous inner tympanum. Two micropterous males and a female from Assam (Bangladesh) have an inner tympanum and the other tympanum represented by a dimple. Four other females from the same place are macropterous and have large inner and outer tympana.

Metioche vittaticollis (Trigonidiinae) are similar to *Euscyrtus*. Macropterous individuals posses large tympana, while micropterous individuals have either small inner and no outer tympana, or small outer and larger inner tympana, or no tympana at all. Of 61 individuals examined only the 45 macropterous individuals had prominent inner and outer tympana.

We also noted dimorphism in wings and tympana in *Trigonidomorpha sjostedti* (Otte and Alexander 1983). In this species wingless males and females usually have small dimples instead of tympana; occasionally a small inner tympanum is visibile. Evans (1988) has further studied wing length and tympana in this species. She crossed the two phenotypes (winged/ +tympana and wingless/ -tympana) and found that the dimorphism does not result from a simple Mendelian 1-locus, 2-allele mechanism, since all crosses produced both phenotypes in both sexes. Field collected wingless/-tympana adults produced winged/ +tympana offspring. She also found that both morphs possessed tympanal organs with well developed scolopidia, attachment cells, and accessory cells, in close proximity to the anterior tympana trachea; but the tympana of the wingless morph were hidden beneath a layer of cuticle.

Several experimental studies have shown that crickets can hear bat sounds and take evasive action in the presence of bat sounds (Griffin 1958, Popov and Mrkovich 1982, Moiseff and Hoy 1983, Nolen and Hoy 1984, Doherty and Hoy 1985).

It has also been suggested that the development of receptors sensitive to aerial sounds may have been favored by selection if they enabled individuals to stay within a dispersing group by responding to the flight sounds of conspecifics (Evans 1988, and references therein).

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THE LEPTOCERIDAE (TRICHOPTERA) OF WEST VIRGINIA[1]

James B. Glover, Donald C. Tarter[2]

ABSTRACT: Over 9,000 adult leptocerids were identified from light trap samples throughout West Virginia. A total of 27 species, including 25 new state records, are reported for West Virginia. The most common species in the state included *Ceraclea cancellata*, *C. maculata*, *Oecetis avara*, and *O. inconspicua*. Species that were abundant only in the larger rivers of the western portion of the state included *C. flava*, *C. maculata*, *Nectopsyche pavida*, and *Triaenodes ignitus*. *Ceraclea neffi* was most abundant in the smaller, cooler, fast-flowing streams at the higher elevations in the eastern part of the state. *Ceraclea ophioderus* (IL, NC, SC), *C. slossonae* (FL, GA, PA, VA), and *C. wetzeli* (MI, PA) were important range extensions into West Virginia. The collection period ranged from 30 April (*O. inconspicua* and *T. ignita*) to 17 October (*O. cinerascens*).

Prior to this study, only two species of leptocerids had been reported from West Virginia: *Oecetis avara* (Banks) (Ross, 1944) and *Mystacides sepulchralis* (Walker) (Yamamoto and Wiggins, 1964). Based on the examination of 9,136 adult leptocerids from black light and Malaise traps, 27 species, including 25 new state records, are recorded from West Virginia.

Three important range extensions are noted: *Ceraclea ophioderus* (Ross) (IL, NC, SC); *C. slossonae* (Banks) (FL, GA, PA, VA); and *C. wetzeli* (Ross) (MI, PA).

The collection period ranged from 30 April, *Oecetis inconspicua* (Walker) and *Triaenodes ignitus* (Walker), to 17 October, *O. cinerascens* (Hagen). The only species that was collected exclusively in the early part of the year (30 April- 6 June) was *T. ignitus*. One male of *C. wetzeli* was collected on 14 May. Some species had extended flight periods beginning in May and extending into September.

Detailed collecting data are found in Glover (1988). All adults are stored in the West Virginia Benthological Survey at Marshall University.

Collecting Stations

Collecting stations are listed alphabetically by county (in caps) and each station is assigned a number. The station numbers given below are shown on Figure 1. Stations number 34 and 47 are listed only as county because of incomplete information and are not shown on map. An

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annotation of the months of collection for each species is given in the species list.

BOONE: 1. Coal River; 2. Madison.
BRAXTON: 3. Burnsville Lake; 4. Falls Mill; 5. Little Kanawha River; 6. Sutton Lake.
CABELL: 7. Greenbottom Swamp; 8. Guyandotte River; 9. Ona; 10. Salt Rock.
GRANT: 11. North Fork of the South Branch of Potomac River; 12. South Branch of the Potomac River.
HAMPSHIRE: 13. Romney.
HANCOCK: 14. Newel.
HARDY: 15. Howards Lick Run; 16. Lost River; 17. Wardensville.
HARRISON: 18. Bridge Port.; 19. East View.
JACKSON: 20. Ravenswood; 21. Ripley.
JEFFERSON: 22. Harpers Ferry; 23. Kearneysville; 24. Shanandoah Junction.
KANAWHA: 25. Charleston; 26. Coal River; 27. Guthrie; 28. London Locks; 29. Marmet Locks.
MASON: 30. Flatfoot Creek; 31. Gallipolis; 32. Lakin; 33. McClintic Pond #16; 34. Ohio River; 35. Point Pleasant.
McDOWELL: 36. Iager.
MONONGALIA: 37. Triune.
MONROE: 38. Hollywood; 39. Union.
MORGAN: 40. Berkely Springs (Yamamoto and Wiggins, 1964).
NICHOLAS: 41. Gauley River; 42. Summersville Lake.
PENDLETON: 43. Seneca Rock; 44. Smoke Hole Camp.
POCAHONTAS: 45. Cranberry Glades; 46. Durbin; 47. Greenbrier River; 48. Marlington
PRESTON: 49. Cranesville.
PUTNAM: 50. Hurricane; 51. Winfield Locks.
RALEIGH: 52. Beckley: 53. Daniels.
RANDOLPH: 54. Valley Bend.
RITCHIE: 55. Hughes River.
SUMMERS: 56. Bluestone River; 57. Bluestone Lake; 58. Hinton; 59. Pipestem.
TAYLOR: 60. Tygart River.
TYLER: 61. Middlebourne.
WAYNE: 62. Dickson dam; 63. Fort Gay; 64. Prichard; 65. Twelvepole Creek.

List of Species

Ceraclea cancellata (Betten). Stations 1, 3, 6, 11, 14, 21, 22, 23, 24, 25, 26, 28, 29, 30, 31, 34, 38, 43, 46, 47, 48, 50, 52, 58, 62. 4 June - 14 August.

Ceraclea diluta (Hagen). Station 46. 5 July; one male.

Ceraclea flava (Banks). Stations 25, 27, 28, 32, 42. 6 June - 23 July.

Ceraclea maculata (Banks). Stations 3, 6, 14, 20, 21, 22, 23, 25, 26, 27, 28, 29, 30, 32, 34, 37, 38, 39, 50, 51, 58, 62, 63, 64. 8 June - 15 September.

Ceraclea neffi (Resh). Stations 5, 6, 43, 46, 57, 58, 59. 6 June - 26 August.

Ceraclea ophioderus (Ross). Station 58. 6 June - 22 August.

Ceraclea slossonae (Banks). Station 13. Collection date unknown.

Ceraclea tarsipunctata (Vorhies). Stations 4, 24, 25, 26, 27, 28, 58, 62, 63, 64. 7 June - 22 July.

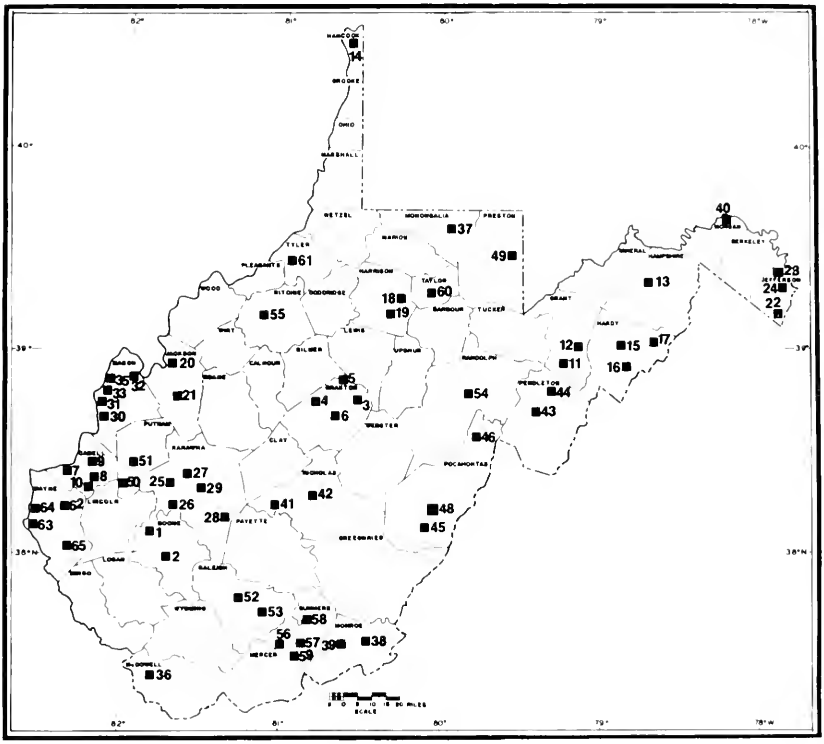

Fig. 1. Collection sites for adult Leptoceridae in West Virginia.

Ceraclea transversa (Hagen). Stations 4, 26, 28, 31, 38, 42, 46, 58. 29 June - 1 September.
Ceraclea wetzeli (Ross). Station 44. 14 May; one male.
Leptocerus americanus (Banks). Station 55. 14 July; one male.
Mystacides sepulchralis (Walker). Stations 6, 13, 40. 5 July - 4 August.
Nectopsyche candida (Hagen). Station 31. 2 June - 20 August.
Nectopsyche exquisita (Walker). Stations 6, 8, 23, 27, 34, 38, 43, 58, 59, 62, 63. 1 June - 10 August.
Nectopsyche pavida (Hagen). Stations 5, 22, 34, 50, 63. 3 July - 22 August.
Oecetis avara (Banks). Stations 4, 6, 12, 17, 22, 25, 27, 28, 38, 41, 42, 43, 44, 56, 58, 59. 5 June - 20 September.
Oecetis cinerascens (Hagen). Stations 22, 33, 34, 54. 7 July - 17 October.
Oecetis inconspicua (Walker). Stations 1, 2, 6, 7, 9, 10, 12, 13, 15, 16, 18, 19, 22, 23, 24, 26, 27, 30, 33, 34, 35, 36, 37, 38, 39, 42, 43, 44, 45, 49, 50, 52, 53, 54, 58, 59, 60, 61, 62, 63, 65. 30 April - 23 September.
Oecetis nocturna Ross. Stations 11, 26, 28, 30, 43, 46, 64. 26 June - 10 September.
Oecetis persimilis (Banks). Stations 6, 9, 20, 46, 58, 59, 62. 1 June - 17 August.
Setodes incerta (Walker). Stations 58, 59. 25 June - 26 August.
Triaenodes flavescens Banks. Stations 38, 59. 30 July - 31 August.
Triaenodes ignitus (Walker). Stations 7, 62. 30 April - 6 June.
Triaenodes injustus (Hagen). Stations 27, 50, 54, 58. 20 June - 2 August.
Triaenodes marginatus Sibley. Stations 58, 59. 1 July - 19 August.
Triaenodes pernus Ross. Station 58. 18 June; one male.
Triaenodes tardus Milne. Station 50. 5 August; two males.

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SOME ECTOPARASITES OF BATS FROM HALMAHERA ISLAND, INDONESIA[1]

B.V. Peterson[2], L.A. Durden[3], J.E. Keirans[4], P.M. Taylor[5]

ABSTRACT: New host and distribution records are given for some ectoparasites of the families Nycteribiidae, Streblidae, Ischnopsyllidae (Insecta), Argasidae, Laelapidae, Spinturnicidae and Trombiculidae (Acari) removed from eight species of bats collected on the Indonesian island of Halmahera.

The ectoparasites upon which this report is based were collected as part of an ethnographic field research study conducted by P.M. Taylor among Tobelo-speaking peoples of Halmahera Island, Indonesia, from December 1980 to November 1981, and was sponsored locally by Khairun University, Ternate, Indonesia. The study was carried out with the cooperation of the Indonesian Institute of Sciences, and the Indonesian Nature Conservancy. Biological specimens were collected throughout the area inhabited by the Tobelo people in order to record local information on the native classification and uses of animals and plants and to provide material for zoological and botanical investigations (Taylor, 1985, in press). Halmahera (sometimes referred to as "Jilolo" or "Gilolo") is the largest island of the Moluccas. It lies on the Equator and is situated southeast of the Philippines, west of the western tip of Irian Jaya, and North of Seram. Knowledge of the ectoparasitic fauna of bats from the Moluccas and surrounding territories, and especially Halmahera, is meager, therefore the records from this survey are valuable for inventory purposes and also for elucidating our knowledge of host-parasite associations in this part of the world.

MATERIALS AND METHODS

Ectoparasites taken during this study were removed from 155 bats of 8 species, plus 16 unidentified bats, mist-netted on the Indonesian island of Halmahera (Kampung Pasir Putih, Jailolo District, at 0°53'N, 127°41'E) by P.M. Taylor and A.C. Messer in 1981. An additional specimen of

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Pteropus personatus Temminck was collected by P.M. Taylor in 1984. As field conditions allowed, care was taken to prevent contamination of ectoparasite collections from different host individuals. All ectoparasites collected were placed in 70% ethanol for later processing and identification. The bat flies and fleas are deposited in the National Museum of Natural History, and the ticks are deposited in the U.S. National Tick Collection, Museum Support Center, Smithsonian Institution, Washington, D.C. Bat nomenclature follows Honacki *et al.* (1982).

RESULTS

The bats examined for ectoparasites were as follows: *Dobsonia crenulata* K. Anderson, *Eonycteris spelaea* (Dobson), *Macroglossus minimus* (E. Geoffroy), *Nyctimene albiventer* (Gray), *Pteropus conspicillatus* Gould, *Pteropus personatus*, *Rousettus amplexicaudatus* (E. Geoffroy) (family Pteropodidae), and *Rhinolophus euryotis* Temminck (family Rhinolophidae). Table 1 depicts the host associations and the numbers of ectoparasites collected in this survey. In addition, 21 nycteribiids, 2 streblids, 208 larval ticks, and a mixture of 13 nymphal and adult spinturnicid mites were removed from 16 bat specimens from which the identification labels became detached. These ectoparasites could not be matched with individual bat species (see Table 1).

DISCUSSION

Of the 11 species of bat flies collected during this survey (7 nycteribiids, 4 streblids) the following represent new records for Halmahera: *Archinycteribia actena* Speiser, *Eucampsipoda inermis* Theodor, *Cyclopodia albertisii* Rondani, *Leptocyclopodia* (*Oncoposthia*) *macrura* (Speiser), *Phthiridium phthisicum* (Speiser) (Nycteribiidae), and *Megastrebla* (*Megastrebla*) *gigantea* (Speiser), *M. parvior* Maa, and *Raymondia pseudopagodarum* Jobling (Streblidae). Two species, *Cyclopodia* species B (Nycteribiidae) and *Brachytarsina* species A (Streblidae), apparently are undescribed but cannot be treated further until specimens of previously described, related species are obtained for comparative purposes. The ischnopsyllid flea, *Thaumapsylla longiforceps* Traub, and the laelapid mite, *Neolaelaps spinosa* (Berlese), are also new records for Halmahera.

Nycteribiidae

Archinycteribia actena has been recorded from Sulawesi (Celebes) and Seram east to the Solomon Islands and Australia (Maa, 1962, 1971; Theodor, 1967, 1968; Durden *et al.*, 1990). In the present survey it was collected from 3 hosts (Table 1), always in association with *Cyclopodia tenuis* and either *Eucampsipoda inermis* or *Megastrebla* (*M.*) *gigantea.* Species of *Dobsonia* Palmer serve as primary hosts of *Archinycteribia actena* throughout the range of this fly with *D. crenulata* the primary host on Halmahera.

Our specimens of *Eucampsipoda inermis* from Halmahera apparently constitute the first record of the genus from the Molucca Islands. This species has been reported from Burma, Thailand, Malaya, Java, Sumba, the Philippines, and Papua New Guinea (Theodor, 1955, 1963, 1967, 1968; Maa, 1962, 1977). Its primary hosts are *Rousettus amplexicaudatus* and *Eonycteris spelaea.* On Halmahera the species also occurred primarily on these 2 hosts; however, a few specimens were collected from *Dobsonia* and *Macroglossus.* The records, other than those from the 2 primary host species, probably represent accidental occurrences.

Cyclopodia tenuis is known from Malaya, Java, Borneo and the Moluccas (Theodor, 1959, 1967; Maa, 1966, 1977). It was first reported from Halmahera by Theodor (1959) from *Macroglossus minimus.* Maa (1966) stated that Theodor's record of a single female from Halmahera needed confirmation. We are now able to verify this distribution record. This was the second most common species in our collection. On Halmahera, *Cyclopodia tenuis* was found almost entirely on *Macroglossus minimus* (originally identified as *M. lagochilus* but Honacki *et al.* (1982) list *lagochilus* as a synonym of *minimus*). This parasitic fly was taken once from *Rousettus amplexicaudatus*, once from *Eonycteris spelaea*, and once from *Nyctimene albiventer.* The latter 3 host records probably represent accidental occurrences.

Cyclopodia albertisii is known from the Moluccas (Goram), Belau (Palau) Islands, Papua New Guinea, and Australia (Theodor, 1959, 1967; Maa, 1962, 1971). Our collection from Halmahera contains 9 specimens all from a single host specimen of *Pteropus conspicillatus.* There were no other associated ectoparasites on this host specimen.

Twenty-two specimens of *Cyclopodia* species B were taken from 4 specimens of *Pteropus personatus.* This fly probably is undescribed even though it runs to *Cyclopodia bougainvillensis* Theodor in Theodor's 1967 keys. There are some differences between features in Theodor's description and those of our specimens but, until comparative material of *bougainvillensis* becomes available, it is impossible to be sure of the correct identity of our specimens.

Thirteen specimens of *Leptocyclopodia* (*O.*) *macrura* were removed from 10 specimens of *Dobsonia crenulata*, and another male was found on 1 unidentified bat. In addition to the range previously recorded for this distinctive species (Durden, *et al.*, 1990), we now add Halmahera. Associated species are listed in Table 1.

Three individual specimens of *Phthiridium phthisicum* were collected from 3 separate individuals of *Rhinolophus euryotis*, and always in association with at least 1 other species, *Raymondia pseudopagodarum* or *Brachytarsina* species A. The female of *Phthiridium phthisicum* was originally described from *Rhinolophus euryotis*, from Amboina (Speiser, 1907). The male was later described from a specimen from Seram taken from an unidentified species of *Rhinolophus* Lacepede, ". . . which according to the form of the thorax and other characters resembles the female closely [and] is considered to belong to this species." (Theodor, 1968). The identity of our female specimen is reasonably certain, but that of our 2 males is less certain. Our males do not completely coincide with Theodor's description or match his figures. It is possible that our, or Theodor's association of the sexes is wrong. Only when both sexes from a single host individual are available can a decision be made. Our specimens might be one of several subspecies mentioned by Maa (1986) but, again, comparative material is needed to be sure.

Streblidae.

Megastrebla (M.) gigantea is a widespread bat fly (Durden *et al.*, 1990). Seven specimens were collected from 3 species of bats and always in association with 1 to 3 species of Nycteribiidae (Table 1).

A single female of *Megastrebla (M.) parvior* was taken from an *Eonycteris spelaea* in association with *Eucampsipoda inermis* and *Cyclopodia tenuis*.

Five specimens of *RaBrachytarsina* (here referred to as species A) were collected from *Rhinolophus euryotis*. This fly closely resembles *Brachytarsina modesta* Jobling and *B. trinotata* Maa, but comparative material is not available to help confirm its identity.

Two males and 2 females of an apparently undescribed species of *Brachytarsina* (here referred to as species A) were collected from *Rhinolophus euryotis*. This fly closely resembles *Brachytarsina modesta* Jobling and *B. trinotata* Maa, but comparative material is not available to help confirm its identity.

Ischnopsyllidae

Thaumapsylla longiforceps was the only species of flea retrieved during this survey. Although it has been collected from several unrelated bat hosts (Hopkins and Rothschild, 1956), it appears to show a preference for various species of the genus *Rousettus* (Holland, 1969). In Java, Hadi *et al.* (1983) recorded '*Thaumapsylla* sp.' from *Rousettus leschenaulti* (Desmarest) and *Eonycteris spelaea*; the latter was the only host species from which *T. longiforceps* was recovered in this survey. *Thaumapsylla longifor-*

ceps has been reported from Java, Borneo and the Philippines southeast to New Guinea (Hopkins and Rothschild, 1956). In addition, we have seen 119 specimens from 21 previously unreported collections of *T. longiforceps*, all identified by R. Traub (pers. comm.): 73 specimens from *Rousettus amplexicaudatus* (Sumatra (8), the Philippines (41), Sulawesi (2), Flores (7) and Timor (15)); 2 specimens from *Rousettus* sp. (the Philippines); 3 specimens from *Cynopterus brachyotis* (Muller) (Sumatra (2) and Java (1); 1 specimen from *Eonycteris major* (K. Anderson) (the Philippines); and 40 specimens from unidentified bats (the Philippines (39) and New Guinea (1)).

Argasidae

All ticks collected were larvae belonging to the genus *Ornithodoros* Koch, subgenus *Reticulinasus* Schulze. All known species of this subgenus parasitize cave-dwelling megachiropteran bats (Dumbleton, 1958; Hoogstraal, 1962; Hoogstraal and Aeschlimann, 1982). Species of *Ornithodoros* (*Reticulinasus*) are known from the Near East, Africa and Madagascar eastward to India, Indo-Australia and the Solomon islands (Dumbleton, 1958; Wiroreno *et al.*, 1979; Hoogstraal and Aeschlimann, 1982). The ticks collected from Halmahera represent 3 undescribed species: most specimens belong to the species here designated as species #1, but 1 specimen removed from *Dobsonia crenulata* belongs to a second species (species #2), and 10 taken from an individual *Rousettus amplexicaudatus* include specimens of species #1 and examples of a third taxon, species #3. It is hoped that future collecting on Halmahera will produce postlarval specimens of these 3 undescribed ticks.

Laelapidae

Neolaelaps spinosa was the only laelapid mite collected in this survey. It occurred in low numbers on both *Dobsonia crenulata* and *Pteropus personatus*. This mite typically parasitizes several species of *Pteropus* and is known from Sri Lanka eastward through Indo-Australia to New Ireland (Strandtmann and Garrett, 1967). Our record from *Dobsonia crenulata* is considered to represent an accidental infestation.

Spinturnicidae and Trombiculidae

The remainder of the ectoparasites collected in this survey consisted of an estimated 6 to 9 species of spinturnicid mites, and 2 species of larval chigger mites (Trombiculidae). The host associations of these two families are shown in Table 1. Both mite groups are frequent ectoparasites of pteropodid bats, particularly in Indo-Australia (Beck, 1971; Hadi *et al.*,

Table 1. Ectoparasites of Bats from Halmahera, Indonesia.

	Dobsonia crenulata (n = 56)	*Eonycteris spelaea* (n = 29)	*Macroglossus minimus* (n = 41)	*Nyctimene albiventer* (n = 2)	*Pteropus conspicillatus* (n = 1)	*Pteropus personatus* (n = 4)	*Rousettus amplexicaudatus* (n = 18)	*Rhinolophus euryotis* (n = 4)	Unidentified bats (n = 16)
Nycteribiidae:									
Archinycteribia actena	88♂,85♀			4♂,5♀*			6♂,7♀*		8♂,4♀
Eucampsipoda inermis	1♂,1♀*	15♂,11♀	2♀*				6♂,7♀		1♂,1♀
Cyclopodia tenuis		1♂*	31♂,29♀	1♂,1♀*			1♂*		6♂,1♀
Cyclopodia albertisii					5♂,4♀				
Cyclopodia sp. B						12♂,10♀			
Leptocyclopodia macrura	7♂,6♀*								1♂
Phthiridium phthisicum								2♂,1♀	
Streblidae:									
Megastrebla gigantea	1♂,4♀*			1♀*					1♂
Megastrebla parvior		1♀							

	Dobsonia crenulata (n = 56)	*Eonycteris spelaea* (n = 29)	*Macroglossus minimus* (n = 41)	*Nyctimene albiventer* (n = 2)	*Pteropus conspicillatus* (n = 1)	*Pteropus personatus* (n = 4)	*Rousettus amplexicaudatus* (n = 18)	*Rhinolophus euryotis* (n = 4)	Unidentified bats (n = 16)
Raymondia pseudopagodarum								1♂,2♀	
Brachytarsina sp. A								2♂,2♀	
Ischnopsyllidae:									
Thaumapsylla longiforceps		3♂,2♀*							
Argasidae:									
Ornithodoros spp.	618L**	29L		1L			83L		208L
Laelapidae:									
Neolaelaps spinosa	1♂,3♀					3♀			
Spinturnicidae	65	159	4				49		13
Trombiculidae	74	1					1		

*Denotes new host record (some of these may represent accidental occurrences).
**L = larvae.

1983; Durden *et al.*, 1990). The chiggers showed a strong host preference for *Dobsonia crenulata* with all but 2 of the 76 specimens collected being taken from this host. Spinturnicid mites were common on *D. crenulata*, *Eonycteris spelaea* and *Rousettus amplexicaudatus*, and scarce on *Macroglossus minimus*; none were taken from the other 4 bat species examined in this survey.

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SOME ECTOPARASITES OF BATS FROM SERAM ISLAND, INDONESIA[1]

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ABSTRACT: New host and distribution records are provided for some ectoparasites of the families Streblidae, Nycteribiidae, Ischnopsyllidae (Insecta), Ixodidae, Argasidae, Laelapidae, Spinturnicidae and Macronyssidae (Acari) removed from 9 species of bats collected in Manusela National Park, on the island of Seram, Indonesia.

The Indonesian island of Seram (Ceram) is situated in the Moluccan Archipelago between Sulawesi and Irian Jaya. Zoogeographically, it is part of the Wallacean subregion (the faunal transition zone between Asia and Australasia) and while part of the terrestrial fauna is endemic, much of it extends to the east and west in varying degrees. No endemic species of bats are known from Seram and this fauna shows Asian, Australasian, Malesian (Melesia: the biogeographical region stretching from Sumatra and the Malay Peninsula east to the Bismarck Archipelago (Whitmore, 1981, 1987)) or Moluccan distributions. Bat ectoparasite records from Seram are few and therefore valuable not only for inventory purposes but also for elucidation of host-parasite associations.

MATERIALS AND METHODS

Ectoparasites were collected by visual searches from 36 bats of 9 species mist-netted in Manusela National Park, Seram (3° 15'S, 129°38'E), during July and August, 1987. Ectoparasite material was stored in 70% ethanol until it could be processed for identification.

RESULTS AND DISCUSSION

The 9 bat species collected and the numbers of each examined for ectoparasites were as follows (bat nomenclature follows Honacki *et al.*, 1982): *Dobsonia viridis* (Huede) (1♂, 16♀♀), *D. moluccensis* (Quoy and Gaimard) (1♂, 1♀), *Rousettus amplexicaudatus* (E. Geoffroy) (2♂♂, 5♀♀),

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Syconycteris australis (Peters) (1♂, 1♀), *Pteropus temmincki* Peters (1♂, 1♀) (family Pteropodidae), *Miniopterus australis* Tomes (2♂♂) (family Vespertilionidae), *Rhinolophus euryotis* Temminck (1♂) (family Rhinolophidae), *Chaerephon jobensis* (Miller) (1♀), and *Mormopterus beccarii* Peters (2♀♀) (family Molossidae).

Table I lists the ectoparasites collected during this survey. The bat flies and the single flea are deposited in the U.S. National Museum of Natural History, Washington, D.C., and the ticks are in the U.S. National Tick Collection, Smithsonian Institution, Washington, D.C. (accessioned under RML 119,061-119,075).

The ectoparasites recorded here from Seram bats are fairly typical for this group of hosts. The following species represent new records for Seram: *Brachytarsina* (*Brachytarsina*) *amboinensis* Rondani, *Megastrebla* (*Magastrebla*) *gigantea* (Speiser), *M.* (*M.*) *parvior* (Maa), *Raymondia pseudopagodarum* Jobling (Streblidae); *Archinycteribia actena* Speiser, *Nycteribia parilis* Walker (Nycteribiidae); *Thaumapsylla breviceps* Rothschild (Ischnopsyllidae), and all of the ticks and mites.

Most of the bats and ectoparasites retrieved during this survey are known to have wide but contrasting geographical distributions. With respect to the streblid bat flies, *Brachytarsina* (*B.*) *amboinensis* was only taken from *Miniopterus australis* which ranges from India to China (Hainan) and northeastern Australia. The known range of *Brachytarsina* (*B.*) *amboinensis* is similar extending from India and Sri Lanka east to Australia, Vanuatu and New Caledonia (Jobling, 1951; Hiregaudar and Bal, 1956; Maa, 1962, 1971a, 1977; Maa and Marshall, 1981). This bat fly is represented by several subspecies in various parts of its range, and specimens from Seram appear to belong to the nominate subspecies. *Brachytarsina* (*B.*) *amboinensis* is principally parasitic on various species of *Miniopterus* Bonaparte.

The streblid, *Megastrebla* (*M.*) *gigantea* was collected from both species of *Dobsonia* Palmer. *Dobsonia viridis* is distributed throughout the Moluccan and Banda Islands and the Philippine island of Negros while *D. moluccensis* extends from the Moluccas eastward to Aru, New Guinea, and northern Queensland. *Megastrebla* (*M.*) *gigantea* has been recorded from India east to New Britain (Jobling, 1951; Hiregaudar and Bal, 1956; Maa, 1962). However, Maa (1971b) later stated that this species with its 3 subspecies (*gigantea gigantea*, *g. kalawawae* Maa, *g. solomonis* Maa) ranges only from Sumba east to the Solomon Islands, and that all other records must be held suspect. This is the largest known species in the genus and is probably restricted to bats of the genus *Dobsonia*. The specimens from Seram are of the nominate subspecies.

Megastrebla (*M.*) *parvior* was collected from *Rousettus amplex-*

icaudatus. This bat ranges throughout Malesia whereas *Megastrebla parvior* has a known distribution extending from India and Burma east to the Philippines, south to Sumatra, Sumba and New Guinea (Maa, 1962, 1971b, 1977). The specimens from Seram are of the nominate subspecies. Maa (1962) recorded the Sumba series of specimens from *Rousettus amplexicaudatus*, and the remaining type series from *Eonycteris spelaea* (Dobson). *Rousettus* Gray is the primary host of the nominate subspecies (Maa, 1971b), but it has also been recorded from a number of other hosts. A second subspecies, *Megastrebla parvior papuae* Maa, was described from New Guinea from *Rousettus amplexicaudatus* and *Dobsonia moluccensis*.

Raymondia pseudopagodarum was removed from a male *Rhinolophus euryotis*. This bat ranges from Sulawesi east to the Moluccas, Timor, New Guinea, the Bismarck Archipelago and adjacent small islands whereas its tiny parasite ranges from Burma, Thailand, China, east to the Philippines, and south to Timor and Seram (Jobling, 1951; Maa, 1962, 1977). Primary hosts for *Raymondia pseudopagodarum* seem to be species of *Rhinolophus* Lacepede and *Hipposideros* Gray, although a few other suspect hosts have been listed for the species.

With respect to the nycteribiid bat flies, *Archinycteribia actena* was collected only from *Dobsonia viridis*. This fly has previously been recorded from Ambon, New Guinea, the Solomon Islands and Australia (Maa, 1962, 1971a; Theodor, 1967). In 4 of the collections, *A. actena* was taken in association with *Leptocyclopodia* (*Oncoposthia*) sp. A, once with *Megastrebla* (*M.*) *gigantea*, and twice by itself.

The single specimen of *Cyclopodia* sp. collected from *Syconycteris australis* is in poor condition, but from the characters that can be seen it could be *Cyclopodia sycophanta* Maa that parasitizes the same host, or it might represent a new species in the *C. sycophanta* group. Additional specimens will be needed before the identity of this species can be determined with certainty.

Leptocyclopodia (*Oncoposthia*) *macrura* Speiser was collected only from *Dobsonia moluccensis*; this bat fly was previously reported from *D. moluccensis* on the islands of Biak and Owi off the northern coast of New Guinea (Hadi *et al.*, 1980). *Leptocyclopodia* (*O.*) *macrura* is a distinctive species and has also been recorded from Sumbawa, Ambon, Seram, New Guinea, and New Britain (Maa, 1962, 1966, 1968, 1975; Treodor, 1959, 1967) which approximates the distribution of *Dobsonia moluccensis*.

Leptocyclopodia (*Oncoposthia*) sp. A was collected mainly from *Dobsonia viridis* although 2 specimens were taken from *Syconycteris australis*. This latter bat species ranges from the Moluccas eastward to New Guinea, the Bismarck Archipelago and adjacent small islands and south to Australia. These bat fly specimens probably represent a new species since neither sex runs successfully in Maa's key (1975) nor do they fully match the descriptions or illustrations of the other species of this subgenus. The true status of this fly can be determined only when comparative material of other closely related species is available.

Nycteribia parilis was found only on a male *Miniopterus australis*. The same host individual yielded 8 specimens of the streblid *Brachytarsina* (*B.*) *amboinensis*. *Nycteribia parilis* is known from Ambon, Batchian, Timor, and other Moluccan islands, New Guinea and Australia principally from various species of *Miniopterus* (Maa, 1962, 1971a; Theodor, 1967). There are 2 subspecies of this bat fly: the nonimate subspecies over most of its range, and *p. vicaria* Maa from Australia.

Thaumapsylla breviceps, the only flea collected, has a very broad geographical range that includes much of the Ethiopian and Oriental Regions. However, 2 subspecies are known: the nominate subspecies in Africa, and *b. orientalis* in Southeast Asia (Hopkins and Rothschild, 1956). Although it is most likely that the latter taxon was collected in this survey, the 2 subspecies can only be separated by male characters and the Seram specimen is a female. This flea typically parasitizes *Rousettus* bats, which agrees with the *R. amplexicaudatus* record documented here for Seram. *Thaumapsylla breviceps* has hyper-developed pronotal combs that may facilitate attachment to its volant hosts and partly explain why this species has such a large geographical distribution (Traub, pers. comm.).

The tick, *Ixodes* (*Eschatocephalus*) *simplex* Neumann, occupies a vast geographical area within the Palaearctic, Ethopian, Oriental and Australasian Regions (Arthur, 1956; Wilson, 1970; Clifford *et al.*, 1973). It was taken only from *Miniopterus australis* in this survey, an anticipated association since *Miniopterus* is the usual host (Wilson, 1970).

Ixodes (*Lepixodes*) *kopsteini* Oudemans is known to parasitize bats in the Ethiopian, Oriental and Australasian Regions including the Moluccas (Kadarsan, 1971; Clifford *et al.*, 1973). During this study it was collected from 3 host species belonging to 2 families. The molossids, *Chaerephon jobensis* which ranges from India and Sri Lanka, east to southern China and Vietnam, and southeast to the Philippines, Borneo, Bali and the Moluccas, and *Mormopterus beccarii* which ranges from the Moluccas east to New Guinea, northern and central Australia and adjacent small islands, appeared to be the main hosts but a single specimen was collected from the pteropodid, *Rousettus amplexicaudatus*. *Ixodes* (*L.*) *kopsteini* possesses certain morphological and reproductive features unknown in other ticks (Kadarsan, 1971). These morphological traits led Anastos (1950) to exclude this unusual tick from his monograph on Indonesian Ixodidae because he considered it to be, "probably a special type of mite."

Table 1. Ectoparasites of Bats from Seram Island, Indonesia, 1987.

	Dobsonia viridis (n = 17)	*Dobsonia moluccensis* (n = 2)	*Rousettus amplexicaudatus* (n = 7)	*Syconycteris australis* (n = 2)	*Pteropus temmincki* (n = 2)	*Miniopterus australis* (n = 2)	*Rhinolophus euryotis* (n = 1)	*Chaerephon jobensis* (n = 1)	*Mormopterus beccarii* (n = 2)
Nycteribiidae:									
Archinycteribia actena	11♂,7♀								
Leptocyclopodia macrura		8♂,3♀							
Leptocyclopodia sp. A	20♂,21♀			1♂,1♀					
Cyclopodia sp.				1♂					
Nycteribia parilis						1♂			
Streblidae:									
Megastrebla gigantea	2♂,1♀	1♂,4♀							
Megastrebla parvior			1♂						
Brachytarsina amboinensis						6♂,2♀			
Raymondia pseudopaoodarum							1♂		

Ischnopsyllidae:									
Thaumapsylla breviceps			1♀						
Ixodidae:									
Ixodes kopsteini			1L*					3N*	1N,6L
Ixodes simplex						1♀			
Argasidae:									
Ornithodoros sp.	70L		2L						
Laelapidae:									
Neolaelaps spinosa					1♂				
Macronyssidae:									
Macronyssus sp.						1N			
Trichonyssus sp.									3N
Spinturnicidae:									
Ancystropus taprobanius			1♂,1♀						
Ancystropus zeleborii			3♀						
Meristaspis calcarata					1♀				
Meristaspis jordani	1♂,7♀								
Meristaspis lateralis	1♂		5♂,4♀,3N						
Paraperiglischrus rhinolophinus							2♀		
Spinturnix psi						1♂,2♀			

*L = larvae, N = nymphs.

Ornithodoros sp. larvae could not be identified further so little can be stated regarding host associations or geographical distribution. Nevertheless, this tick genus occurred almost exclusively on *Dobsonia viridis* (70 specimens) although 2 specimens were taken from a female *Rousettus amplexicaudatus.*

The laelapid mite, *Neolaelaps spinosa* (Berlese) is parasitic on a variety of fruit bats in the genus *Pteropus* Erxleben. It ranges from Sri Lanka to Australia so the present record from *P. temmincki* on Seram is expected. This mite occasionally has been found attached phoretically to nycteribiid bat flies (Maa, 1971a) but this phenomenon was not observed in the Seram material.

All 4 macronyssid mites were damaged protonymphs and could not be identified beyond genus. Two genera were collected: *Macronyssus*, which is most often retrieved from vespertilionid bats, agreeing with the *Miniopterus australis* record documented here, and *Trichonyssus* which occurs principally on vespertilionids but also on some other bat families including Molossidae from which the Seram collections were made. While the genus *Macronyssus* is virtually cosmopolitan in distribution, there does not appear to be any previous records for *Trichonyssus* outside of Australia and Tasmania (Radovsky, 1979; Micherdzinski and Domrow, 1985; Domrow, 1987).

Seven species of spinturnicid mites were collected. *Ancystropus taprobanius* (Turk) and *A. zeleborii* Kolenati were both taken from *Rousettus amplexicaudatus* which concurs with previously documented host records especially those from southern Asian species of *Rousettus* (Prasad, 1969; Domrow, 1972; Hadi *et al*., 1980). Three species of *Meristaspis* were identified from different bat hosts. *Meristaspis lateralis* (Kolenati), which ranges from the Near East (Palestine and Yemen) southeast to New Guinea, is principally parasitic on *Rousettus* species (Delfinado and Baker, 1963; Prasad, 1969). The present records of *Meristaspis lateralis* from *Rousettus amplexicaudatus* therefore conform to this trend although the single specimen of *Meristaspis lateralis* from *Dobsonia viridis* is an exception. *Meristaspis jordani* (Radford) was collected only from *Dobsonia viridis.* Previous records show this mite to be parasitic mainly on bats of the genus *Dobsonia*, and to range from Sulawesi and the Philippines to New Guinea and the Bismarck and Solomon Islands (Prasad, 1969; Domrow, 1972). *Meristaspis calcarata* (Hirst) typically parasitizes numerous species of *Pteropus* bats and ranges from Madagascar to Australia and a number of Pacific islands (Delfinado and Baker, 1963; Prasad, 1969). The present record from *P. temmincki* fits this distribution. *Paraperiglischrus rhinolophinus* (Koch) is associated with numerous species of *Rhinolophus* bats, and ranges from the British Isles southeast to Africa, southern Asia and Australia. In this survey it was collected from *R. euryotis*. *Spinturnix psi* (Kolenati) is another ectoparasite with a wide geographical distribution. There are records of this mite from France, southern Europe, Madagascar, southern Asia and Australia. In this survey, *Spinturnix psi* was collected only from *Miniopterus australis* which concurs with its known host preference for species of *Miniopterus* (Baker and Delfinado, 1964; Prasad, 1969; Domrow, 1972).

The above records extend the known geographical distributions of most of the ectoparasites collected during this survey. Geographical distributions of the bat species and their associated ectoparasites are not congruent in the majority of cases. Different bat species are parasitized by these ectoparasites in other parts of their range. Conversely, a few of the ectoparasites were more host specific and may be expected to overlap more closely with the distributions of their hosts. The dispersive abilities of their volant hosts and the facility of some bat ectoparasites to utilize a spectrum of host species probably explains, at least in part, the large geographical distributions of many bat-associated arthropods.

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ANNOTATED CHECKLIST OF THE RHYACOPHILOIDEA AND INTEGRIPALPIA (TRICHOPTERA) OF ALABAMA[1]

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ABSTRACT: Distributional records of 132 species of caddisflies in the suborder Annulipalpia, (superfamily Rhyacophiloidea) and the suborder Integripalpia (superfamilies Limnephiloidea, Phryganeoidea, Leptoceroidea, and Sericostomatidea) from Alabama are listed, along with information on seasonal occurrence, habitat and relative abundance. This checklist brings the total number of caddisflies known from Alabama to 323 species.

The caddisfly fauna of the southeastern United States has received considerable attention in recent years and species checklists are now available for Tennessee (Etnier and Schuster, 1979), North and South Carolina (Unzicker *et al.*, 1982), Kentucky (Resh, 1975), Virginia (Parker and Voshell, 1981), and Mississippi including southeastern Louisiana (Holzenthal *et al.*, 1982). This is the third and final contribution in a series of papers (Harris, 1986a; Lago and Harris, 1987) on the caddisfly fauna of Alabama. This checklist presents distributional records for 132 species in the families Glossosomatidae and Rhyacophilidae (infraorder Spicipalpia, Weaver, 1984); Goeridae, Limnephilidae, Uenoidae, Brachycentridae, Lepidostomatidae, Phyrganeidae (infraorder Plenitentoria, Weaver, 1984); and Odontoceridae, Calamoceratidae, Leptoceridae, Molannidae, Helicopsychidae, and Sericostomatidae (infraorder Brevitentoria, Weaver, 1984). The Hydroptilidae which are also in the infraorder Spicipalpia (Weaver, 1984) are not included in this checklist, but were compiled in Harris (1986a). Of the 132 species identified from Alabama, ten were described during the course of the study (Harris, 1986b, 1987, 1989; Vineyard and Wiggins, 1987) and two others will be described in the near future. The species richness is indicative of the range of physiographic regions represented in the state. These include the East Gulf Coastal Plain, Piedmont Plateau, Valley and Ridge, and Appalachian Plateau, including the Highland Rim Plateau and Cumberland Plateau subregions (Sapp and Emplaincourt, 1975).

CHECKLIST OF SPECIES

In the following checklist each species is followed by numerically

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coded county records. These counties and their location, both within the state and within a physiographic province, are depicted in Figure 1. General information on distribution and abundance in the state is included with each species, followed by collection months and numbers of specimens examined ( ). In most cases only adult males were examined, except as noted. Detailed locality and collection information will be provided in an overall summary of the caddisfly fauna of the state, to be published later. This checklist represents over 600 collections made primarily with black-light traps between 1981 and 1987. Voucher specimens are maintained in the insect collections of the Geological Survey of Alabama and the University of Alabama.

SPICIPALPIA

HYDROPTILOIDEA

Glossosomatidae

Agapetus alabamensis Harris. 25. Known only from two small streams of the Cumberland Plateau. April, May. (30)

A. avitus Edwards. 1, 2, 4, 10. Locally common in northern Alabama, particularly the Highland Rim. April-June. (94)

A. crasmus Ross. 3, 4. Locally common in lower Appalachians of northeastern Alabama. June. (51)

A. gelbae Ross. 1. Uncommon in small Highland Rim streams. April-June. (20)

A. hessi Leonard and Leonard. 3, 8, 12, 34. Locally common; primarily in small streams of northern Alabama. May, June. (115)

A. iridis Ross. 17. Record from small stream in lower Appalachians provided by D.A. Etnier. April. (4)

A. pinatus Ross. 17. Only records from a small stream in the lower Appalachians. May. (2)

A. rossi Denning. 8, 12, 17, 26, 31, 34. Frequently collected at scattered localities in northern half of state. April-June. (319)

A. spinosus Etnier and Way. 5. Rarely collected; in small streams of the lower Appalachians. May. (4)

A. tomus Ross. 14, 17, 20, 34. Uncommon; in small streams of northcentral Alabama. May. (12)

Glossosoma nigrior Banks. 1, 2, 5, 6, 8-10, 13, 14, 17-20, 25, 27, 29, 31, 32, 51. Widespread and common; primarily in small streams of northern Alabama. April-September. (405)

Matrioptila jeanae (Ross). 5, 17, 26, 29, 31, 32, 34. Most frequent in small Piedmont streams, never collected in large numbers. May, June. (135)

Protoptila cahabensis Harris. 19. Known only from a small section of the Cahaba River. May, August, October. (70)

P. georgiana Denning. 31. Only records from Hillabee Creek, a large Piedmont stream. May. (8)

P. maculata (Hagen). 16-18. Locally abundant in small streams of lower Appalachians and upper Piedmont. May, June, September, October. (134)

P. palina Ross. 3, 12-14, 17-20, 25, 26, 29, 31, 32, 34, 54, 63-65. Widespread and common in Alabama, but most frequently collected in northern half of state. April-October. (2491)

RHYACOPHILOIDEA

Rhyacophilidae

Rhyacophila carolae Harris. 8. Known only from type locality, a small first order stream in Bankhead National Forest. May. (2)

R. carolina Banks. 1, 5, 6, 8, 10, 11, 13, 14, 17-22, 25, 27-29, 31, 32, 34, 42, 51, 53, 66. Most common and widespread *Rhyacophila* in Alabama; most commonly collected in northern half of state. April-October. (353)

R. fenestra Ross. 1, 2. Only records from extreme northwestern Alabama on Highland Rim. June. (6)

R. fuscula (Walker). 14, 17, 18, 25, 27-29, 31, 32. Occurring in northern half of Alabama, primarily in Piedmont. April-June, September, October. (81)

R. glaberrima Ulmer. 8, 11, 13, 18, 25. Infrequently collected at scattered north Alabama localities. May, June, September, October. (25)

R. ledra Ross. 1-3, 6, 14, 17, 20, 21, 25, 39, 51, 52, 58, 66, 67. Widespread, but infrequently collected in state. May, June. (46)

R. lobifera Betten. 14, 21, 25. Common in a few small streams of the Cumberland Plateau in central Alabama. April, May. (86)

R. nigrita Banks. 17, 18, 25, 29. Uncommon; mainly in small Piedmont streams. May, June. (13)

R. teddyi Ross. 17. Only records from small streams in lower Appalachians. May. (2)

R. torva Hagen. 17, 18, 31. Infrequently collected in small Piedmont and lower Appalachian streams. May, June. (15)

R. vuphipes Milne. 34. Larval records from Little Cahaba River provided by D.A. Etnier. This record is tentative but the specimens key to *R. vulphipes* in Unzicker *et al.* (1982) and not to any of the recorded species from the Cahaba River system or from central Alabama. April. (2)

PLENITENTORIA

LIMNEPHILOIDEA

Goeridae

Goera calcarata Banks. 1, 5, 6, 16-19, 27, 28, 34. Common in northern Alabama, particularly in small streams of lower Appalachians. April-October. (273)

G. townesi Morse. 8, 12, 17, 18, 25, 27, 29, 32. Similar in occurrence to *G. calcarata*, but more frequently collected in Piedmont and Cumberland Plateau streams. May, June. (233)

Limnephilidae

Hydatophylax argus (Harris). 25. Larval records from several small streams of the Cumberland Plateau. April, May. (37)

Ironoquia kaskaskia (Ross). 22. Only record from a large, sand-bottom river. October. (1)

I. punctatissma (Walker). 18, 20, 25, 34, 35, 43, 45. Most often collected along large rivers, but generally uncommon in our collections. September, October. (34)

Platycentropus radiatus (Say). 8, 12. Rare in small streams of Cumberland Plateau. May. (3)

Pycnopsyche gentilis (MacLachlan). 18, 27. Rarely collected in small streams of lower Appalachians. March (larva), October (adult). (2)

P. indiana (Ross). 18, 20, 22, 25, 34, 67. Uncommon in small streams, mainly in west central Alabama. October, November. (30)

P. lepida (Hagen). 18, 22, 25. Uncommon in several small streams of northern Alabama. September, October. (13)

P. luculenta (Betten). 18, 25, 34. Locally common in small streams of northern Alabama. October. (65)

P. scabripennis (Rambur). 1, 16, 18, 25, 34, 45. Uncommon at scattered localities in northern half of Alabama. June, September, October. (27)

P. virginica (Banks). 18. Single record from Coldwater Spring provided by K.L. Manuel. November. (1)

Uenoidae

Neophylax acutus Vineyard and Wiggins. 4. Records from small streams in southern Appalachians (Vineyard and Wiggins, 1987). October. (10)

N. atlanta Ross. 8. Record from small stream on Cumberland Plateau. November. (1)

N. concinnus McLachlan. 8, 25. Larvae collected from several small streams of Cumberland Plateau. March, May. (5)

N. oligius Ross. 25. Collected along several small streams of Cumberland Plateau. November. (5)

N. ornatus Banks. 8, 25. Rare along several small streams of Cumberland Plateau. April. (2)

N. securis Vineyard and Wiggins. 4. Record from small stream in southern Appalachians (Vineyard and Wiggins, 1987). October. (1)

Brachycentridae

Brachycentrus chelatus Ross. 67. Endemic to the Coastal Plain, collected by sweeping. March. (6)

B. numerosus (Say). 25, 34, 39, 54. Collected in a few streams in western Alabama, mainly as larvae. March, May. (14)

Micrasema charonis Banks. 17. Record from a small stream in lower Appalachians provided by D.A. Etnier. (23)

M. n. sp. 51, 53, 65-67. Endemic to the Coastal Plain and common in small streams; being described by J. Chapin and J. Morse. March-August. (226)

M. rusticum (Hagen). 12, 17, 25, 26, 31, 34, 39, 45, 51, 54, 66, 67. Common and widespread throughout Alabama. March-May. (697)

M. wataga Ross. 1, 3, 5, 6, 8, 10-12, 14, 17-21, 25-27, 29, 31, 32, 34, 43, 45, 51, 52, 64. Commonly collected throughout state, but most abundant in northern portion. April-October. (1007)

Lepidostomatidae

Lepidostoma latipenne (Banks). 10-12, 17-19, 25, 31, 34, 45. Occurring at scattered localities in northern half of state; never collected in large numbers. May, June, September, October. (77)

L. tibiale (Carpenter). 21, 28, 32. Uncommon; primarily collected in small Piedmont streams. May, June. (23)

L. togatum (Hagen). 17, 18, 23, 28, 29, 31, 32, 54. Locally common, especially in small Piedmont streams. May, June, September, October. (147)

L. weaveri Harris. 25. Only known from type locality, a small temporary stream of the Cumberland Plateau. March. (39)

Theliopsyche melas Edwards. 5. Only record from a small temporary stream of the lower Appalachians. June. (1)

T. tallapoosa Harris. 31. Known only from a small Piedmont stream. May. (3)

PHRYGANEOIDEA

Phryganeidae

Agrypnia improba (Hagen). 45. Records from vicinity of Auburn University. October. (28)

A. vestita (Walker). 22, 25, 34. Rare in our collections. October. (3).

Banksiola concatenata (Walker). 39, 45, 53. Only taken on Coastal Plain, but rare in our collections. April, May. (3)

Ptilostomis ocellifera (Walker). 22, 23, 25, 26, 33, 36, 42, 66, 67. Primarily collected on Coastal Plain, particularly the northern portion. April-July. (32)

P. postica (Walker). 17, 18, 24, 27, 29, 35, 39, 43, 45, 51, 66. Widespread in state, but rare in our collections. April-June, September. (16)

BREVITENTORIA

LEPTOCEROIDEA

Odontoceridae

Psilotreta frontalis Banks. 11, 17, 18, 25, 27, 53. Uncommon from scattered, primarily northern portions of the state. April, May, October. (29)

P. labida Ross. 1, 19, 53. Rarely collected from scattered localities in Alabama. May, June. (26)

P. rufa (Hagen). 17. Only record provided by D.A. Etnier from a tributary to Shoal Creek in northeastern Alabama. April. (1)

Calamoceratidae

Anisocentropus pyraloides (Walker). 1, 8, 11, 12, 14, 17, 18, 25, 28, 29, 31, 32, 36, 39, 42, 45, 51-53, 58, 64-67. Widely distributed in state, but most abundant in small Costal Plain streams. April-August. (561)

Heteroplectron americanum (Walker). 8, 17, 18, 25, 28, 29, 51. Primarily occurring at scattered localities in northern Alabama, but never collected in large numbers. April-June. (15)

Leptoceridae

Ceraclea alabamae Harris. 5. Only known in Alabama from the Little River. June. (248)

C. alces (Ross). 5. A north-central North American species, locally abundant in the Little River. June. (158)

C. ancylus (Vorhies). 3, 11, 12, 14, 17, 25, 28, 29, 31, 34, 45. Widespread, but uncommon in northern half of state. May, June. (295)

C. cancellata (Betten). 1-6, 8-10, 13, 14, 16-18, 20, 24-26, 28, 29, 31, 32, 35, 39, 41, 43, 45, 49, 51-54, 63-67. Widespread and common in state. May-September. (2651)

C. diluta (Hagen). 5, 66, 67. Locally common, both on the Coastal Plain and in the lower Appalachians. March-May. (152)

C. flava (Banks). 1-4, 9-11, 13, 16-18, 20, 22, 24-26, 29, 32, 34, 35, 37-39, 41, 45, 49, 51, 53, 60, 63-67. Widespread and common in state. May, June. (2025)

C. maculata (Banks). 1-6, 8-18, 20-26, 28, 29, 31-37, 39-43, 45, 49-55, 58, 60, 63-67. Abundant in our collections from throughout the state. April-October. (8396)

C. mentiea (Walker). 24. Record from the Tombigbee River provided by D.A. Etnier. July. (11)

C. neffi (Resh). 4, 5, 54. Rarely collected in lower Appalachians and from a single location on the Coastal Plain. May, June. (5)

C. nepha (Ross). 1-3, 5, 6, 8, 9-14, 16-18, 20-22, 24, 25, 29, 31-34, 39, 45, 51, 58, 66, 67. Widespread in state, but most frequently collected above fall line. April-June. (438)

C. ophioderus (Ross). 25, 26, 33-35, 41, 45, 49, 51, 53, 54, 60, 63-67. Primarily Coastal Plain in distribution. May-September. (1192)

C. protonepha Morse and Ross. 1-3, 5, 6, 8-14, 17, 18, 20-23, 25, 26, 29, 31, 32, 34, 39, 45, 51, 53, 54, 58, 64, 66, 67. Widespread, but most frequently collected in northern half of state. March-June. (1320)

C. resurgens (Walker). 34, 35, 66, 67. Collected only from a few localities on the Coastal Plain. March, April. (18)

C. tarsipunctata (Vorhies). 1-6, 8-10, 12-14, 16-21, 24-26, 29, 31, 32, 34, 35, 37, 39-45, 49-54, 58, 63-67. Widespread and common in Alabama. April-June. (4075)

C. transversa (Hagen). 1-3, 5, 6, 12-18, 25, 28, 29, 31, 32, 34, 43, 45, 51, 64, 66. Occurring throughout Alabama, but most abundant in northern counties. April-July. (283)

Leptocerus americanus (Banks). 1, 8, 11-13, 17, 21 24, 33, 38, 39, 41, 43, 51, 53. Infrequently collected in small streams of Cumberland Plateau and western Coastal Plain. April-June. (84)

Mystacides sepulchralis (Walker). 1, 2, 4-6, 8-11, 14-18, 20, 22, 25, 26, 28, 29, 31, 34, 45. Restricted to northern half of Alabama, primarily in small streams. May-October. (233)

Nectopsyche candida (Hagen). 1, 8-12, 16-18, 20-25, 29, 31, 33, 35, 36, 39-42, 45, 49, 51-55, 58, 64-67. Common throughout state except lower Appalachians. May-August. (943)

N. exquisita (Walker). 1, 3, 4, 9-14, 16, 17, 20-22, 25, 26, 28, 29, 31, 32, 34-36, 39-41, 45, 49, 50, 52, 54, 60, 63-67. Widespread and common in state. May-September. (743)

N. paludicola Harris. 66, 67. Endemic to small streams of the Coastal Plain. May-August. (82)

N. pavida (Hagen). 1-6, 9-26, 31-37, 39, 40, 42, 43, 45, 51-55, 58, 60, 63-67. Most common and widespread *Nectopsyche* in state. May-October. (1275)

N. spiloma (Ross). 34, 35, 66, 67. Restricted to large Coastal plain rivers. May-October. (844)

Oecetis avara (Banks). 1, 10-12, 20, 23-26, 28, 32-36, 39-42, 45, 49, 50, 53-55, 65. Most frequently collected on Coastal Plain, particularly western portion. May-September. (2893)

O. cinerascens (Hagen). 1, 2, 4, 6, 11, 14-16, 18, 20, 22, 24-26, 32, 34-39, 43, 45, 50-53, 58, 60, 64, 66, 67. Widespread in state, but never collected in large numbers. April-October. (241)

O. daytona Ross. 52, 65-67. Rare; in small Coastal Plain streams. April, May, August. (12)

O. ditissa Ross. 1, 2, 5, 6, 8-12, 14-26, 29, 31, 33-41, 43, 45, 51-55, 58, 60, 63-67. Widespread and common in state. April-October. (877)

O. georgia Ross. 12, 17, 22, 23, 25, 36, 42, 51-53, 65-67. Primarily occurring in Coastal Plain streams. May-August. (171)

O. inconspicua (Walker). 1-6, 8-26, 28, 29, 31-43, 45, 49-55, 58, 60, 63-67. One of the most commonly collected caddisflies in the state. April-October. (6487)

O. morsei Bueno-Soria. 34, 35. Only collected from the Cahaba River. June-October. (14)

O. nocturna Ross. 1-6, 9-26, 28, 29, 31-36, 38-43, 45, 49-53, 55, 63-67. Widespread and common in Alabama. April-October. (2658)

O. osteni Milne. 11, 17, 20, 23-25, 33, 34, 36, 40, 45, 51, 54, 60, 64-67. Primarily Coastal Plain in occurrence. March-October. (451)

O. persimilis (Banks). 1-3, 5, 6, 8-26, 29, 31-34, 36, 37, 39-41, 45, 49-55, 58, 60, 63-67. Widespread and common in state. April-October. (2144)

O. scala Milne. 5, 18, 34. Collected from several streams of the lower Appalachians and in the Cahaba River system. June-October. (401)

O. sphyra Ross. 10-12, 16-18, 22-26, 31-37, 39, 41, 42, 45, 51-55, 58, 60, 63-67. Most frequently collected on Coastal Plain, particularly along sand-bottomed rivers. May-September. (7697)

Setodes dixiensis Holzenthal. 34, 35. Restricted to the Cahaba River system. May, June, September, October. (496)

S. guttatus (Banks). 34, 54. Only collected at two localities, locally common. May, August, September. (48)

S. incertus (Walker). 32. Restricted to several small Piedmont streams. May. (5)

S. stehri (Ross). 54. Only records from the Sepulga River, where *S. guttatus* also occurs. May, September. (62)

Triaenodes aba Milne. 20, 39. Rarely collected in Alabama. May, June. (2)

T. cumberlandensis Etnier and Way. 5, 8, 17, 21, 22, 25. Collected from scattered localities on Cumberland Plateau and lower Appalachians. May, June, August. (63)

T. dipsia Ross. 25. Only record from a small headwater stream of the Cumberland Plateau. July. (1)

T. flavescens Banks. 1, 17. Rarely collected, in northern Alabama. June. (8)

T. florida Ross. 64. Collected from Lake Jackson. June. (12)

T. helo Milne. 60, 66, 67. Rare in collections; restricted to Coastal Plain. April-June, August, September. (11)

T. ignita (Walker). 1-6, 8-12, 14, 16-18, 20, 22-26, 29, 31, 33-37, 39, 42, 45, 49, 51-55, 58, 60, 63-67. Widespread and common in Alabama. April-October. (814)

T. injusta (Hagen). 1-4, 8, 9, 14, 17, 18, 20-22, 25, 26, 34, 64. Primarily occurring in northern portion of state. April-September. (199)

T. marginata Sibley. 1, 14, 17, 18, 20, 22, 25, 29, 31, 45, 51. As with *T. injusta*, most frequently collected in northern half of Alabama. April-August. (59)

T. melaca Ross. 39. Collected among small streams with sand-gravel substrates. April, May. (4)

T. n. sp. 42, 52, 65, 66. Restricted to small Coastal Plain streams; being described by K.L. Manuel. May, June, August. (29)

T. nox Ross. 29, 34, 45. Collected in Piedmont region and from a tributary to the Cahaba River. May (4)

T. ochracea Betten and Mosely. 1, 4, 6, 8, 17, 22, 23, 25, 29, 51, 52, 66, 67. Collected infrequently throughout the state. April-June. (64)

T. perna Ross. 5, 9, 16, 18, 20, 22, 25, 26, 34, 52, 66, 67. Distribution and abundance similar to *T. ochracea*. May-September. (58)

T. smithi Ross. 8, 25, 35, 52, 53, 64. Uncommon in collections, primarily from western portion of Alabama. May, June, August. (16)

T. taenia Ross. 17, 18, 39, 45. Most specimens taken in small Piedmont streams. May, June. (5)

T. tarda Milne. 6, 14, 18, 20, 24, 25, 32, 38, 41, 49, 50, 51. Collected at scattered localities throughout the state. May, June. (68)

T. tridonta Ross. 51. Collected from several small Coastal Plain streams with substrates of sand-gravel. April. (17)

Molannidae

Molanna blenda Sibley. 17, 18, 20, 25, 26, 29, 45, 51, 53, 66. Widespread, but infrequently collected in state. April-June. (27)

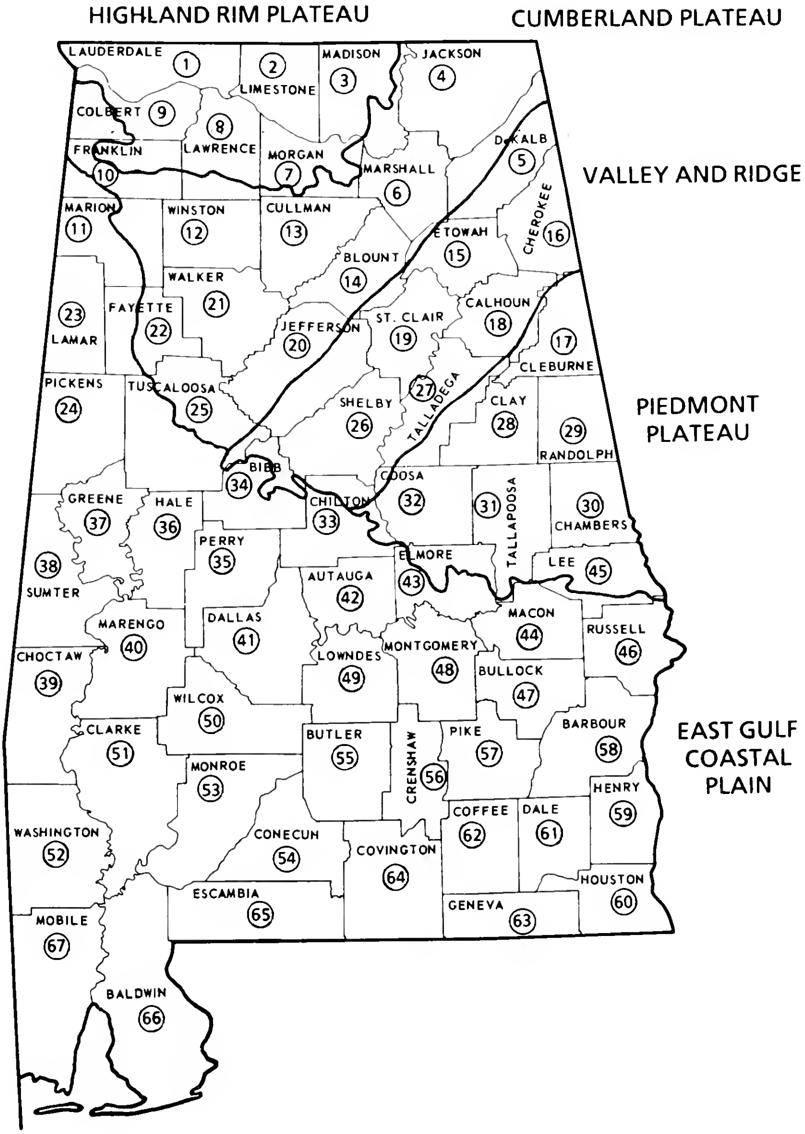

Figure 1. Counties and physiographic provinces of Alabama.

M. tryphena Betten. 1, 8, 12, 14, 17, 18, 25, 28, 36, 45, 51, 53, 64-67. Widespread in state, but never collected in large numbers. April-September. (56)

M. ulmerina Navas. 12-14, 17, 18, 20, 21, 24, 25, 28, 31, 39, 52-55, 58, 64, 66, 67. Most widely occurring and frequently collected *Molanna* in the state. April-September. (108)

SERICOSTOMATOIDEA

Helicopsychidae

Helicopsyche borealis (Hagen). 1, 8, 10, 12, 14, 17, 19, 20, 25, 27, 28, 32, 34, 39, 50, 51, 53, 54. Widespread and common in state, particularly above the fall line. April-October. (871)

Sericostomatidae

Agarodes alabamensis Harris. 51. Only known from the type locality, a small Coastal Plain stream. April. (2)

A. crassicornis (Walker). 12, 21, 22, 45, 52, 53, 58, 63, 65-67. Most common in small sand-bottom streams of the lower Coastal Plain. April-June. (211)

A. griseus Banks. 8, 10, 17, 31, 32, 45. Collected above the fall-line, most frequently in the Piedmont region. April-June. (73)

A. libalis Ross and Scott. 22, 24, 36, 65-67. Commonly collected in small Coastal Plain streams. April-August. (307)

A. stannardi (Ross). 10-12. Uncommonly collected in several small streams of northwestern Alabama. May, June. (10)

SUMMARY

This checklist, combined with those previously published (Harris, 1986a, 1988; Lago and Harris, 1987), brings the total number of caddisflies in Alabama to 323 species. This total is comparable to the 298 species reported from Tennessee (Etnier and Schuster, 1979) and the 330 species from North and South Carolina (Unzicker *et al.*, 1982). This species total is probably a reflection of the range of physiographic regions represented in the state (fig. 1) as well as the result of intensive collecting. Collections from neighboring Mississippi, for example, which lies almost entirely within the East Gulf Coastal Plain yielded only 139 caddisfly species (Holzental *et al.*, 1982).

The 323 species of caddisflies were distributed among 57 genera and 17 families. Hydroptilidae were best represented (97 species), followed by Leptoceridae (56 species), Hydropsychidae (47 species), and Polycentropodidae (32 species). These four families which accounted for 72% of the total fauna in Alabama are noted for their ability to exploit warm water habitats typical of Alabama (Wiggins, 1977).

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COLLECTIONS OF *DUFOUREA VERSATILIS* (HYMENOPTERA: HALICTIDAE) FROM IDAHO[1]

Sharon Luce Walsh[2]

ABSTRACT: *Dufourea versatilis* was collected outside California for the first time on *Mimulus nanus* (Scrophulariaceae) at two areas in central Idaho during the summers of 1987 and 1988.

Insect visitors of *Mimulus nanus* (Scrophulariaceae) were collected in the summers of the 1987 and 1988 at two locations in central Idaho: one at Craters of the Moon National Monument, Butte County and the other north of Ketchum, Blaine County. The vegetation in both areas consists of rabbit-brush (*Chrysothamnus nauseosus*), sagebrush (*Artemesia tridentata*), antelope bitter-brush (*Purshia tridentata*), and many annual and perennial herbs. The mean annual precipitation in each area is approximately 38 cm. Insect visitors were collected twice weekly starting in late May when the plants started blooming and continued until plants stopped blooming. In 1987 insects were collected through July, whereas in 1988, because of drought conditions, all *M. nanus* plants were finished blooming by the first of July.

One insect collected, *Dufourea versatilis* (Bridwell) (Halictidae), previously had been collected only in California (Hurd 1979). Both male and female bees were collected, but during 1987 only 1 male was collected at the Craters site whereas 1 male and 3 females were collected from the Ketchum site. In 1988 no *D. versatilis* were collected at the Craters site, but 19 of the 25 insect visitors collected at the Ketchum site were *D. versatilis*. Of these 19, 14 were females and 5 were males.

Dufourea versatilis is an oligolege of *Mimulus* species in California (Hurd 1979). In all sampling periods during this study, *D. versatilis* was observed foraging only on *M. nanus* at the two areas. It is likely that it has never been collected outside California because insect pollinators of most *Mimulus* species have not been collected elsewhere. I predict that *D. versatilis* will be found in any location that has populations of *M. nanus*, including eastern Oregon, eastern Washington, northern Nevada, western Montana, central and western Idaho, and western Wyoming around Yellowstone and Grand Teton National Parks.

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(Continued on inside of back cover)

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TWO IMMIGRANT SYNANTHROPIC FLOWER FLIES (DIPTERA: SYRPHIDAE) NEW TO NORTH AMERICA[1]

F. Christian Thompson[2], Frank D. Fee[3], Larry G. Berzark[4]

ABSTRACT: Two flower flies are recorded from North America for the first time: *Eristalinus (Eristalodes) taeniops* - Florida; and *Syritta flaviventris* - Texas and Mexico. Diagnostic characters are given for these species, along with biological data.

Two flower flies are recorded from North America for the first time: *Eristalinus (Eristalodes) taeniops* (Wiedemann) - Florida; and *Syritta flaviventris* Macquart - Texas and Mexico. Both are hemisynanthropes, close associates of human ecosystems, and common filth flies in the Old World. Diagnostic characters are given for these species, along with biological data.

Two synanthropic flower flies, one presently unknown in the New World and the other unknown from North America, were recently collected for the first time in the United States. *Syritta flaviventris* Macquart was collected in southern Texas and Mexico, and *Eristalinus taeniops* (Wiedemann) was collected in southern Florida. Both belong to predominantly Old World tropic groups and are properly hemisynanthropes (Povolny, 1971).

Key to the New World species of *Syritta*

1. Face silvery white pollinose; antenna extensively dark, from all black in most males to basoflagellomere more than 2/3r dark brown in females and some males; fore and midlegs entirely orange; wing without spurious vein (fig. 4) and with orange veins, almost completely bare, only sparsely microtrichose on apical margins; male hind femur with a large basoposterior ventral tubercle (fig. 5); male hind tibia expanded apically; male abdomen with orange areas on 2nd and 3rd segments much more extensive and only narrowly separated medially (female similar, figs. 6-7); male 4th sternum deeply excavated (depth much greater than breadth) and with strong yellow bristles .... *flaviventris* Macquart

— Face golden pollinose; antenna entirely or more than 2/3rd pale orange; fore and midlegs not brownish black posteriorly on femora and apically on tibiae and on tarsi; wing with spurious vein (fig. 3) and brownish black veins, more extensively microtrichose, microtrichose areas extending into apical cells; male hind femur without tubercle; male hind tibia slender; male abdomen with orange areas on 2nd and 3rd segments reduced and broadly separated medially (female similar, figs. 8-9); male 4th sternum shallowly excavated (breadth much greater than depth) and with only few fine hairs .... *pipiens* Linnaeus

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ENT. NEWS 101(2): 69-74, March & April, 1990

Syritta flaviventris Macquart

Syritta flaviventris Macquart, 1842: 135. Type locality: Senegal. Type depository: Male, MNHN, Paris.

Syritta spinigera Loew, 1848: 331. Type localities: Greek islands, Sicily & Turkey. Type depository: syntypes, males & females, ZMHU, Berlin.

Syritta flaviventris and *pipiens* are so similar that no description is given. The above key serves as a differential diagnosis for these species.

North American Records: MEXICO, NUEVO LEON, Apodaca, "E. L. Mezquital", 26 May 1984 (C. Alvarez Pereyra; IIBIII lot # 84-07029.) USA, TEXAS, Hidalgo County, Bentsen-Rio Grand Valley State Park, 21 October 1984 (F. D. Fee), 1 female, Relampago, 15-19 October 1986 (F. D. Fee), 6 males, 1 female. The material from Texas was collected in a locality about 48 miles east on the Mexican specimen (initial record). The specimens from Relampago were all collected in or along the banks of an abandoned drainage ditch or canal. The males were patrolling and visiting flowers of *Schinus, Serjania* and *Polygonum*. The female was taken on *Polygonum*. Voucher specimens deposited in the National Museum of Natural History, Smithsonian Institution, Washington; other specimens retained in Fee Collection.

Syritta flaviventris is readily distinguished from *pipiens*, the only other New World species of the genus, by the absence of a spurious vein (fig. 4) and the presence of a strong basoposterior ventral spur on the male hind femur (fig. 5); and from other Old World congeners by male genitalic characters (Thompson, 1972: 170, fig. 69).

Syritta is not indigenous to the New World but has been introduced with Man. The larvae of *Syritta* breed in almost any kind of waste, and *pipiens* has been frequently reported to breed in human feces (Farrar 1987: 361, Henning 1952: 189). *Flaviventris* was first recorded from the New World by Fluke (1960), who recorded the species from Brazil, Sao Paulo, collected in 1954. Marnef (1967) recorded it from Chile as *Austrosyritta cortesi* Marnef (synonymy by Thompson 1971), and Argentina was added to its New World distribution by Thompson, *et at.* (1976: 119). In the Old World, *S. flaviventris* ranges from the Mediterranean (Spain to Bulgaria and Turkey), south to South Africa (Cape of Good Hope), and is found on Saint Helena. Campos and Pena (1973: 225; Smith and Vockeroth (1980: 507)) recorded it from Easter Island. *Syritta pipiens* is found throughout northern North America and is recorded as far south as central Mexico (Durango and Chihuahua) (Thompson, *et al.* 1976: 119).

Key to the New World Species of *Eristalinus*

1. Eye with large brown fasciae in addition to smaller brown puncta (fig. 1) .... *taeniops* (Wiedemann)

— Eye with only small brown puncta (fig. 2) .... *aeneus* (Scopoli)

Eristalinus (Eristalodes) taeniops (Wiedemann)

Eristalis taeniops Wiedemann, 1818: 42. Type locality: South Africa, Cape of Good Hope. Type depository: Males & females, NM, Vienna.

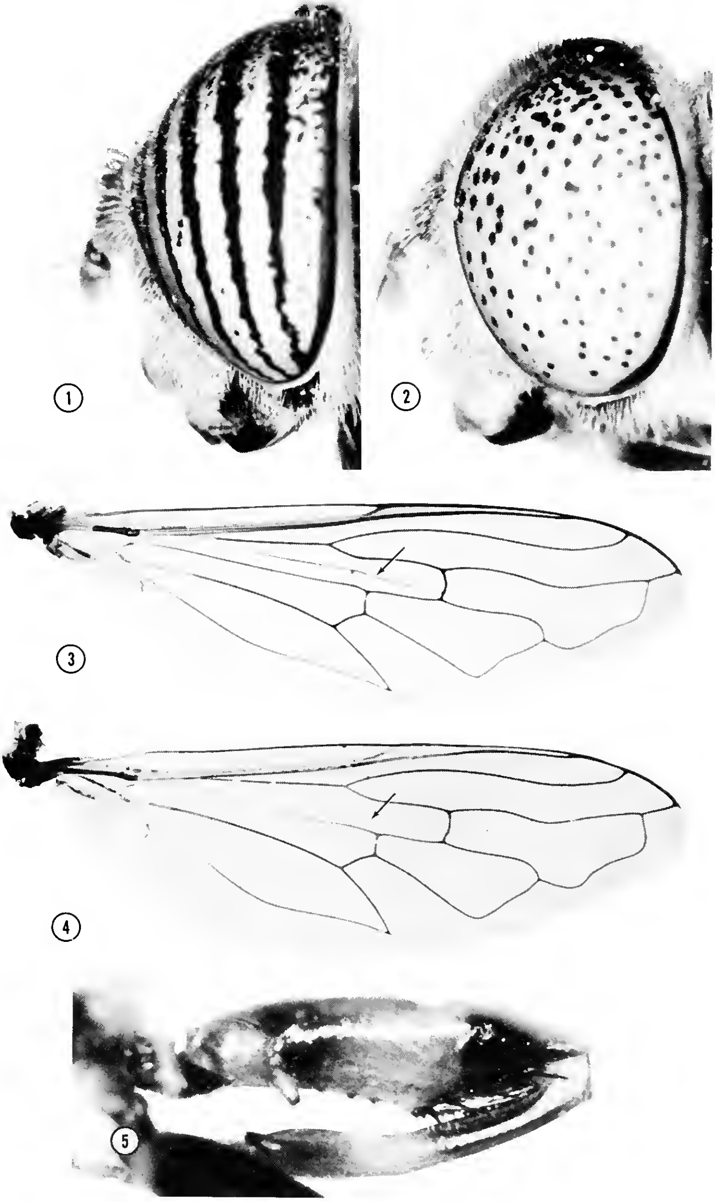
Head: black, extensively gray pollinose and white pilose; face with a medial and sublateral shiny vittae; frontal triangle and front partially black pilose; vertex shiny; antenna black, except basoflagellomere rarely orange basally and on ventral 1/4 or less, arista orange becoming brown apically; eye yellow with brown fasciae, light brown pilose.

Thorax: black, gray pollinose and white pilose; mesonotum indistinctly vittate; scutellum yellow, white pilose except with some black pile medially; plumula, squama and halter yellowish white. Wing hyaline, bare. Legs: femora reddish brown to black except orange on apex; tibiae orange basally, brownish black apically; front tibia orange on basal 2/3, mid tibia on basal 3/4, rarely entirely orange, hind tibia on basal 1/4 or less; tarsi orange on basal 2 tarsomeres, dark brownish on apical 3 tarsomeres; leg pilose yellowish white except for a few black hairs apicoventrally on hind femur and extensively black pilose on hind tibia.

Abdomen: first tergum orange on lateral quarter, black medially, gray pollinose, white pilose; 2nd tergum orange except narrowly brownish black on basal and apical margins, yellowish white pilose except black pilose on dark apical margin, slightly gray pollinose medially; 3rd tergum orange on basal 1/4 to 1/2, apically brownish black, dull, gray pollinose on medial 1/3 in males, basal 1/3 in females, yellow pilose except for a few apical black hairs; 4th tergum black, rarely orange basomedially, dull black pollinose, with grayish white sinuous fascia on basal 1/2 in male, grayish white pollinose on basal 1/3 in female, shiny on apical margin, white pilose; 5th tergum black, black pollinose, white pilose; venter white polose and sparsely white pollinose, basal sterna usually orange, except rarely brownish black medially, 4th sternum brownish black. Male genitalia black.

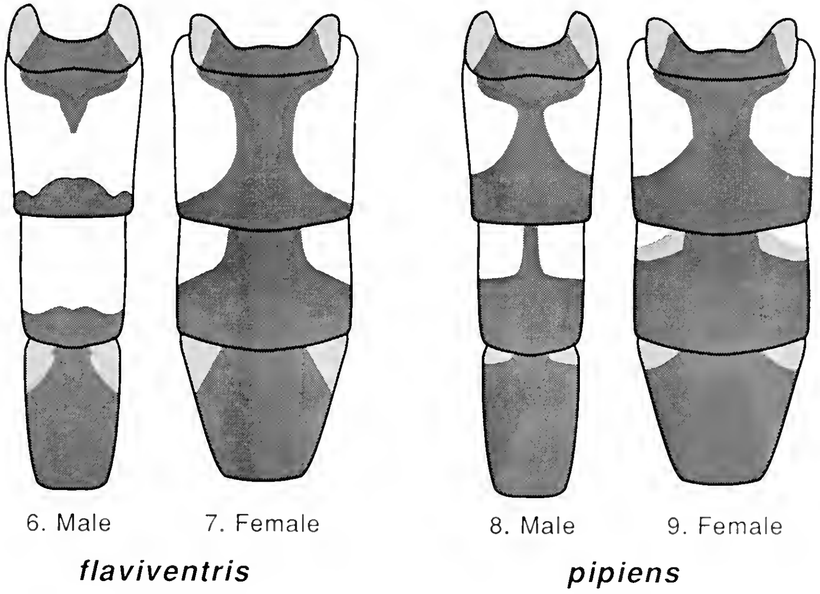
New World record: USA, FLORIDA, Dade County, Florida City, 7 December 1985 (L. G. Bezark) 1 male (USNM). The specimen was swept from *Bidens*, a common weedy composite, along a hedgerow of tamarisk trees (*Tamarix*) adjacent to a field of cultivated tomatoes.

Eristalinus taeniops is easily distinguished from all other New World eristalines (species with sinuate R 4+5 vein) by its fasciate eyes (fig. 1). The only other species of *Eristalinus* known from the New World, *aeneus* Scopoli, has punctate eyes (fig. 2), and all other New World eristalines have no maculation on the eyes. *Eristalinus taeniops* belongs to a small group of species of *Eristalinus* which have distinct fasciae on the eyes in addition to puncta.



Figs. 1-5. 1-2. Heads of *Eristalinus* species, lateral view. 1. *E. taeniops* (Wiedemann). 2. *E. aeneus* Scopoli. 3-4. Wings of *Syritta*, dorsal view. 3. S. *pipiens* Linnaeus. 4. *S. flaviventris* Macquart. 5. Hind leg of *Syritta flaviventris* Macquart, lateral view.

Eristalinus is not indigenous to the New World, but two species have now been introduced. *Eristalinus* larvae, commonly called rat-tailed maggots, have been recorded to breed in putrid waters associated with man, such as sewers, privies, etc (Ferrar 1987: 359-360, Hennig 1952: 184-185). *Eristalinus taeniops* has never previously been recorded from the New World. In the Old World, the species ranges from the Mediterranean (Spain to Greece and Bulgaria), east to Pakistan, and south to South Africa (Cape of Good Hope). *Eristalinus aeneus* Scopoli ranges from California to Ontario and New Hampshire, south to Texas and Georgia; and in the Old World *aeneus* ranges throughout the Palaearctic Region (Peck 1988: 182, Knutson *et alia* 1975:347) and has been introduced into Tanzania in Africa (Smith and Vockeroth 1980: 501) and Wake Island, the Hawaiian and Gilbert Islands in the Pacific Ocean.



Figs. 6-9. Abdominal patterns of *Syritta* species, dorsal view. 6. *S. flaviventris*, male. 7. *S. flaviventris*, female. 8. *S. pipiens*, male. 9. *S. pipiens*, female.

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REDESCRIPTION OF MALES, BIOLOGICAL NOTES, AND IDENTIFICATION OF AMERICAN *ACANTHOCHALCIS* (HYMENOPTERA: CHALCIDIDAE)[1]

Jeffrey A. Halstead[2]

ABSTRACT: Males of *Acanthochalcis nigricans* and *A. unispinosa* are redescribed, voucher specimens designated, diagnostic characters illustrated, and a key to the American species presented. Characters to distinguish *Acanthochalcis* from other Nearctic Chalcididae are presented. The taxonomic and biological information on *Acanthochalcis* is summarized and new hosts, rearings, and floral visitations are recorded. A third species, *A. gigas*, is known from Madagascar.

Acanthochalcis are the largest chalcidids in the Nearctic region with males ranging in length from 6 to 11 mm and females from 7 to 24 mm. These wasps are black with reddish brown to brown legs and smokey or yellowish wings. Females are unique among Nearctic Chalcididae in having a spear-like ovipositor which projects posteriorly a distance equal to or greater than the length of the abdomen. *Acanthochalcis* are uncommonly collected, though have been taken by sweeping flowering vegetation and netting individuals around host inhabiting trees and shrubs.

To improve the taxonomic information on American *Acanthochalcis*, the males of *A. nigricans* Cameron and *A. unispinosa* Girault are redescribed, the species distinguished in a key, the taxonomic history reviewed, and characters presented to distinguish this genus from other Nearctic Chalcididae. This information improves the brief original male descriptions and is needed to identify *Acanthochalcis* and its American species. Male voucher specimens are deposited with their female holotype for use in future studies. The redescriptions will also be useful to delineate the presently unknown male of *A. gigas* Steffan (from Madagascar), and help establish the relationship between American and Madagascaran *Acanthochalcis*.

Both American *Acanthochalcis* are parasitoids of buprestid beetle larvae which inhabit oak trees (*Quercus* spp.) (Halstead and Haines 1985); however, new information indicates buprestid hosts in saltbush (*Atriplex* sp.), ocotillo (*Fouguieria splendens*), and *Baccharis* sp. Overall, the biological information on *Acanthochalcis* is very limited. This information is summarized and new host, rearing, and floral visitation records

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are presented to encourage and aid future research.

Steffan (1959) recognized in *Acanthochalcis* two American species *A. nigricans* (Cameron 1884) and *A. unispinosa* (Girault 1917, 1921; in Gordh, *et al.* 1979) and *A. gigas* (Steffan 1950) from Madagascar. Drawings of the apex of both the abdomen and scutellum for *nigricans* were presented. Characters for the previously unknown males of *A. nigricans* and *A. unispinosa* were presented in a key. The male of *A. gigas* is unknown. Steffan also proposed subgenera, placing *nigricans* in *Acanthochalcis*, *unispinosa* in *Belochalcis*, and *gigas* in *Trypanochalcis*, but the designation of subgenera for each species seems unwarranted on the basis of the few species and at least for *nigricans* and *unispinosa* on morphological grounds.

Acanthochalcis, the only member of the tribe Cratocentrini in the Nearctic region, may be distinguished from other Nearctic Chalcididae by the following characters: head without horns on dorsal area of frons, antennae inserted in center of frons, abdomen sessile, hindtibiae with one apical spur and the apex obliquely sinuate (Brachymerinae); postmarginal vein much longer than marginal vein, scrobe cavity almost touching vertex of clypeus, mesopleuron deeply excavated by a acetabulum which receives the mesotibia and mesofemur in response, (♀) with 4 visible tergites, (♂) with 7 visible tergites (Cratocentrini); propodeum produced laterally into a flattened triangular mass (dorsal view).

Key to American species of *Acanthochalcis* Cameron

1. Propodeum dorsally with a median tooth (Fig. 9), in lateral view with posterior margin truncate; hindfemur narrowly ovoid (Fig. 4); (♀) epipygidium with ventral margin straight; (♂) abdomen dorsoventrally flattened (Figs. 2, 6) .... *unispinosa* Girault

1.′ Propodeum dorsally without a tooth, in lateral view projecting posteriorly as a triangular tooth which overhangs base of hindcoxae (Fig. 8); hindfemur broadly ovoid (Fig. 3); (♀) epipygidium with ventral margin toothed (Fig. 7); (♂) abdomen oval (Figs. 1, 5) .... *nigricans* Cameron

Acanthochalcis nigricans Cameron, Male Redescription

Figures 1, 3, 5, 7, 8

Type-species ♀ (Cameron 1884). ♂ description (Steffan 1959).

Length: 11mm. Black with labrum clypeus, coxae, trochanters, femora (hindfemora apically and basally), tibiae, tarsi, tergites 1-5 posteriorly and ventrally, sternites 1-6 posteriorly, epipygidium, hypopygidium, and hindwing vention reddish brown. Pubescence white, dense patches on axillae posteriorly, propodeum laterally, hindcoxae dorsally, and submedian length of tergite 6.

Pronotum with anterior, dorsolateral margin rounded, posterior margin emarginate; propodeum laterally produced as a flat triangular posterior projection, in lateral view posterior margin produced as a tooth, with a strong transverse basal carina and two longitudinal submedian carina, rectangular area between these carinae polished; hindfemur broadly ovoid, 11 teeth along ventral margin, a sharp tooth on inside at base, outer and inner surface polished, setal depressions separated by a distance equal to their own diameter, inner surface with sparse setal depressions; hindcoxa length 3X its greatest width, inner surface with sparse setal depressions; forewing infuscate, apical margin with a darkened band; hindwing hyaline, slightly infuscate apically; stigma with a prominant uncus; postmarginal vein 2.5X length of marginal vein.

Abdomen sessile, ovate, dorsal margin convex in lateral view; tergite 2 (T2) with 3-4 punctures at median length; tergites laterally perpendicular to body axis, with dense setigerous punctures except for coriaceous band along posterior and ventral margins of T1-5; epipygidum triangular, matte, basal 1/6 punctate, with a flat median and carinate sublateral ridge; sternites convex, sternites 1-5 (S1-5) punctate medially, S6 punctate throughout.

Types. — Holotype female collected from Sonora, Mexico; type in the British Museum of Natural History (BMNH). I designate a male voucher specimen with a red label: "Voucher Specimen, Male redescription, *Acanthochalcis nigricans* Cameron, det. J.A. Halstead 1987" with data: "Arizona, Pima Co., Madera Canyon, VIII-24-1977, *Prosopis juliflora*, R.W. Brooks." Voucher male deposited in BMNH.

Variation. — Males 8-11 mm, usually about 10 mm. Females 7-24 mm, usually about 20 mm. Halstead (1987) noted three rubinistic colored (i.e., typically black areas are reddish brown) males from El Salvador. A male from 23 mi S. Matias Romero, Oaxaca, Mexico, IV-22-1962, F.D. Parker (University of California Davis collection) is also this color.

Host/rearings. — A probable host *Chrysobothris femorata* (Olivier) (Coleoptera: Buprestidae) was discussed by Halstead and Haines (1985) and additional probable hosts *Dicerca horni* Crotch or *Polycesta california* (LeConte) (both Coleoptera: Buprestidae) in interior live oak (*Quercus Wislizenii*) suggested. Label data on specimens denotes the following host associations or rearings. Three females (Palm Springs, San Bernardino Co., California) were reared from *Chrysobothris* sp. in the roots of saltbush (*Atriplex* sp.). A female (6 mi E. of Apache Junction on Hwy. 88, Maricopa Co., Arizona) was reared from *Baccharis* sp. A female (Tucsun, Pima Co., Arizona) was associated with *Chrysobothris edwardsi* Horn (Buprestidae) in a dead ocotillo (*Fouquieria splendens*).

Floral visitations/possible host substrates. — *Atriplex, Baccharis glutinosa, B. neglecta, Bebbia juncea, Encelia* sp., *Encelia farinosa, Flourensia cernua* associated with *Tachardella cornuta* (Homoptera: Lacciferridae), *Helianthus annuus, Koeberlinia, Larrea, Lupinus inflatus, Placelia distans, Prosopis chilensis, P. juliflora, Sphaeralcea,* and *Stanleya pinnata*.

Distribution. — California east to Kansas, south through Mexico to Costa Rica (Halstead 1987).

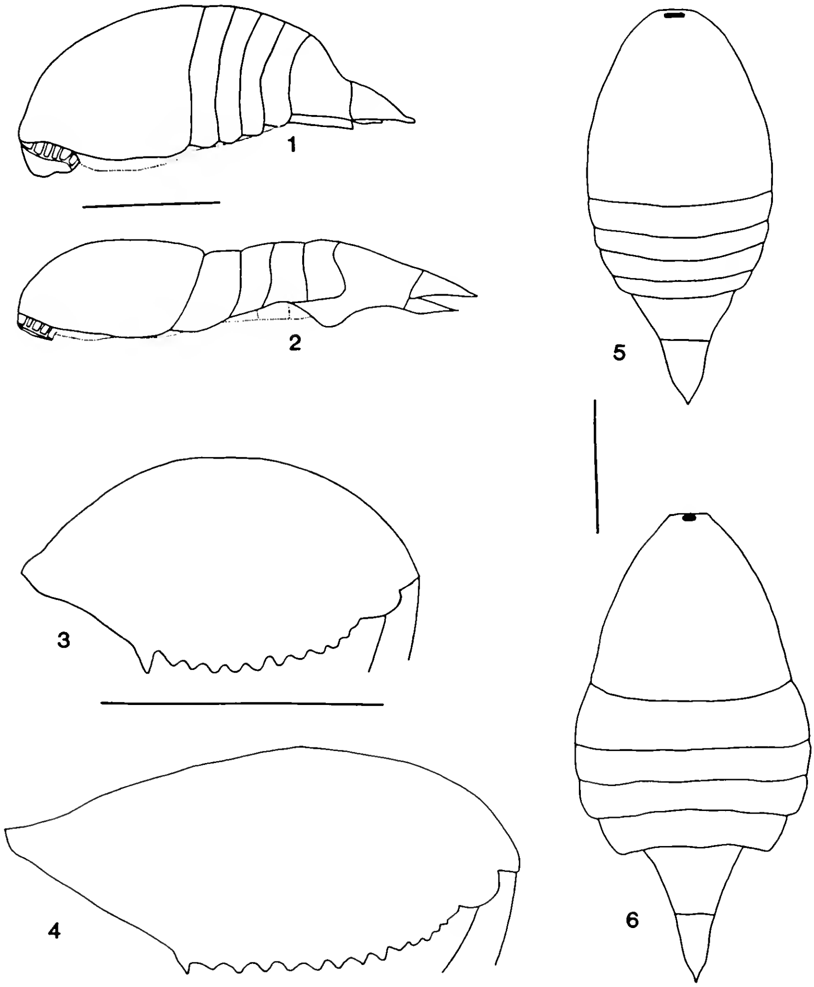
Acanthochalcis unispinosa Girault, Male Redescription

Figures 2, 4, 6, 9

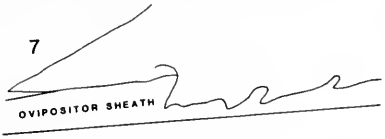
Original description ♀ (Girault 1917, 1921). ♂ description (Steffan 1959).

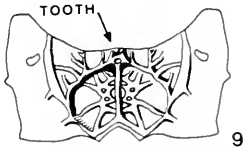
Length 11 mm. Black with tegulae, tibiae, tarsi, and posterior and ventral margins of T1-5 brown.

Pronotum with anterior, dorsolateral margin squared, posterior margin deeply emarginate; propodeum laterally produced as a flat triangular posterior projection, though not as acute posteriorly as in *nigricans*; in lateral view posterior margin squared, with a transverse medially arching carina and a strong median carina which meet to form a raised acute toothlike process, area between these carina with a reticulation of carinae; hindfemur narrowly ovoid, ventral margin with 12 teeth, without a tooth on inside at base, outer and inner surface with dense setal depressions and densely setose; hindcoxa length 5X its



Figs. 1-6. *Acanthochalcis* spp. (males). *A. nigricans*: 1, Abdomen, lateral view; 3, Hindfemur, lateral view; 5, Abdomen, dorsal view. *A. unispinosa*: 2, Abdomen, lateral view; 4 Hindfemur, lateral view; 6, Abdomen, dorsal view. Scale lines 2.0 mm.





Figs. 7-8. *Acanthochalcis nigricans*: 7, epipygidium of female, lateral view; 8, propodeum and metapleuron, lateral view. Fig. 9. *Acanthochalcis unispinosa*, propodeum, only carinae in medical area drawn, dorsal view.

greatest width, inner surface with dense setal depressions and apical 1/3 with prominant transverse striae; forewing infuscate, with a yellow tint; hindwing infuscate, darker from under marginal vein to apex; stigma with a prominant uncus; postmarginal vein 2X length of marginal vein.

Abdomen sessile, dorsoventrally compressed, dorsal margin flat in lateral view; T2 with 6-7 punctures at median length; tergites (especially T2-5) flaring outward from body axis, with dense setigerous punctures except for a smooth band along posterior and ventral margins of T1-6; epipygidium triangular, coriaceous, basal 1/4 punctate, with a median and submedian carina; sternites convex, punctures on S2-5 originating from anterior margin and forming a half circle shaped area; S1 and S6 punctate medially.

Types. — Holotype female collected from Belfrage, Texas; type in the United States Museum of Natural History (USNM). I designate a male voucher specimen with red label: "Voucher Specimen, Male Redescription, *Acanthochalcis unispinosa* Girault, det. J.A. Halstead 1987" with data: "CA. Tulare Co., Ash Mtn. Kaweah Powerhouse #3, VI-19-1982, coll. R.D. Haines." Voucher male deposited in USNM.

Variation. — Males 6-11 mm, usually about 10 mm. Females 17-24 mm, usually about 21 mm.

Host/rearings. — A probable host *Polycesta california* (Coleoptera: Buprestidae) in Valley Oak (*Quercus lobata*) was suggested by Halstead and Haines (1985). Label data on specimens denotes a rearing and a possible host substrate. A female (Pinon Flats, San Diego Co. California) was reared from scrub oak (*Quercus dumosa*). A female (near Eskimizin, Pima Co., Arizona) was flying about dead limbs of palo verde (*Cercidium* sp.).

Distribution. — California, Arizona, Texas.

ACKNOWLEDGMENTS

I thank D.J. Burdick (California State University, Fresno), R.D. Haines (Tulare County Agricultural Commissioner's Office, Visalia, California), N.J. Smith (Fresno County Department of Agriculture, Fresno, California), S.R. Shaw (Harvard University, Cambridge, Massachusetts), and an anonymous reviewer for editorial comments on earlier drafts of this paper. I thank E.E. Grissell (Systematic Entomology Laboratory, ARS-USDA) for the opportunity to examine types and Z. Boucek (CAB Institute of Entomology, London, England) for comparing specimens of *A. unispinosa*. I lastly thank the Kings River Conservation District, Fresno, California for the use of word processing equipment.

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INSECT FIELD DAY

The fourth annual Insect Field Day sponsored by the American Entomological Society and the Young Entomologists' Society will be held Saturday June 23, 1990 from 9 to 5 at the Fair Hill Nature Center in Fair Hill, Maryland. Entomologists, young and old, amateur or professional and their friends are invited to join in a day of collecting, identifying, sharing, and socializing. For registration forms, directions, program, and other information write to: Insect Field Day, American Entomological Society, Academy of Natural Sciences, 19th & Race Sts., Philadelphia, PA 19103.

LEPIDOSTOMA (NOSOPUS) OZARKENSE (TRICHOPTERA: LEPIDOSTOMATIDAE), A NEW SPECIES FROM ARKANSAS[1]

Oliver S. Flint, Jr.[2], Phoebe A. Harp[3]

ABSTRACT: *Lepidostoma (Nosopus) ozarkense*, a new species from northern Arkansas and eastern Oklahoma belonging to the *Modestum* Group, is described. The distinctive male and female genitalia are described and figured. The spring emerging adults were taken near small streams which may dry up in summer. Details of the physicochemical and biological characteristics of the topotypical stream are given.

While surveying benthic organisms of intermittent streams, Harp collected examples, both adult and larvae, of a number of Trichoptera that were sent to Flint for identification. In these collections a species of *Lepidostoma* that appeared to be undescribed was discovered. Consequently, correspondence with D.E. Bowles at the University of Arkansas revealed that he had additional examples of this species from other localities in Arkansas and Oklahoma. The recently published revision of the New World species of *Lepidostoma* (Weaver 1988) confirms that this species is heretofore unknown.

Lepidostoma (Nosopus) ozarkense Flint & Harp, new species

Adult: Length of forewing, male 6—7mm, female 7—7.5mm. color in alcohol uniformly dark brown. Venation in both sexes typical of group (Weaver 1988, Figs. 46a, 46b). Male with scape about 3 times as long as broad; maxillary palpus apparently one-segmented, filled mesally with long spatulate hairs (essentially as in Weaver 1988, Fig. 32). Male genitalia (Figs. 1-4): Ninth segment annular, widened ventrally, with a ventrolateral brace. Tenth tergum elongate, blunt apically, with scattered setae arising from protuberant bases; with a narrow, dorsomesal incision about a third length of segment, with a darkened, internal sclerotization around base of incision; with a basoventral process as long as dorsal lobe and tapering to an apical point in both dorsal and lateral aspects. Clasper with basodorsal process rather straight,apex truncate in dorsal and obliquely truncate in ventral aspect, lying on segment one; segment one slightly inflated basally, hirsute ventrolaterally, membranous mesoventrally, curved and bluntly pointed mesad; segment two a small subapical lobe directed mesad. Phallus lacking sclerotized parameres, but with a bilobed, apicodorsal, membranous appendage; apex slightly decurved, with a darkened internal phallotremal sclerite, beyond which it is membranous. Female genitalia (Figs. 5-6): Eighth sternum with lateral fourths strongly sclerotized, almost square in shape, concave, connected mesally by a lightly sclerotized band along anterior margin. Ninth tergum with a long anterolateral apodeme, ventral margin strongly concave; dorsally with a distinct projection subapically. Membrane ventrolaterally between eighth and ninth segments bearing convoluted sclerotized and semisclerotized bands. Vaginal sclerite in ventral aspect with

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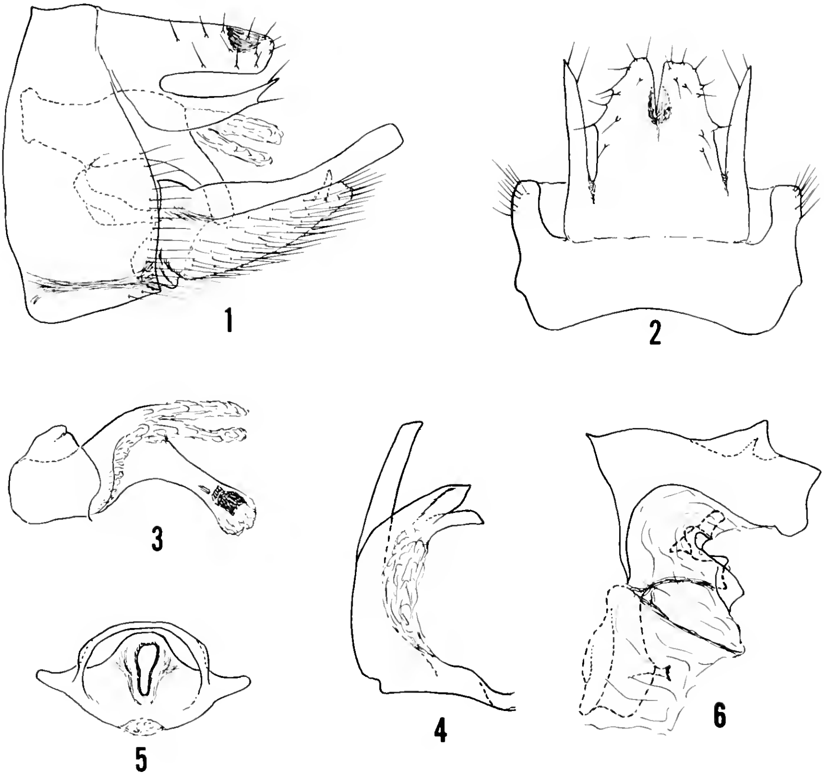
an arcuate posterior bridge, with lateral angles projecting, centrally with a keyhole-like opening.

Material: Holotype, male: U.S.A., Arkansas, Independence Co., unnamed stream (T11N, R6W, Sec. 2 SW1/4), 5.6km N Pleasant Plains on US Hwy 167, 18 April 1987, Phoebe A. Harp. NMNH Type. Paratypes: Same data, 2 males, 7 females; same, but 21 Mar 1987, 1 male. Johnson Co., spring-run, 7mi W Oark on Hwy 215, 16 Apr 1987, D.E. Bowles, UV light, 1 male; Sulphur Creek, 89mi N Hagarville on Hwy 123, 29 Mar 1986, C.D. Rowbotham, lab reared, 1 male. Logan Co., Mt. Magazine, Gutter Rock Creek, 6 May 1988, Bowles & Mathis, UV light, 1 male, 2 females; same, but 14 May 1988, D.E. Bowles, UV light, 1 male; same, but Dripping Springs, Gutter Rock Creek, 20 Apr 1987, sweeping, 19 males, 14 females. Pope Co., Petite Jean State Park, SW slope, stuck to fire pink near ephemeral stream, 16 Apr 1988, R. Leschen, 1 male. Oklahoma, Latimer Co., Robbers Cave State Park, Rough Canyon spring run, 2 Apr 1988, D.E. Bowles, 12 males, 2 females. Paratypes deposited in collections at Arkansas State University (Department of Biological Sciences), University of Arkansas (Department of Entomology), and National Museum of Natural History.



Figs. 1-6. *Lepidostoma (Nosopus) ozarkense* n.sp. 1, male genitalia, lateral. 2, male ninth and tenth terga, dorsal. 3, male phallus, lateral. 4, male clasper, ventral. 5, female vaginal sclerite, ventral. 6, female genitalia, lateral.

This species is a member of the *Modestum* Group (Weaver 1988:35) and is closely related to *L. ontario* Ross. These are the only two species in which the males possess a basoventral process from the tenth tergum and the only apparently significant and consistent difference between them lies in the length and shape of this process. In *ozarkense* the process is only as long as the tenth tergum and is pointed in both lateral and dorsal aspects. However, in *ontario* this process is almost 1.5 times as long as the tenth tergum, and, although it may appear pointed or furcate in lateral aspect depending on the angle, in dorsal aspect it is flattened, curved, widened and shallowly furcate apicad (Ross 1941, Fig. 98; Weaver 1988, Fig. 72). The females are quite similar in all species of the group, and specific differences are less certain. However, the lightly sclerotized, convoluted bands ventrad of the ninth tergum and the projecting lateral angle of the vaginal sclerite in *ozarkense* appear to be diagnostic.

DISCUSSION

This species brings to seven the number of species described in the *Modestum* Group, all of which are limited to eastern North America. Four of the species, *lydia* Ross, *modestum* (Banks), *ontario* Ross, and *pictile* (Banks), have rather similar distributions, running in general from Newfoundland or Quebec south along the Appalachian Mountains into the western Carolinas or northwestern Georgia (cf. Fig. 7, the distribution of *ontario*). Three species appear to have very restricted ranges: *compressum* Etnier & Way in Cumberland Co., Tennessee, *weaveri* Harris in Tuscaloosa Co., Alabama, and *ozarkense* n.sp. in Independence, Johnson, Logan, and Pope Cos., Arkansas and Latimer Co., Oklahoma. All of these species occupy areas outside the broad range of *ontario*. This pattern is suggestive of either relictual distributions resulting from expanding and contracting ranges related to earlier advances and retreats of ice sheets, or random dispersal events from the main range of the species group.

ECOLOGICAL - BIOLOGICAL DATA

The topotypical stream, an intermittently flowing second-order tributary of Salado Creek, is located in the Boston Mountains of the Ozark Plateau. The sampling site (Fig. 8) was a 100m stretch of the stream which parallels highway US 167, approximately 0.8km south of the

Salado Creek bridge (Harp 1988). The stream margins are heavily forested, primarily with loblolly pine (*Pinus taeda* L.), shortleaf pine (*Pinus echinata* Mill.), eastern redcedar (*Juniperus virginiana* L.), southern red oak (*Quercus falcata* Michx.), and white oak (*Quercus alba* L.).

Selected physicochemical parameters were measured from 27 Dec 1986 through 18 Jul 1987 (Table 1). This unnamed intermittent stream is a slightly acidic, soft-water stream. Alkalinity ranged between 19—88ppm with the highest values recorded during low flow. The pH ranged from 6.6—7.0, averaging 6.7. The low alkalinity and pH values reflect the soil type, Enders stony fine sand loam (Ferguson *et al.* 1982).

Flow volume measured 120—300,000cc/sec. Temperature ranges included: water 5.0—27.5°C, and air, -1.5—28°C. The first adult *Lepidostoma ozarkense*, a male, was taken on 21 March. Flow peaked on this date; water temperature was 15°C, and air temperature 24°C. The remaining specimens were collected on 18 April. On this date the flow measured

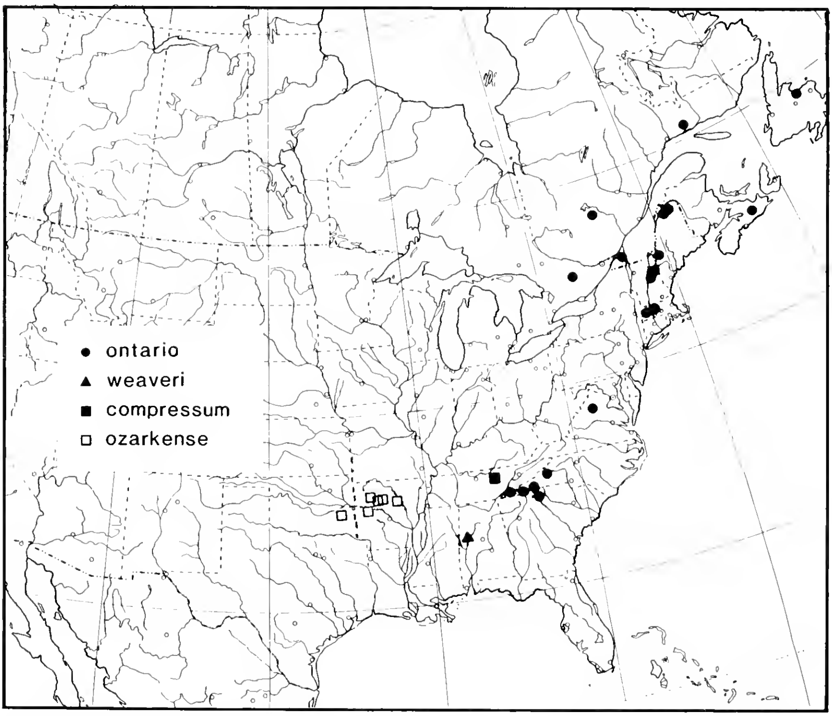


Fig. 7. Recorded distributions of *Lepidostoma (Nosopus) ontario* Ross, *L. weaveri* Harris, *L. compressum*, Etnier & Way, and *ozarkense* n.sp.

Fig. 8. Topotypic habit of *Lepidostoma (Nosopus) ozarkense* n.sp.

19,000cc/sec; water temperature was 14.5°C, and the air was 25°C. Thus this trichopteran was present during high flow and when water temperature was above 14°C.

Aquatic samples, totalling fifteen, were taken twice monthly, each the result of a two hour collecting period. A Turtox Indestructable Dip Net was the primary collecting instrument, but smaller samples were taken from a Tyler Standard Screen (mesh size 0.295mm) after disturbing the bottom. Adults, which were taken incidentially, were not included in the sample statistics. The aquatic stages of a minimum of 54 taxa were collected in the samples. Of these taxa, 46 were insectan: 12 beetles, 10 stoneflies, 8 caddisflies, 6 flies, 5 mayflies, 4 water bugs, and 1 fishfly. The eleven most common insects (numbers 10 and 11 had identical counts), in order of abundance, were: *Amphinemura delosa* (Ricker), *Prosimulium* spp., *Pseudocloeon* spp., *Ameletus* spp., *Isoperla* spp., *Agapetus illini* Ross, *Neophylax concinnus* McLachlan, *Clioperla* sp., *Tipula* spp., *Stenonema femoratum* (Say), and *Perlesta* spp. A paper presenting the full results of the survey is being prepared by the junior author.

Table 1. Selected physicochemical parameters in an unnamed intermittent stream, Independence County, Arkansas, 27 December 1986 - 18 July 1987.

Date	Dec 27	Jan 11	Jan 24	Feb 7	Feb 21	Mar 7	Mar 21	Apr 4	Apr 18	May 2	May 16	May 30	Jun 20	Jul 4	Jul 18
Air Temp., C	9.0	4.9	-1.5	15.0	9.0	17.5	24.0	9.5	25.0	23.5	26.5	21.0	28.0	26.0	27.5
Water Temp., C	7.5	6.5	5.0	7.5	7.5	10.0	15.0	9.0	14.5	16.5	18.0	19.0	19.0	*	22.0
Mean depth, cm	10	12	8	16	17	11	16	11	4	3	1	3	8	4	4
Mean width, m	2.7	3.0	2.5	2.6	3.7	3.5	3.4	3.1	2.8	0.6	0.2	0.6	1.1	0.7	0.4
Current flow, cm/sec	38	75	54	34	54	67	100	60	27	*	12	25	25	12	6
Current factors	0.7	0.7	0.7	0.7	0.5	0.7	0.7	0.5	0.7	0.5	0.5	0.7	0.5	0.25	0.6
Volume flow, 1000 cc/sec	59	156	64	80	137	144	300	79	19	*	0.12	2	9	7	0.5
Alkalinity, ppm	26	19	23	27	29	23	27	21	28	34	52	55	*	88	72
pH	6.7	6.7	6.6	6.8	6.7	6.7	6.9	6.7	6.7	7.0	6.7	6.9	6.7	6.5	6.7

* Not available for this date.

Although 37 *Lepidostoma* larvae (fifteenth in order of abundance) were collected at the topotypical site, they were not reared, and we feel it wisest not to risk an erroneous aasociation at this time. Both Bowles and Harp are planning work on the immature stages of this species.

ACKNOWLEDGMENTS

We wish to extend thanks to George L. Harp for assisting in the field and lab, for identifying the beetles and confirming many other identifications, to Barry K. Poulton for suggesting the study site, to Bill P. Stark, Richard W. Baumann and Barry K. Poulton for identifying the stoneflies, to Rhonda K. Boyer for identifying the *Prosimulium*, to Peggy A. McDaniel, Betty G. Cochran, Geoffrey R. Harp, Mitchell K. Marks, D. Cecilia Reiman, and Tim W. Steward for providing additional valuable field assistance, and to D.E. Bowles, W.N. Mathis, P.J. Spangler and two anonymous individuals for reviewing this manuscript.

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A NEW SPECIES OF *NEOTRICHIA* (TRICHOPTERA: HYDROPTILIDAE) FROM COLORADO WITH ADDITIONS AND CORRECTIONS TO THE DISTRIBUTION AND RECORDS OF COLORADO TRICHOPTERA[1]

D.E. Ruiter[2]

ABSTRACT: *Neotrichia downsi*, new species, is described from Jackson County, Colorado. Illustrations of the male and female genitalia are provided. Additions and corrections to the list of Colorado Trichoptera are also included. Fifteen species are added to the Colorado list, bringing the total number of species reported from Colorado to 188.

As part of continuing studies on the taxonomy and distribution of Rocky Mountain Trichoptera, a new hydroptilid caddisfly was discovered in material collected by Dr. Wilbur G. Downs from the North Platte River. Notes on new distributional records of other Colorado Trichoptera and corrections to the list by Herrmann *et al.* (1986) are also provided.

Neotrichia downsi, new species

Figure 1

Male: Body and appendages typical for subgenus, light brown, total body length 2 mm. Bracteole of IX segment constricted throughout basal third. In dorsal view, membranous X tergite evenly tapered, a pair of stout setae located laterally, approximately one-third from apex. Inferior appendages heavily sclerotized; ventrally triangular, with a minute, mesal tubercle near midpoint; rapidly tapered in lateral view, apex slightly upturned, bearing several minute tubercles. Subgenital plate heavily sclerotized, massive; in lateral view hooked slightly ventrad apically, extending 0.75 length of inferior appendage. Phallus with long, wide basal portion, tapering evenly to constriction at spiral process, apical portion slightly expanded at base with apex incised; spiral process encircles phallus approximately 1.5 times.

Female: Body and appendages typical for subgenus, light brown, no apparent sexual dimorphism, total body length 2 mm. Sclerotized portion of VIII sternite resembling an inverted champagne glass. Bursa with apex long and slender. Scale-like setae at distal margin of VII sternite smoothly rounded at apex.

Etymology: Named for the collector, Wilbur G. Downs, in recognition of his extensive collection of insects from the type locality.

Holotype male: Colorado, Jackson County, Ginger Quill Ranch at the North Platte River, altitude 2,370 meters (7,700 feet) above mean sea level, 7 July 1986, W.G. Downs, black light trap collection. Deposited in the Illinois Natural History Survey collection.

Paratypes: Same as above, except 4 July 1987, 1 male, 1 female. The female is in poor condition, only the abdomen is relatively intact. Deposited in the United States National Museum collection.

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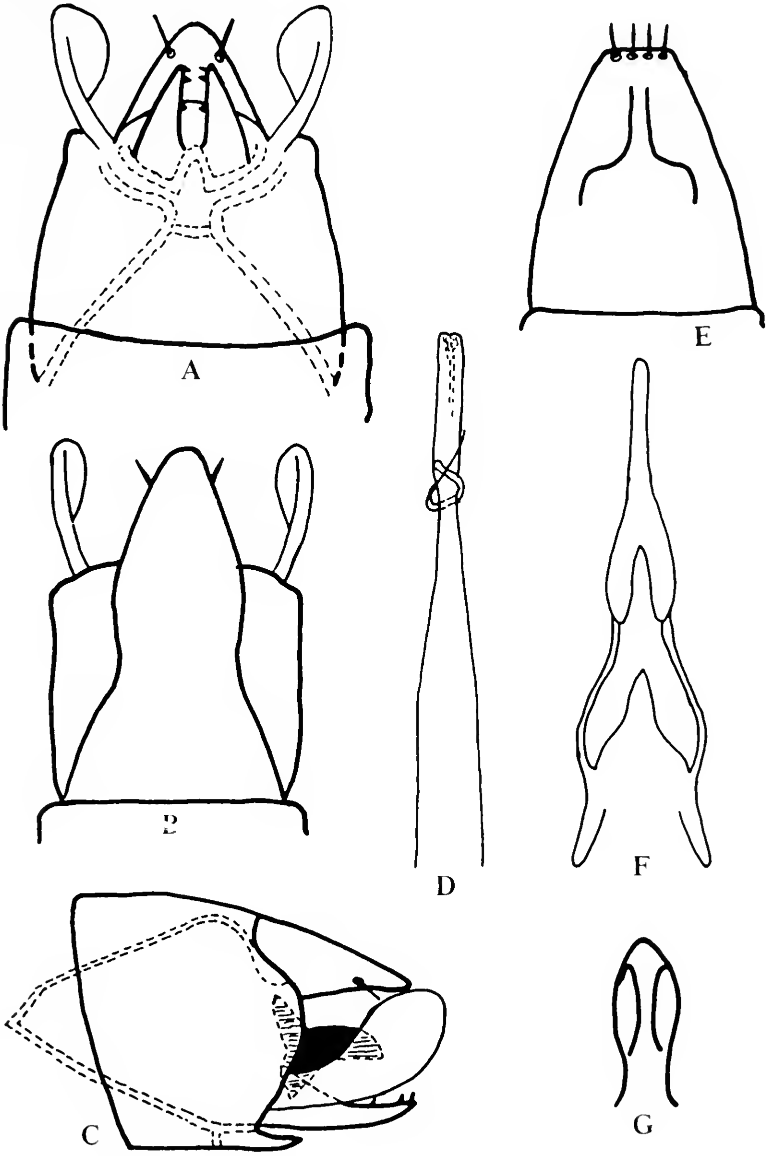

Fig. 1. ***Neotrichia downsi***. A. male, apex of abdomen, ventral; B. male, apex of abdomen, dorsal; C. male, apex of abdomen, lateral; D. male, phallus, ventral; E. female, VIII sternite; F. female, bursa, ventral; G. female, scale setae of VII sternite.

This species belongs to the *collata* species group, closely related to *N. okopa* Ross, *N. sonora* Ross and *N. osmena* Ross. This species appears most similar to *N. okopa* Ross from which it can be readily separated by the dorso-ventrally flattened inferior appendages, constricted basal third of the spatulate lateral appendages, and the evenly tapered X tergite. The new species can be distinguished from *N. sonora* by the absence of the long membranous IX tergite, and lack of long, sclerotized lateral projections on the tenth tergite. *Downsi* differs from *osmena* by the shape of the inferior appendages and lack of the sclerotized, forceps-like structure of the X tergite. However, the phallus of *N. downsi* is indistinguishable from that of *N. osmena*. The female association is inferred from the synchronous collection with the male and the distinct difference from *N. halia* Denning, the only other *Neotrichia* species collected at the type locality during nearly ten years of collecting.

Corrections and New Distributional Records

Lepidostoma grisea (Banks) originally included by Herrmann *et al.* (1986) is removed from the Colorado distribution list. This record was questioned by John Weaver (personal communication) and after a diligent search, this specimen could not be located. Weaver (1988), also synonymized several species of *Lepidostoma* occurring in Colorado (*L. moneka* Denning 1968 = L. *ormea* Ross 1946; *L. mira* Denning 1954 = *L. cascadense* (Milne) 1936; *L. strophis* Ross 1938 = *L. cinereum* Banks 1899; *L. veleda* Denning 1948 = *L. pluviale* (Milne) 1936).

Since publication of the Colorado list (Herrmann *et al.*, 1986) several new records have been published and additional species collected through the efforts of W.G. Downs, B.C. Kondratieff and this author. The county, known Colorado emergence period, and notes where appropriate are listed below.

Culoptila cantha Ross, Jackson County, 2 August.
Cheumatopsyche speciosa (Banks), Moffatt County, 11 July. This appears to be the first record of this species west of the continental divide. Previously reported from locations in the east with the most western records being from Montana and Oklahoma (Gordon, 1974; Nimmo, 1987).
Hydropsyche alhedra Ross, Grand and Jackson Counties, 23 July - 20 August.
Hydropsyche bidens Ross, Weld County, 3 August. Previously reported from the eastern portion of the Great Plains (Hamilton and Schuster,

1979; Nimmo, 1987). Its collection in eastern Colorado indicates it has successfully crossed the prairie to the upper Platte River basin.

Hydropsyche slossonae Banks, Grand County, (Schefter and Wiggins, 1986). Jackson County. 15 July - 16 August.

Hydroptila angusta Ross, Moffatt County, 11 July. This appears to be the first record for this species from west of the continental divide. Previously reported from the east with western records in New Mexico, Texas and Kansas (Ross, 1944; Schuster and Hamilton, 1978).

Mayatrichia ayama Mosely, Mesa County, 30 July.

Ceraclea arielles (Denning), Jackson County, 15 July - 9 August.

Ceraclea resurgens (Walker), Grand and Moffat Counties, (Herrmann, 1988) 25 July - 1 August.

Limnephilus apache Flint, Larimer and Pueblo Counties, 27 July - 2 August. This species has not been reported since Flint's 1965 description from collections in Arizona and New Mexico. The collections in Larimer and Pueblo Counties represent significant northern distributional extensions.

Limnephilus selatus Denning, Grand County, 3 August.

Pycnopsyche guttifer (Walker), Jackson County, 31 July - 20 September.

Polycentropus aureolus (Banks), Jackson County, 1-9 August. Previously reported from the northern states and Canada (Nimmo, 1986) with the nearest records from Idaho and North Dakota.

Agrypnia colorata Hagen, Larimer County, 28 June. *A. colorata* is also a seldom reported species. Most records are from Canada (Betten, 1934; Ross and Spencer, 1952) with the nearest previous records from Montana (Roemhild, 1982).

Gumaga griseola (McLachlan), Yuma County, 25 June. (Kondratieff and Ward, 1987). I have examined this specimen and while the specimen was about half the typical size of specimens from California, the genitalia were nearly consistent with California specimens. Hamilton and Schuster (1980) also noted structural differences in Kansas populations of *G. griseola*. While it is clear the collection of *Gumaga* is a new record (including a new familial record) for the state, further collections will be necessary to determine the variation within the species.

Given the fairly detailed lists available for several of the adjacent states (Kansas: Schuster and Hamilton, 1978; Hamilton and Schuster, 1979, Hamilton and Schuster, 1980; Utah: Baumann and Unzicker, 1981; Wyoming: Ruiter and Lavigne, 1985), it appears many of the species which may be on the fringe of their distributional areas are also extremely localized in their distribution, having not been reported from neighboring states.

With the removal of four species, the description of one species, and the addition of the 15 species just listed, the total number of Trichoptera species reported from Colorado is 188.

ACKNOWLEDGMENTS

The author wishes to thank J. D. Unzicker, Boris Kondratieff and Steve Harris for providing critical comments on early versions this manuscript. J.D. Unzicker also provided material of *N. okopa* Ross for comparison. O.S. Flint, Jr. identified the *L. apache* Flint specimens. Wil Downs must be sincerely thanked for providing thousands of specimens from the Ginger Quill locality.

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A NEW SPECIES OF *ZONANA* (HOMOPTERA: CICADELLIDAE) FROM VENEZUELA[1, 2]

Paul H. Freytag[3]

ABSTRACT: A new species of *Zonana* is described from Venezuela. This fairly small genus previously was known from only two species from Central America, so the known range of the genus is extended to the upper part of South America.

New species of *Zonana* is described at this time from Venezuela. This species is the third species placed in this genus; the other two were described from Central America (DeLong and Freytag 1963).

Zonana bilobata sp. n.

(Figures 1-5)

Length of males 6.4-6.7 mm.; female unknown.

Resembling *flamma* in general size, shape and color, but differs in shape of aedeagal shaft and processes.

Color: Similar to *flamma*, except with three additional dark spots along commissure of each forewing. Dark punctures present on pronotum and along basal costal area of forewing.

Male genitalia: Pygofer truncate and bilobed at apex, with small dorsal subapical lobe. Genital plate short with truncate apex. Style short, sharply pointed at apex, with an enlarged rounded caudal lobe. Aedeagus short, subapical ventral cleft forming lateral hook-like lobes with several small spines along ventral margin; apex rounded, with two darker sclerotized spine-line areas.

Holotype male: VENEZUELA, Aragua, El Limon, 450 m., 26-VI-1974, En Luz de Mercurio, F. Fernandez Y. & F. Fernandez H., in the University of Central Venezuela collection. Paratypes: One male, VENEZUELA, Aragua, El Limon, 450 m.; 1-I-1981, F. Fernandez Y. Coll., in the University of Kentucky collection; one male, VENEZUELA, Bolivar, Rio Surukum, Carretera, Sta. Elena Icabara, 850 m., 19-31- I-19895, F. Fernandez Y., Anibal Chacon and Jurg Demarmels Colls.; one male, VENEZUELA, Miranda, Valle Rio Cuira, 280 m., S. of Panaquire, approx. 10° 12′ N; 66° 17′ O, 18-21-IX-1979, F. Fernandez Y. & J. A. Clavijo Colls., both in the University of Central Venezuela Collection.

Note: This species can be separated from the closest species, *flamma*, on the basis of the distinct aedeagus and the additional punctures on the pronotum and costal area of the forewing.

I wish to thank the late Dr. Fernandez Yepes who was instrumental in collecting this most interesting species and making the specimens available for study.

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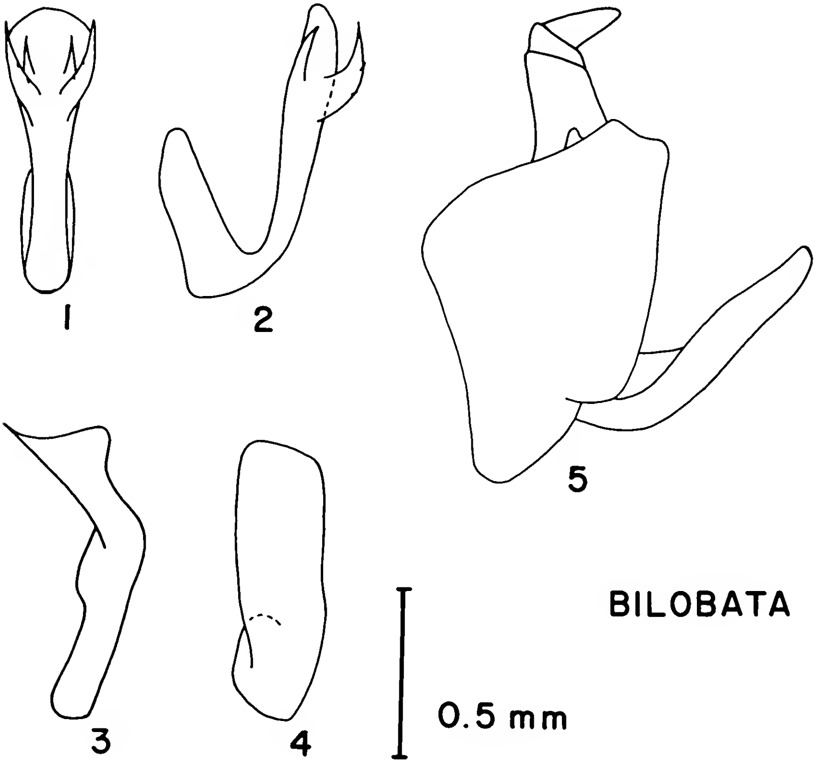

Figures 1-5, *Zonana bilobata* sp. n., male genitalia. Fig. 1, caudal view of aedeagus; fig. 2, lateral view of aedeagus; fig. 3, lateral view of style; fig. 4, ventral view of genital plate; fig. 5, lateral view of genital capsule and anal tube. All drawn to the same scale.

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EURYPAUROPUS SPINOSUS (ARTHROPODA: PAUROPODA: EURYPAUROPODIDAE) FROM ARKANSAS AND A KEY TO THE NORTH AMERICAN *EURYPAUROPUS* SPECIES[1, 2, 3]

Robert T. Allen[4]

ABSTRACT: *Eurypauropus spinosus* is reported for the first time in Arkansas. A key is given to the three North American species of *Eurypauropus*.

In the closing section of his paper on the Pauropoda of the United States, Scheller (1985) notes "that there are large lacunae in the knowledge of the ranges" of most pauropod species. This paper serves to fill in one of those lacunae for *Eurypauropus spinosus* Ryder, and to provide a key, based on information from the literature whereby other workers can identify *Eurypauropus* specimens.

The family Eurypauropodidae is easily recognized by the large, sclerotized tergal plates on each body segment. These plates conceal the head, terminal segments, and the legs when viewed from above. Brues, *et al.* (1954) present a key that will allow workers to place Pauropoda in the correct families. As far as known, *Eurypauropus* is the only genus in the family Eurypauropodidae occuring in North America.

In the United States four species of *Eurypauropus* have been described, one of which has been synonymized. *Eurypauropus spinosis* appears to be the most common species and has been reported from eleven states, Fig. 4. Recent collections, listed here, add two new localities from Arkansas to the list of areas from which *E. spinosus* is known. The two Arkansas localities are as follows: Pulaski County, Pinnacle Mountain State Park, east summit trail, 25 January 1988, Robert T. Allen collector; Yell County, entrance to Mount Nebo State Park, 15 April 1988, C. E. Carlton collector.

Eurypauropus californicus MacSwain & Longham was described from California, but was reduced to a synonym of *E. spinosus* by Remy (1956). In the same paper Remy described a new species, *E. unciger* from Kentucky. In the most recent and complete paper on the Pauropoda of the United States, Scheller (1985) described *E. washingtonensis* from Olympic National Park in Washington State. The following key, based on characters extracted from the papers by Remy (1956) and Scheller

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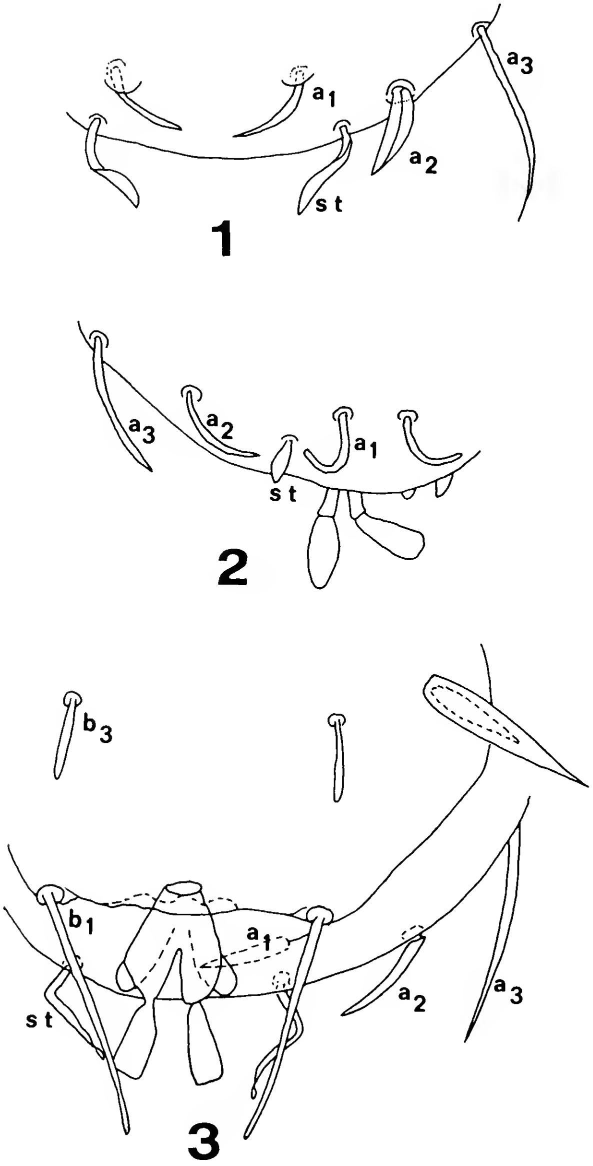

Figures 1-3. The terminal segments of the three species of *Eurypauropus* from the United States. Fig. 1, *E. spinosus* (redrawn from Remy, 1956); Fig. 2, *E. unciger* (redrawn from Remy, 1956); Fig. 3, *E. washingtonensis* (redrawn from Scheller, 1985).

(1985) will enable workers to identify *Eurypauropus* specimens from North America.

Key to North American Species of *Eurypauropus*

1. Style (*st*) of the pygidial tergum elongate (Figs. 1 & 3) 2
   Style of the pygidial tergum short, oblong-oval (Fig. 2) .... *unciger* Remy

2. Style elongate, straight, not bent (Fig. 1) .... *spinosus* Ryder
   Style elongate, elbowed with a distinct bend (Fig. 3) .... *washingtonensis* Scheller.

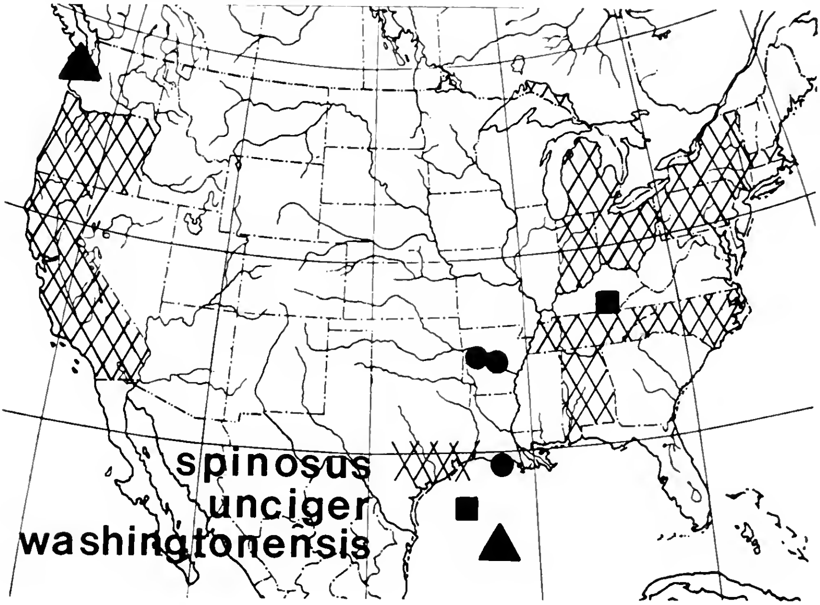

Figure 4. Map showing the distribution of *Eurypauropus* species in North America. The crosshatching for *E. spinosus* represents one or more records from a state, not a general distribution.

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SCIENTIFIC NOTE
DYSCINETUS MORATOR (COLEOPTERA: SCARABAEIDAE) FEEDING ON ROOTS OF AZALEAS (*RHODODENDRON* SPP.)[1, 2]

C. L. Staines, Jr.[3]

Dyscinetus morator (Fab.) (Coleoptera: Scarabaeidae), a common scarab distributed from New York south to Florida and west to Texas and Mexico (Gordon & Anderson, 1981), is widely distributed in Maryland (Staines, 1986). The adults are attracted to lights and remain in the area of the lights during the day by hiding under available debris (Woodruff, 1970). *Dyscinetus morator* has been reported to attack rice, *Oryza sativa* L. (Anonymous, 1953); pangola grass pastures, *Digitaria decumbens* Stent. (Anonymous, 1956); caladium bulbs, *Caladium* x *hortulanum*, cranberry, *Vaccinium macrocarpon* Ait. (Woodruff, 1970); corn, *Zea mays* L. (Anonymous, 1980); carrot, *Daucus carota* L., radish, *Raphanus sativus* L., lettuce, *Lactuca sativa* L. (Foster *et al.*, 1986); and waterhyacinth, *Eichhornia crassipes* (Mart.) Solms (Buckingham & Bennett, 1989). This species is associated with wet soils and marsh areas (Anonymous, 1980; Buckingham & Bennett, 1989).

On 2 August 1982, during a routine inspection of a commercial nursery in Baltimore County, Maryland there were discovered larvae, pupae, and teneral adults of an unknown scarab around the root zone of container-grown azaleas (*Rhododendron* spp.). All life stages were abundant and root feeding was obvious on the azaleas. E. J. Ford, USDA, APHIS, PPQ, Baltimore (retired), identified the adults as *Dyscinetus morator*, the rice beetle.

The azalea growing area of this nursery was bounded on three sides by salt marsh. The azaleas were grown in containers and were maintained under damp conditions, thus providing a suitable habitat for the beetle. The production area was not lighted, so the infestation did not result from light-attracted adults. Adult beetles may have been attracted by the moist, high organic matter content of the potting mixture used by the nursery.

This is the first report of *Dyscinetus morator* colonizing a woody ornamental. Subsequent surveys in this nursery have failed to yield further populations of this beetle in azaleas, though the beetle is common outside of the growing area.

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[2] Maryland Department of Agriculture Contribution Number CN 58-89

[3] Maryland Department of Agriculture, Office of Plant Industries and Resource Conservation, Plant Protection Section, 50 Harry S Truman Parkway, Annapolis, Maryland 21401.

SEASONAL FLIGHT ACTIVITY OF MALE VELVET ANTS (HYMENOPTERA: MUTILLIDAE) IN SOUTH FLORIDA[1]

Mark Deyrup[2], Donald Manley[3]

ABSTRACT: Seasonal male flight data from a four-year study are presented for 19 species of mutillids belonging to the genera *Ephuta*, *Photomorphus*, *Pseudomethoca*, *Sphaeropthalma*, and *Timulla*. A total of 2,391 specimens was collected. At the study site in southern Florida, most species flew during at least 8 months of the year. Two species flew only late in the year. All species showed marked fluctuations in abundance from year to year.

Velvet ants (Hymenoptera: Mutillidae) are solitary parasitoid wasps, most of them having as hosts pupae or mature larvae of bees and wasps (Mickel, 1928). Male flight activity is particularly important for gene flow in this group, as females are always apterous, and aerial dispersal is by males. Males of a few species pick up and transport females, and might cross barriers that would baffle an earth-bound female (Evans, 1969). We have collected in Malaise traps copulating pairs of *Timulla floridensis*, *Ephuta floridana*, *E. pauxilla*, and an associated pair of *E. slossonae*. Male flight activity also offers the best methods for estimating relative numbers of adults of a species, as the males seem rather vulnerable to Townes traps (modified Malaise traps). Females can be sampled with pitfall traps, but we have found that the numbers of specimens collected in such traps is relatively small, even when there are many traps and their efficiency is enhanced with long metal barriers (drift fences) that direct the mutillids into the traps. Nothing has been published on the seasonal flight patterns of male mutillids. The purpose of this paper is to contribute basic information on this little-known group of insects, and to provide a data base that could be used in comparative studies of seasonality elsewhere.

MATERIALS AND METHODS

The study site is on the Archbold Biological Station (Highlands County), located at the southern end of the Lake Wales Ridge in south-central Florida. The site is in a transitional zone between warm and subtropical zones. Winters are mild and dry, with temperatures during some years falling below 0°C for a few hours. Sheltered microhabitats are

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frost-free. Summers are warm and humid, with daytime temperatures over 25°C. Mutillid species diversity is high, with over 30 species known. The vegetation of the study site is a thin canopy of sand pine (*Pinus clausa* Chapman), with a thick 1.5 - 3.5m understory of scrub oaks (*Quercus* spp.), staggerbush (*Lyonia* spp.), silk bay (*Persea humilis* Nash), scrub pawpaw (*Asimina obovata* Nash), and scrub hickory (*Carya floridana* Sargent). The paths through this thick brush appeared to act as flight cordiors for mutillids.

Mutillids were collected in 2 small Townes traps (modified Malaise traps) that were set up across 2 east-west paths. The traps were kept in place and continuously monitored from May 1983 through December 1986. Each trap was annually replaced with an identical trap to forestall the effects of wear. Specimens were collected 3 times a week. The mutillids were identified by the authors. Specimens of all species are in the collection of the Archbold Biological Station and in the collection of Donald Manley. Synoptic collections of most species have also been deposited in the Florida Collection of Arthropods (Gainesville) and the collection of Denis Brothers (University of Natal, Pietermaritzburg, South Africa).

RESULTS

Over the 4-year period, the traps collected 2,391 specimens belonging to the genera *Ephuta*, *Pseudomethoca*, *Timulla*, *Photomorphus*, and *Sphaeropthalma*. Many specimens of *Dasymutilla* were also collected; these are not discussed here because of problems with the identification of some species.

Ephuta floridana Schuster. 50 of 51 specimens taken May-December (Figure 1). Annual numbers from 6 (1984) to 27 (1986).

E. stenognatha Schuster. 94 of 100 specimens taken May-November (Figure 2). Annual numbers from 4 (1986) to 64 (1983).

E. slossonae (Fox). 132 of 134 specimens taken April-November (Figure 3). Annual numbers from 20 (1984) to 46 (1986).

E. margueritae Schuster. All 118 specimens collected April-December (Figure 4). Annual numbers from 8 (1984) to 44 (1986).

E. pauxilla Bradley. 40 of 42 specimens collected April-November (Figure 5). Annual numbers from 3 (1093) to 15 (1985, 1986).

E. spinifera Schuster. No specimens collected 1983-1986. 8 specimens collected in July-August 1987, in a temporary trapping site in mature sand pine scrub.

Photomorphus paulus (Bradley). 885 of 888 specimens taken April-November (Figure 6). Annual numbers from 85 (1985) to 354 (1984).

P. alogus Viereck. All 18 specimens collected June-December. Annual numbers from 1 (1986) to 9 (1983).

P. archboldi Manley and Deyrup. All 12 specimens collected May-October. Annual numbers from 1 (1986) to 5 (1984).

Pseudomethoca oculata (Banks). All 129 specimens taken September-December (Figure 7). Annual numbers from 13 (1985) to 59 (1983).

P. sanbornii (Blake). 69 of 71 specimens collected May-November (Figure 8). Annual numbers from 3 (1985) to 50 (1983).

P. simillima (Smith). 63 of 67 specimens collected October-November (Figure 9). Annual numbers from 12 (1983) to 32 (1986).

P. torrida Krombein. 418 of 425 specimens collected May-November (Figure 10). Annual numbers from 58 (1985) to 158 (1983).

P. vanduzei Bradley. All 18 specimens collected April-October. Annual numbers from 2 (1984) to 6 (1985).

Sphaeropthalma pensylvanica (Lepeletier). All 17 specimens collected April-December. Annual numbers from 3 (1985, 1986) to 6 (1983).

Timulla dubitata (Smith). 25 of 26 specimens collected May-September (Figure 11). Annual numbers from 1 (1985, 1986) to 12 (1983, 1984).

T. floridensis (Blake). 262 of 269 specimens collected March-December (Figure 12). Annual numbers from 46 (1984) to 118 (1983).

T. ornatipennis (Bradley). 2 specimens, July 1983.

T. vagans (Fabricius). 1 specimen, May 1983.

DISCUSSION

At the Archbold Biological Station, males of most mutillid species are active over a long period. Eight of the 12 species represented by at least 25 specimens were active during 8 or more months of the year. The prolonged flight season is likely to be related to the mild climate of the study site, though complementary data from farther north are needed to support this conclusion. As can be seen from the graphs (Figures 1-12), most species are slow to begin flight activity in the spring. Flight activity is seasonally less symmetrical than monthly average temperatures at the station. Two species, *P. oculata* and *P. simillima*, have flight seasons restricted to late in the year (September-December). There are no corresponding spring-flying species. One species, *P. paulus*, shows a consistently bimodal pattern reflecting a reduction in numbers in August and September.

When species are active over a long period, a record of flight activity does not provide good estimates of longevity. *P. oculata* and *P. simillima*, with their short flight seasons, provide more useful information. Assuming that large reductions from one month to the next reflect natural mortality rather than a drastic effect of the traps on local populations, many males of these species must live a month or less. The short life spans of these species may not be typical if cooler temperatures in December and late November are killing males. There is a case of an individual male *Dasymutilla foxi* (Cockerell) that lived about 6 months in captivity (J. Schmidt, personal communication).

The flight activity of males is presumably related to emergence of females. Females apparently mate only once, immediately after emergence (Brothers, 1972; J. Schmidt, personal communication). Male flight activity need not closely reflect total seasonal activity of females, as at least some female mutillids appear to be long-lived insects (Schmidt, 1978). Female *P. oculata* and *P. simillima*, for example, are active in spring and early summer, when there are no records of males. The fall and winter emergence of these species may actually indicate a heavy dependence on early spring hosts, rather than a dependence on fall or winter hosts.

All species showed marked variation in annual abundance, with maximum annual collections at least twice minimum collections. The seven most frequently collected species showed no clear evidence that their numbers were similarly and simultaneously affected by common factors such as rainfall or temperature. The fluctuations seen in these species may be unintelligible until we have identified hosts and know something of the population dynamics of these hosts.

SUMMARY

At our study site in southern Florida, most species of mutillids fly through much of the year. With the exception of 2 species of *Pseudomethoca*, there is no evidence of phenological niche partitioning or dependence on hosts that are only available for a short season. All abundant species showed large population fluctuations during the 4-year study period. We hope that our information will encourage publication of similar data sets from other areas. We would like to think that our work is the first of a series of studies of geographic phenological variation in mutillids, that can be interpreted in terms of evolutionary pressures exerted by different climatic regimes.

ACKNOWLEDGMENTS

We thank Nancy Deyrup for tabulating the data and creating and preparing the graphs. Justin Schmidt (Carl Hayden Bee Research Center, Tucson, AZ), and Fred Lohrer (Archbold Biological Station), and two anonymous specialists reviewed the manuscript and provided useful comments. The manuscript was typed by Patricia Bache.

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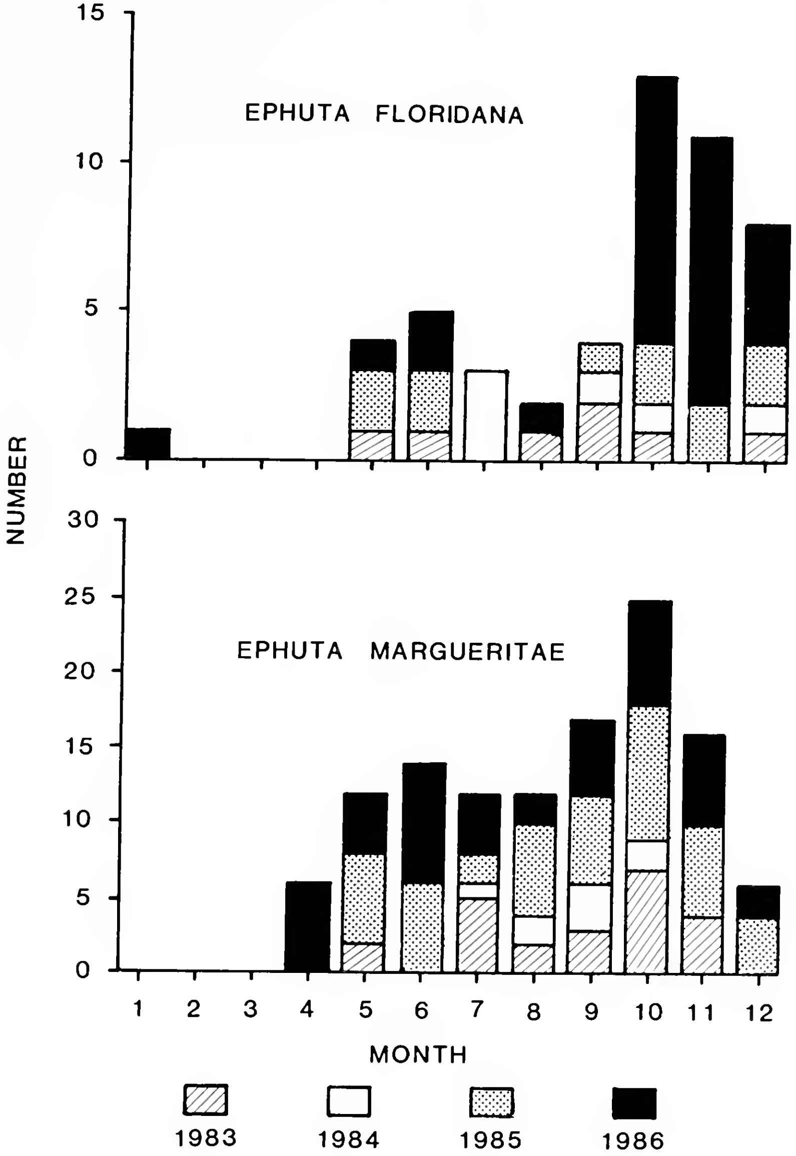
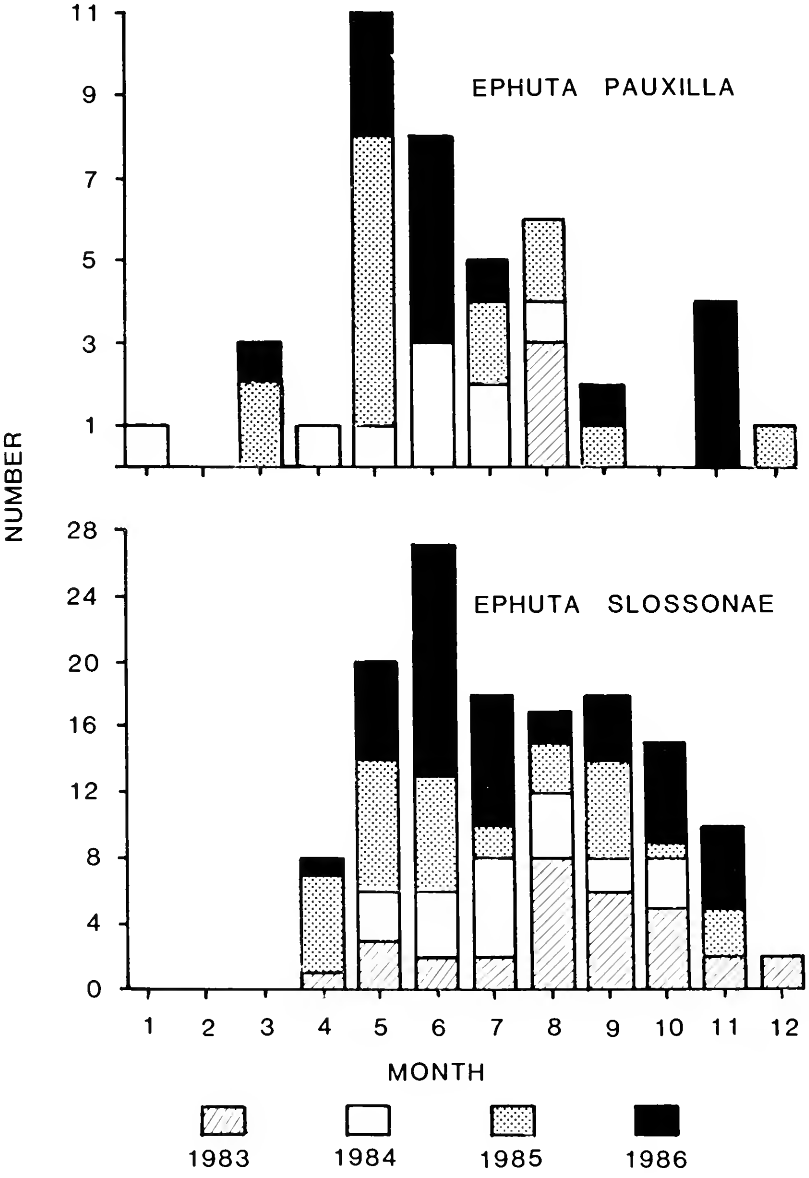
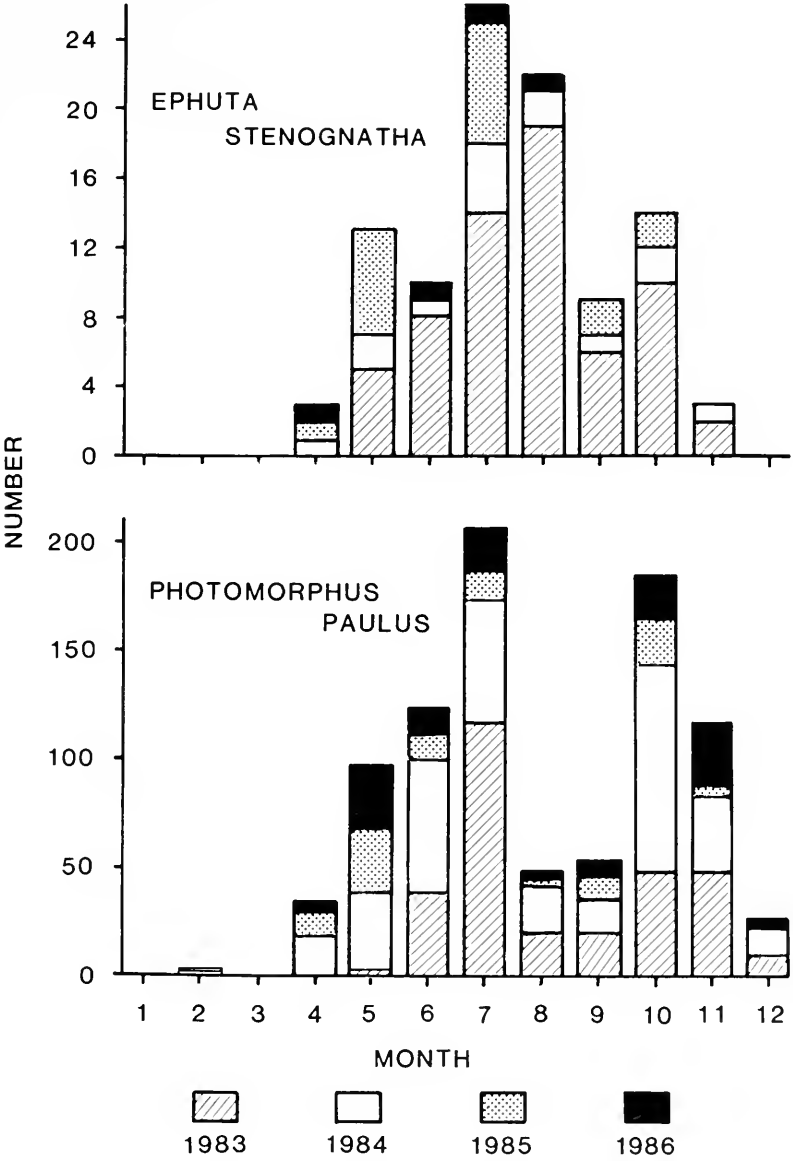


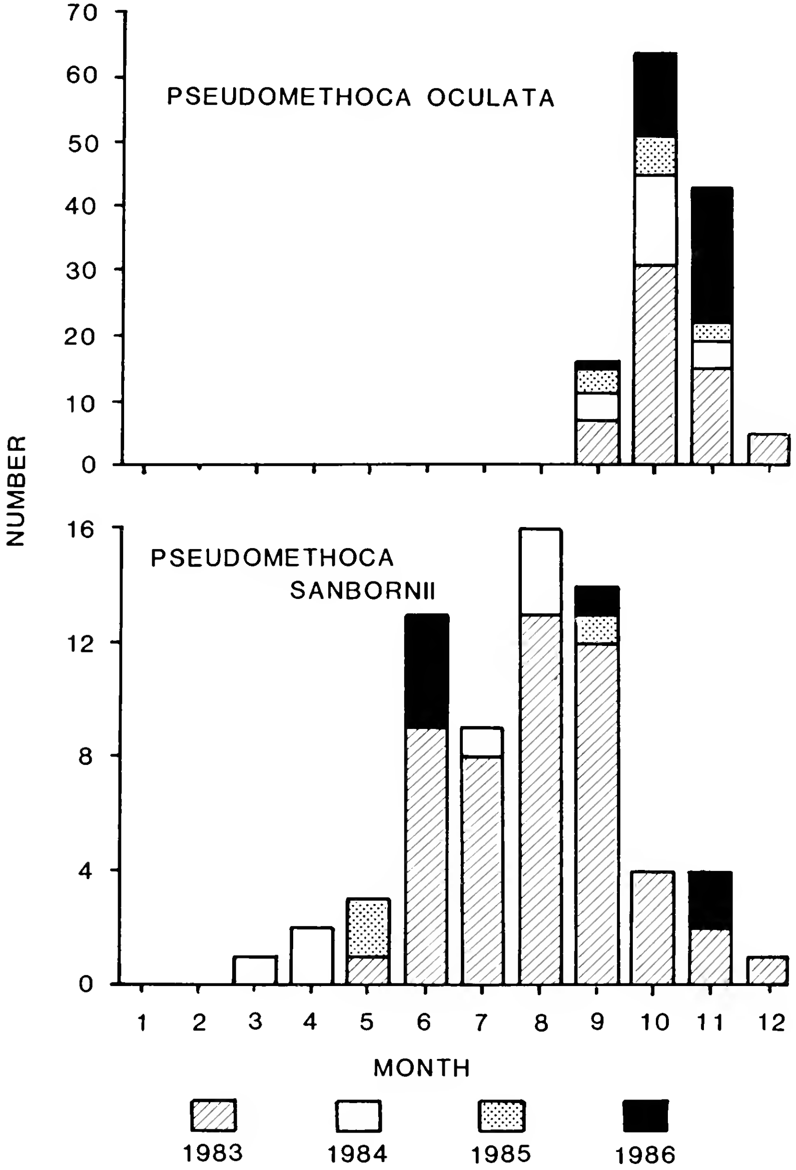
Figures 1 and 2. Seasonal flight, *Ephuta floridana* and *E. margueritae*



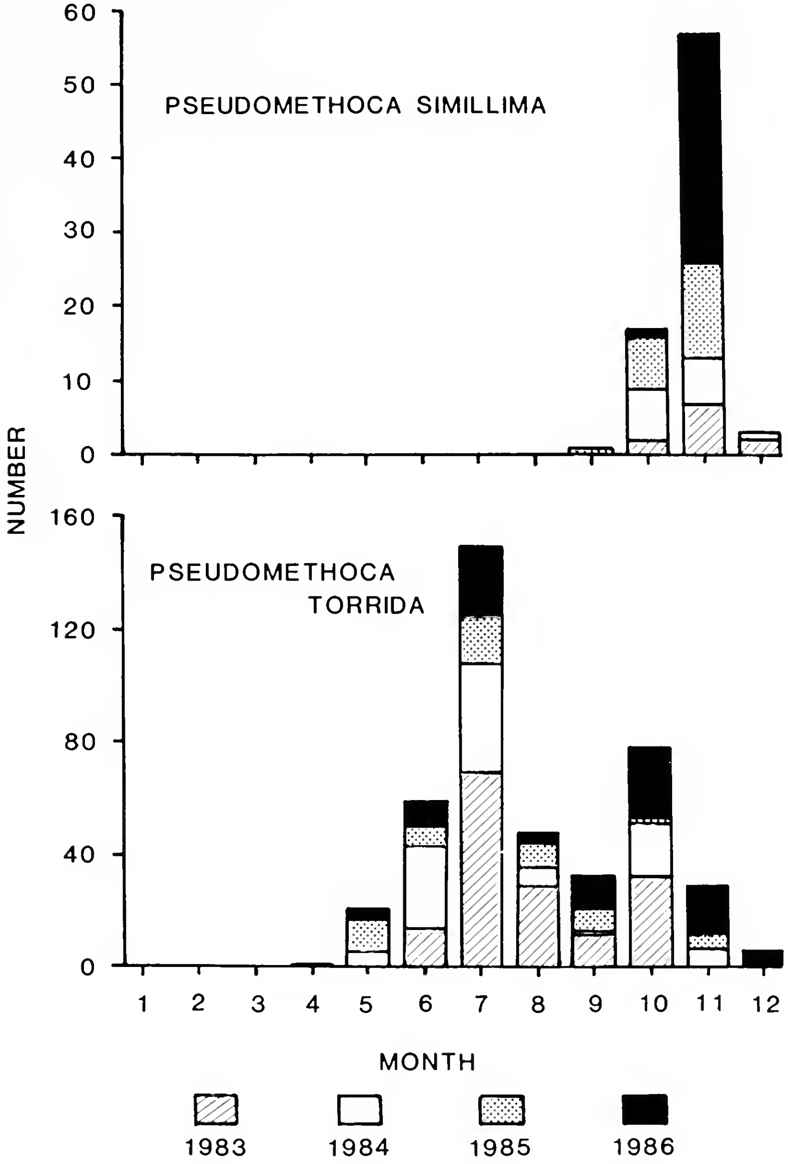
Figures 3 and 4. Seasonal flight, *Ephuta pauxilla* and *E. slossonae*



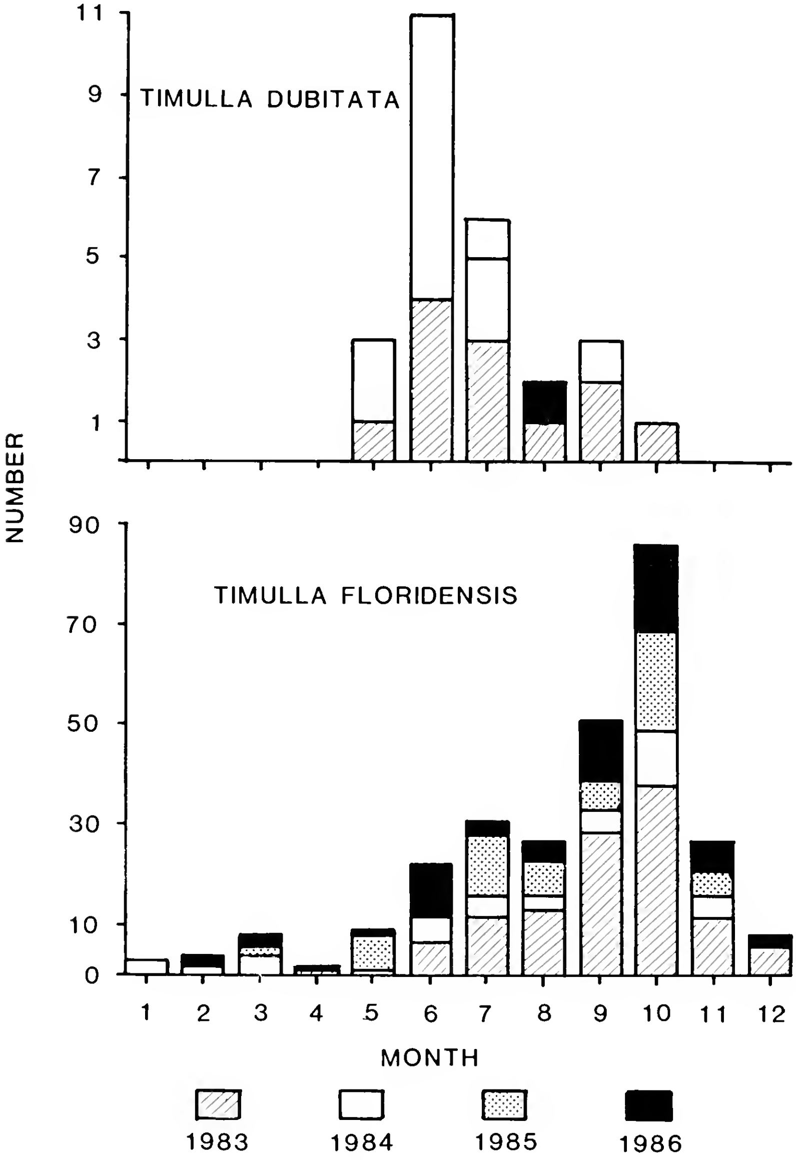
Figures 5 and 6. Seasonal flight, *Ephuta stenognatha* and *Photomorphus paulus*



Figures 7 and 8. Seasonal flight, *Pseudomethoca oculata* and *P. sanbornii*



Figures 9 and 10. Seasonal flight, *Pseudomethoca simillima* and *P. torrida*



Figures 11 and 12.Seasonal flight, *Timulla dubitata* and *T. floridensis*

TAXONOMIC DISTRIBUTION AND PHYLOGENETIC SIGNIFICANCE OF THE MALE FORELEG HAIRPENCIL IN THE TORTRICINAE (LEPIDOPTERA: TORTRICIDAE)[1]

John W. Brown[2]

ABSTRACT: I report for the first time male foreleg hairpencils in the tortricine tribes Euliini, Schoenotenini, and Atteriini. The structures are identical in Euliini and Schoenotenini, and their shared possession is considered a putative synapomorphy for these two tribes. Although similar in structure and point of origin, the hairpencil in Atteriini lies along the anterior longitudinal axis of the femur rather than along the outer base of the coxa as in Euliini and Schoenotenini. The atteriine hairpencil may represent an independently derived structure, or, more likely, a modification of that found in the other two tribes.

Male secondary structures (e.g., costal fold, corema, hairpencil) are common and diverse among exoporian and ditrysian Lepidoptera (Varley 1962; Birch 1972, 1985). Although these structures may be strikingly unique and almost certainly homologous among taxa sharing them, their value in elucidating phylogenetic relationships is diminished by the fact that they are evolutionarily more labile than many other adult morphological features. Shared possession of uniquely derived male secondary structures provides compelling evidence of common ancestry (Birth 1972; Varley 1962), but their absence may be meaningless in a phylogenetic context since the correct position in the transformation series (i.e., primitively absent - present - secondarily lost) may be impossible to determine.

Few characters of the legs of tortricids have been studied on a comparative basis. Examples include the work of Falkovitch (1962) on male secondary structures in Olethreutinae, and that of Yasuda (1972) on tarsal setae of Japanese Tortricinae. Horak (1984) concluded that legs provide few characters useful in resolving phylogenetic relationships within Tortricinae. However, my recent discovery of male foreleg hairpencils among the tortricid tribes Euliini, Schoenotenini, and Atteriini may be useful in demonstrating the monophyly of these taxa and in elucidating relationships among their members.

Hairpencil in Euliini and Schoenotenini

Structure. The foreleg hairpencil in Euliini and Schoenotenini con-

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sists of a fascicle of 15-25 slender, pale yellow, hairlike scales, that arise together from the proximal end of the femur and extend along the outer surface of the coxa to near its base (Figs. 1-3). Scales on the trochanter and the distal portion of the coxa form a broad groove that partially conceals the basal portion of the hairpencil. On the thorax near the base of the coxa, there is an invaginated region and associated cuticular flap which receives the distal ends of the hairpencil (Fig. 4). The function of the hairpencil is unknown; presumably it plays a role in dissemination of short-range courtship pheromones. Baker and Carde (1979a, 1979b) and Baker, Nishida, and Roelofs (1981) have shown that male abdominal androconia of *Grapholita* (Olethreutinae), consisting of an eversible membranous sac, are used to release a close-range female attractant.

Taxonomic distribution. The euliine/schoenotenine hairpencil has a sporadic distribution throughout the two tribes (Tables 1 and 2); i.e. the structure is present in 48% of euliine and 43% of schoenotenine genera examined. In addition to those genera listed in Table 1, several underscribed euliine genera and many unplaced species of "*Eulia*" Hübner possess the hairpencil. In some genera all species have the hairpencil; in others it is absent and presumably secondarily lost in one or more species. Its presence in the presumably most primitive as well as the more derived genera of Euliini (Brown and Powell, in prep.) suggests that it represents a synapomorphy uniting the Euliini and Schoenotenini rather than a character derived numerous times within the two tribes.

The Euliini, as recently redefined by Powell (1986), previously was considered a para- or polyphyletic assemblage of primarily Neotropical genera, characterized by symplesiomorphies of male and female genitalia (Horak and Brown 1990). Possession of the hairpencil demonstrates the common ancestry of genera that share this unique structure; however, absence of the hairpencil among several taxa does not necessarily exclude them from the tribe since it may have been lost secondarily. The structure is absent in more than half of the genera included by Powell (1986) in the Euliini; on the basis of this and other characters, a few of these genera likely are assigned incorrectly to this tribe (e.g., *Ecnomiomorpha* Obraztsov, *Deltobathra* Meyrick).

Hairpencil in Atteriini

Structure. In Atteriini, the hairpencil typically consists of a dense brush of > 50 fine, flattened, setalike scales, arising along a narrow patch on the anterior edge of the femur immediately distad of the junction with the trochanter. The scales are shorter in relation to coxa length, more flattened, and greater in number than those in Euliini and Schoenotenini. When not displayed, the hairpencil lies along the longitudinal

1

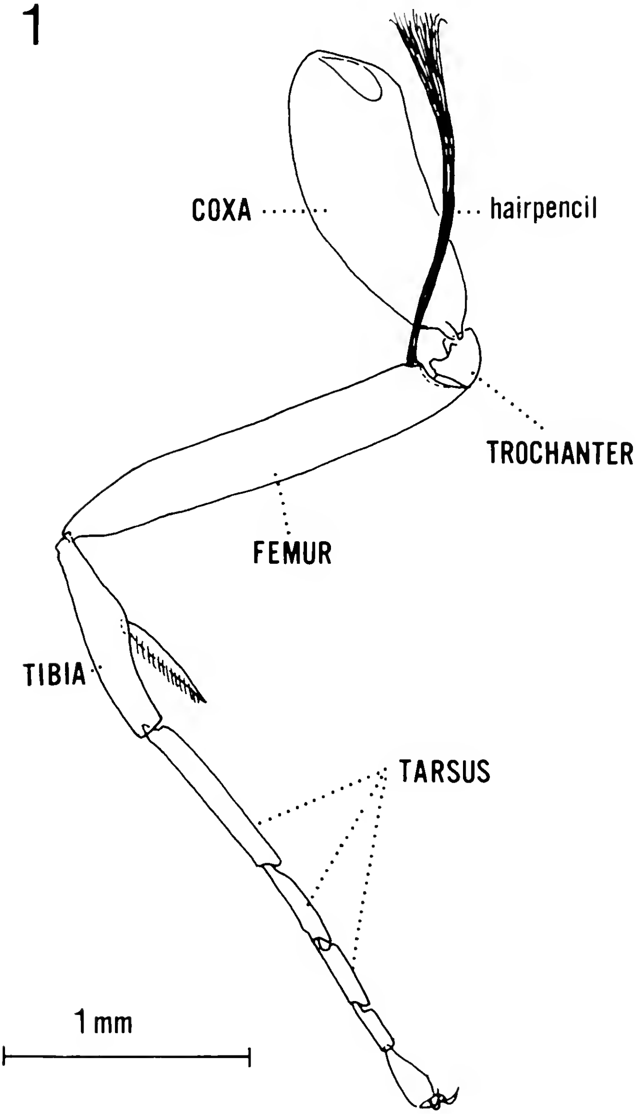
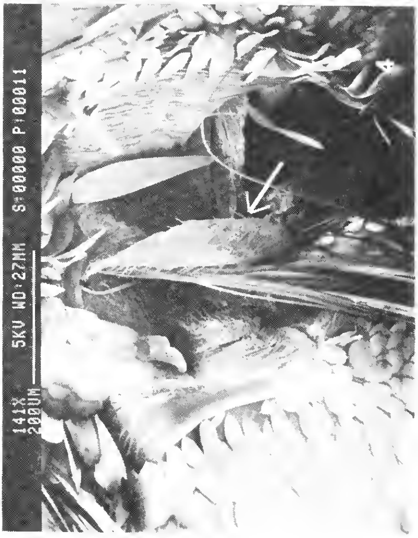
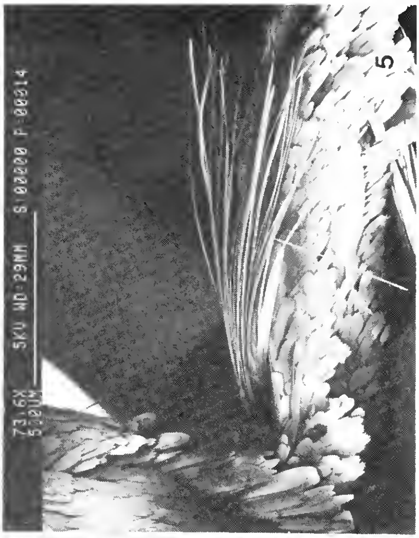


Fig. 1. Diagram of male foreleg illustrating position of hairpencil.





Figs. 2-3. Scanning electron micrograph of hairpencil of *Eulia ministrana* L. (Euliini).
Fig. 4. Thoracic receptacle of hairpencil in *Eulia ministrana*.
Fig. 5. Scanning electron micrograph of hairpencil in *Tinacrucis* sp. (Atteriini).

axis of the femur, extending approximately to the distal end of the femur (Fig. 5).

Taxonomic distribution. The foreleg hairpencil is present in seven of eight described atteriine genera; it is absent in the monotypic *Holoptygma* Powell which is the only atteriine with a costal fold. It is absent in one or more species of six of the seven genera (Table 3).

The monophyly of the Atteriini is convincingly demonstrated by the modified "corethrogyne" scales on sterna VI and VII of the female and the correlated oviposition behavior (Powell 1986). The corethryogyne scaling is evidently absent in *Sisurcana* Powell where no unequivocal association of males and females is known (Powell 1986). The unique hairpencil provides further evidence for the monophyly of the Atteriini, as well as confirming the membership of *Sisurcana*.

CONCLUSIONS

Two types of male foreleg hairpencils are found in the Tortricinae, one type in Euliini and Schoenotenini, and the other in Atteriini. The hairpencils are similar in structure, configuration, and point of origin. Consequently, the shared presence of these structures may be interpreted as evidence of the common ancestry of these tribes.

Males of an undescribed genus that possess convincing atteriine genitalia [i.e. "*Philedone*" *aluminias* (Meyrick) and "*P.*" *citrochyta* (Meyrick)], have typical euliine/schoenotenine hairpencils. It is possible that the genus represents an early branch of Atteriini (before the development of the atteriine hairpencil), and that the atteriine hairpencil represents a modification of that found in the Euliini and Schoenotenini. If this interpretation is correct, the character supports relationships unsuspected by previous workers attempting to reconstruct tortricoid phylogeny.

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Table 1. Distribution of male foreleg hairpencil in Euliini ("-" = structure not observable; "F" = genera known only from females).

GENUS	No. of spp. examined	% possession of hairpencil
Acroplectis Meyrick	1	0
Anopina Obraztsov	30	100
Anopinella Powell	8	0
Apolychrosis Amsel	4	0
Apotomops Powell	2	0
Bicavernaria Razowski	1	100
Bonagota Razowski	6	0
Chicotortrix Razowski	1	100
Chileulia Powell	1	0
Chilips Razowski	2	-
Chrysoxena Meyrick	1	0
Clarkenia Razowski	5	0
Clarkeulia Razowski	18	83
Coryssovalva Razowski	1	0
Deltinea Pastrana	1	0
Dorithia Powell	17	0
Eriotortrix Razowski	2	100
Ernocornutia Razowski	2	100
Ernocornutina Razowski	1	100
Eulia Hübner	1	100
Gauruncus Razowski	3	100
Helicteulia Razowski	1	100
Hynhamia Razowski	3	67
Inape Razowski	10	90
Neoeulia Powell	1	0
Nesochoris Clarke	2	0
Oregocerata Razowski	1	-
Orgyuncus Razowski	1	-
Ortognathosia Razowski	1	0
Paraptila Meyrick	4	100
Popayanita Razowski	2	50
Proeulia Clarke	20	85
Pseudomeritastis Obraztsov	4	75
Ptyongnathosia Razowski	1	100
Quasieulia Powell	1	0
Rhythmologa Meyrick	1	F
Seticosta Razowski	15	100
Silenis Razowski	3	100
Telurips Razowski	1	0
Terinebrica Razowski	5	100
Uelia Razowski	1	0
Uncicida Razowski	1	0

Table 2. Distribution of male foreleg hairpencil in Schoenotenini ("F" = genera known only from females.

GENUS	No. of spp. examined	% possession of hairpencil
Antigraptis Meyrick	1	F
Archactenis Diakonoff	2	100
Barygnathella Diakonoff	9	0
Campotenes Diakonoff	4	50
Choristenes Diakonoff	1	F
Cornuticlava Diakonoff	3	33
Copidostoma Diakonoff	1	F
Diactenis Meyrick	1	0
Homalernis Meyrick	2	F
Litotenes Diakonoff	1	100
Metachorista Meyrick	6	0
Neotenes Diakonoff	1	100
Rhopalotenes Diakonoff	4	100
Rhabdotenes Diakonoff	6	100
Schoenotenes Meyrick	7	100
Stenotenes Diakonoff	2	0
Saetotenes Diakonoff	6	100
Oligotenes Diakonoff	2	0
Orthocomotis Dognin	25	0
Paracomotis Razowski	1	0
Protarchella Diakonoff	3	33
Proactenis Diakonoff	1	0
Zenotenes Diakonoff	1	0

Table 3. Distribution of male foreleg hairpencil in Atteriini.

GENUS	No. of spp. examined	% possession of hairpencil
Anacrusis Diakonoff	8	88
Archipimima Powell	3	67
Atteria Walker	4	100
Holoptygma Powell	1	0
Sisurcana Powell	4	25
Templemania Busck	4	25
Tina Powell	1	100
Tinacrucis Powell	3	67

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BOOKS RECEIVED AND BRIEFLY NOTED

THE BUTTERFLIES OF HISPANIOLA. A. Schwartz. 1989. Univ. of Florida Press, Gainesville, FL. 580 pp. 7 pl. $35

Each species account provides detailed collection and distribution data, accompanied by a range map. Species accounts also contain substantial ecological information. One new species is described. A key to the butterflies of Hispaniola is included.

ECOLOGY AND NATURAL HISTORY OF TROPICAL BEES. D.W. Roubik. 1989. Cambridge University Press. 514 pp. 22 pl. $69.50

This book summarizes and interprets worldwide research on the diversity of bees, emphasizing their function within the tropical biota and including their interaction with human populations. The book draws together several major themes of ecology, natural history, and evolution and is intended to be a reference for research workers in the field.

ACALYPTRATE DIPTERA REARED FROM HIGHER FUNGI IN NORTHEASTERN OHIO[1]

Britt Bunyard, B.A. Foote[2]

ABSTRACT: Living fungi were collected from two sites in northeastern Ohio between the fall of 1987 and fall of 1988. Flies reared from this material in the laboratory were determined to species.

Fourteen species of acalyptrate Diptera, comprising five families and eight genera, were reared from 44 species (14 families) of higher fungi. Among flies reared was *Leiomyza laevigata* [Asteiidae]. No descriptions of the immature stages of any of the over 100 species of Asteiidae worldwide are available. Also reared was *Drosophila guttifera* [Drosophilidae], another species whose biology is poorly known.

Most mycetophagous Diptera appeared to be generalists with respect to utilization of fungal species. Larvae of several species were probably scavengers, utilizing decaying fungal material.

Aside from a few publications (Buxton, 1960; Pielou, 1966; Pielou and Mathewman, 1966; Pielou and Verma, 1968; Shorrocks, 1973; Valley, *et al.*, 1969), the study of mycetophagous Diptera associated with mushrooms remains in a pioneer stage (Graves and Graves, 1985).

The purpose of this study was to determine the species of acalyptrate Diptera associated with higher fungi in northeastern Ohio (Portage Co.). Generalizations about the trophic relationships of certain Diptera to their fungal hosts (strict mycophagy, polyphagy, saprophagy) are also given.

MATERIALS AND METHODS

Two sites in Portage Co. were chosen for the collection of fungi: Towner's Woods near Kent and West Branch State Park near Ravenna.

Material was collected between September of 1987 and September of 1988. Each collected fungus was placed in a plastic bag or wrapped in wax paper to prevent larvae of one mushroom from entering another. Fungi were then identified using various sources (Graham, 1944; Lincoff, 1981). To avoid incidental occurrences of Diptera with the fungi (e.g. resting or hiding in crevices), only adults which actually emerged from larvae occurring within the fungus were counted.

Upon emergence, adult Diptera were retained alive for at least 24 hours to allow the exoskeleton to harden and then killed and preserved. Adults were either pinned or placed directly into 70% ethanol. Larvae

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were killed in boiling water and then preserved in 70% ethanol. Preserved specimens were placed in the Kent State University collection of Diptera.

Rearing required the construction of special containers which allowed the fungi to remain in a somewhat natural condition. The bottom of these rearing chambers consisted of the bottom of petri dishes (10 x 100mm) to which had been added moistened pulverized peat moss. It was necessary to keep the peat moss substrate in contact with the fungus initially and to moisten it frequently to prevent desiccation. As the fungus decayed, the substrate absorbed moisture produced by the fungus. The remainder of the rearing container consisted of clear plastic tubing having a diameter of 90mm and cut to various lengths. To the top of this was glued fine polyester mesh material. The rearing chamber was placed over the fungus in the petri dish. The fungal material was retained in the rearing containers for at least three months.

RESULTS AND DISCUSSION

Species of acalyptrate Diptera reared from the fungal material are given in table 1.

Table 1. Associations between acalyptrate Diptera species and their fungal hosts.

Acalyptrate Species	**Fungal Host Species**																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Asteiidae																				
Leiomyza laevigata		+																		
Chloropidae																				
Gaurax atripalpus							+													
Tricimba lineella				+																
Tricimba sp.											+									
Nartshukialla sp. poss. *melancholica*					+															
Drosophilidae																				
Drosophila duncani						+														
Drosophila falleni			+					+	+										+	+
Drosophila guttifera												+	+							
Drosophila putrida	+		+		+		+		+					+		+	+		+	+
Drosophila testacea																+				
Drosophila tripunctata						+														
Mycodrosophila dimidiata										+										
Ephydridae																				
Athryroglossa granulosa															+					
Lonchaeidae																				
unknown spp.																		+		

1 Agaricus arvensis
2 Lepiota rachodes
3 Amanita muscaria
4 Boletus chrysenteron
5 Pluteus cervinus
6 Laetiporus sulfureus
7 Polyporus pubescens
8 Russula compacta
9 Russula vesca
10 Pholiota mutabilis
11 Pholiota squarrosa
12 Psilocybe polytrichophila
13 Collybia dryophila
14 Marasmius oreades
15 Mycena galericulata
16 Omphalotus olearius
17 Oudemansiella radicata
18 Pleurotus ostreatus
19 Pleurotus pulmonaria
20 Tricholomopsis platyphyla

Leiomyza laevigata Meigen [Asteiidae] has been reared from fungi previously (Buxton, 1960; Sabrosky, 1957). The family Asteiidae is a small one of some 100 species of which little is known. No descriptions of the immature stages of any species of Asteiidae are available.

Gaurax atripalpus Sabrosky [Chloropidae] has been reared previously from *Fomes* sp., [Polyporaceae] (Valley, *et al.*, 1969). It is apparent from this and our more recent rearings that *G. atripalpus* utilizes the fungi as both a food source and site of overwintering.

The rearing of *Athyroglossa granulosa* Cresson [Ephydridae] from fungi is surprising, because members of this family usually have larvae that are aquatic or semiaquatic. Grimaldi and Jaenike (1983) reared adults from larvae feeding in decaying skunk cabbage, *Symplocarpus foetidus* (L.) Nutt.

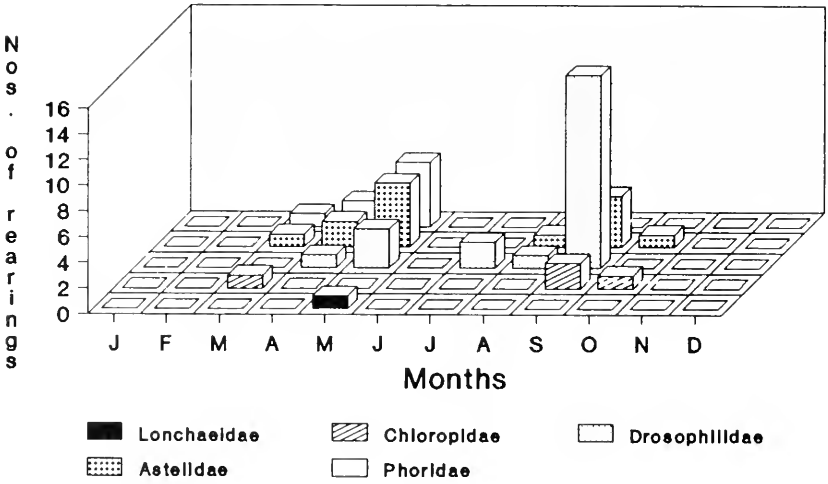
There are many known species of fungivorous Drosophilidae. *Drosophila falleni* Wheeler, *D. putrida* Sturtevant, *D. testacea* von Roser, *D. tripunctata* Loew, and *Mycodrosophila dimidiata* Loew, which were all reared in this study, are all well known fungal feeders (Jaenike, 1977, 1978; Jaenike, *et al.*, 1983; Patterson and Stone, 1952). However, none is known to be monophagous (Jaenike, 1978; Lacy, 1984). *Drosophila duncani* Sturtevant and *D. guttifera* Walker are also known to be fungal feeders but little is known about the life history of either species (Patterson and Stone, 1952).

Two drosophilids, *D. falleni* and *D. putrida*, were reared from toxic species of *Amanita* mushrooms. These two as well as a few other species have been reared in the past (Jaenike, 1977; Jaenike, *et al.*, 1983) from mushrooms containing toxic amanitins. The amanitins are alkaloid compounds which are potent inhibitors of RNA polymerase II, the enzyme which transcribes genes that encode messenger RNA's (Wieland, 1968). Therefore, these compounds are potentially toxic to all eukaryotes. How these drosophilids manage to avoid being affected deleteriously is not known (Jaenike *et al.*, 1983).

An interesting question raised by this study concerns how so many different acalyptrate species, sometimes of the same genus, can coexist in the same substrate (Table 1)? As many as six species were found in the same fungal sporophore at the same time. When examined more closely it was apparent that in most cases larvae of the different species were feeding on the same material, at the same time, and in a similar manner (i.e. burrowing through the fungal sporophore). Apparently, competitive exclusion is not a factor here, as the fungal food probably was not a limiting resource. However, Grimaldi and Jaenike (1984), demonstrated that mycophagous larvae frequently do exhaust the food available in individual mushrooms. It is probable that predators or parasites of these larvae functioned to reduce competition (both inter - and intraspecific) between larvae. Many parasitic wasps were obtained from many of the fungi surveyed.

Another point made evident by this study as well as earlier one (Buxton, 1960) is that certain fungi are more attractive to species of Diptera than other fungi. For example, *Pluteus cervinus* Fr. [Pluteaceae] possessed the greatest diversity of acalyptrate species (Table. 1). In contrast, several species of fungi were repeatedly examined, but no species of acalyptrate Diptera were obtained. The reasons for this are unclear and further research in this area is necessary. A final point to be made by this study concerns the mechanisms utilized by the many species of fungivorous Diptera to cope with the fact that fungal sporophores represent an ephemeral and unpredictable food source. The months of May and September produced the highest number of species of emerging adults (Fig. 1). Many species of Diptera probably initiate a reproductive diapause during times of no larval food sources, such as the dry summer months. Other species may utilize other food sources, including live, injured, and decaying vegetation. An example is *Drosophila guttifera* [Drosophilidae], a rare species that was believed to be strictly mycophagous (Patterson and Stone, 1952). However, we discovered that this species, at least in laboratory rearings, readily accepted other substrates (tomato juice, agar, bananas, commercial Drosophila medium) as an ovipositional site and larval food source (Bunyard and Foote, 1990). Similar results have been obtained in laboratory rearings of other mycetophagous species of the *guinaria* group of *Drosophila* (Grimaldi,

Fig. 1 Number of rearings per month for five families of acalyptrate Diptera.



pers. comm.). However, no field-based records of rearings from non-fungi sources have been reported for these species, and the laboratory results thus may not reflect reality.

ACKNOWLEDGMENTS

We wish to thank D. Grimaldi, American Museum of Natural History, New York City, and K. Valley, Pennsylvania Department of Agriculture, Harrisburg, for their assistance in identification of Diptera.

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SOCIETY MEETING OF FEBRUARY 28, 1990

EVOLUTION OF *EUPHILOTES* BIOTYPES: TRIALS AND TRIBULATIONS OF THE BUTTERFLY BLUES

By Dr. Gordon F. Pratt

Darwin's book, *The Origin of Species*, changed the way we view ourselves and the world around us; nevertheless, the origin of species remains a central concern of evolutionary biologists. Because insects represent the great majority of known species, they are often the subject of studies on speciation. Dr. Gordon F. Pratt, now a post doctoral associate at the University of Delaware, is interested in insect speciation. While he was a graduate student in California he studied a fascinating complex of blue butterflies of the genus *Euphilotes* whose larvae feed exclusively on the blossoms and seeds of one or another of the species of wild buckwheat, *Eriogonum*.

Variation in altitude, soil type, and climate in the southwestern United States have created habitat islands suitable for the growth of *Eriogonum* and in turn *Euphilotes*. The tight coupling between the flowering of particular host species and the butterfly's life cycle has resulted in many local races that are behaviorly distinct. For example, some emerge in the spring and others in the fall. Some adults fly near the ground where the flowers of their food plant are, while others fly higher for flowers of a different species. The sister species *Euphilotes enoptes* and *E. battoides* have sharp differences in male and female genitalia; however, electrophoretic analysis of allozymes in various host races show they are closely related. These studies also indicate that host races are evolving rapidly and suggest that *E. battoides* evolved from the *E. enoptes* host race that feeds on *Eriogonum umbellatum*.

The adults of *Euphilotes* obtain nectar from the same plants on which they lay their eggs. The larvae are cryptic and assimilate pigments from the flowers on which they feed. They are attended by ants. Pupation occurs in the ground beneath the host plant. Presumably, in desert environments where moisture triggers seed germination or growth of perennial species, moisture also serves to synchronize adult emergence with blossoming. The fact that pupae can survive up to five years in the laboratory helps to explain the absence of adults in dry years and their reappearance several years later. The ability of the butterfly to evolve different local populations adapted to specific host plants has resulted in sympatric populations of a single species that do not interbreed.

Dr. Pratt's talk at the Philadelphia Academy of Natural Sciences drew one of the largest audiences for a membership meeting in five years. Eighteen members and twelve guests were present. Like Dr. Pratt's talk, the notes of local entomological interest focused on the Lepidoptera and speciation. Dr. Chuck Mason reported that both the E and Z pheromone races of the European corn borer, *Ostrinia nubilalis*, are common in Delaware. The E-type emerges early and produces offspring that feed on a variety of early host plants other than corn. The other type produces the Z isomer of the pheromone, emerges later, and attacks corn in its first generation. The second generation of both types reproduce on corn. Hybrid individuals produce a mixture of the pheromones. Dr. Duke Elsner noted a possibly related situation of cranberry fruitworm, *Acrobasis vaccinii*. Attempts to attract males with a pheromone extracted from the conspecific race feeding on blueberry have been unsuccessful. Dr. Ken Frank noted that female cecropia moths, *Hyalophora cecropia*, that emerge in captivity later than their wild counterparts will sometimes attract males of the introduced cynthia silkmoth, *Samia cynthia*, which normally emerge later than cecropia in the wild. At the end of the meeting Dr. Frank distributed a number of cecropia coccoons he had rescued from a city site likely to be destroyed before summer.

Harold B. White
Corresponding Secretary

IMPROVED CULTURE TECHNIQUES FOR MASS REARING *GALLERIA MELLONELLA* (LEPIDOPTERA: PYRALIDAE)[1]

Frank A. Eischen[2], Alfred Dietz[3]

ABSTRACT: Supplementing an artificial diet with 5% pollen, honey, or beeswax significantly increased survival of adult *Galleria mellonella*. Survival on the basic diet averaged 27.4%. When honey, pollen, or wax was added, survival was 44.7%, 80.8%, and 89.6%, respectively. Developmental time for moths fed diets containing 5% pollen or a combination of pollen, honey, and wax was shorter by approximately 2-5 days. Newly emerged virgin females which had fed as larvae on a 100% pollen, honey, and wax diet weighed 36% more than females derived from larvae fed the artifical diet. A phagostimulatory hypothesis is suggested.

Additionally, 78% of prepupae accepted cut plastic soda straws as puparial sites and spun their cocoons in them. This greatly facilitated the handling of individual prepupae and pupae and should be a convenience to both research programs and commercial wax moth producers.

The greater wax moth, *Galleria mellonella*(L.), is easily reared and is often used as a laboratory animal. However, our initial attempts to establish a culture from wild stock resulted in low survival rates (ca. 30%) when an artificial diet [Stoneville(SV) developed by King *et al.* 1979] was used. However, pilot studies indicated that survival was good (ca. 95%) on a diet composed wholly of their naturally occurring larval food, i.e. pollen, honey, and beeswax. Inspection of the artificial diet (King *et al.* 1979) did not reveal nutritional shortcomings. Previous studies have shown that small amounts of beeswax improved growth rates (Beck 1960, Dadd 1966, Young 1964). Further, Dadd (1966) observed higher survival rates during portions of larval development when beeswax was added to an artificial diet. These findings suggested that small amounts of natural food could play an important nutritional role in adult survival. We report here the results of a study done to determine why survival differed so strikingly on artificial diet compared with a diet composed of natural ingredients.

MATERIALS AND METHODS

Six diets were tested. Their composition by weight was as follows: 1) 100% Stoneville(SV), 2) 95% SV + 5% pollen(P), 3) 95% SV + 5% honey(H), 4) 95% SV + 5% beeswax(W), 5) 95% SV + 5% PHW, 6) 100% PHW.

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The Stoneville diet consists largely of baby foods (Gerber® mixed and high protein cereals), gycerol, wheat germ, water, sucrose, and vitamins (see King *et at.* 1979 for details). Its protein composition is about 13%. The pollen-honey-wax diet was made by mixing bee-collected pollen (63%; see Dietz 1982 for plant species represented) with chipped honey comb (37%). The honeycomb (cappings) contained approximately 50% honey. The protein content of this diet is estimated to be about 13%. Twenty grams of diet were placed in 100ml glass rearing jars, sealed and kept frozen until used. Fortified diets were prepared by placing 19g of SV diet in the rearing jar, and then 1g of either pollen, honey, or wax was sprinkled or dripped onto its surface.

Moths were obtained by removing overwintering prepupae from a dead honey bee hive in Athens, Georgia. They were incubated at 30°C. Adults emerged in about two weeks and mated *inter se*. Eggs were collected between strips of pleated wax paper. Three days after laying, egg masses were divided into small clusters of 10-15 eggs. These clusters were placed on filter paper in petri dishes and incubated at 30°C + 2°C. Just before hatching, eggs were examined and clusters containing at least 10 larvae that appeared normal were selected for testing. Excess larvae were destroyed by puncturing the eggs with a needle. Eggs were then placed in small aluminum foil baskets (16mm x 10mm) and randomly assigned to diets. Twenty replications of each diet were performed. After addition of the eggs, the rearing jars were sealed with a solid metal screw lid containing a rubber interseal. Rearing jars were held at 32°C ∓ 1°C, 40 ∓ 10% RH, and 12:12LD. Seven days after infestation, egg clusters were removed and per cent hatch determined. Also, the solid lids were replaced with a similar lid containing a 9mm hole. This hole was covered with a piece of transparent tape, sticky side out. Several small holes were punched in the tape with a small pin to allow air exchange. When the first prepupae were observed, this tape was replaced with a circular piece of aluminum screen. At this stage, rearing jars were inspected daily. As adults appeared they were removed, sexed, and their emergence date noted. The first twenty adult virgin females that emerged from the SV and the pollen-honey-wax diets were weighed. Sixty days from the time of egg laying, the contents of the rearing jars were examined. Cocoons were counted and pupal mortality noted.

Survival and emergence data were analyzed with a 1-way ANOVA, and differences among treatments evaluated with Duncan's multiple range test. Student's t-test was used to determine differences in adult female weights.

To confirm that the supplemented Stoneville diet was suitable for a mass rearing program, we fed the Stoneville+5% fresh frozen pollen to ca. 6,000 hatching *G. mellonella* larvae (eggs were weighed, not counted).

As prepupae emerged from the diet and began spinning light cocoons, they were removed and placed in 3.8l glass jars containing cut plastic soda straws (2 X 0.5cm; Sweetheart^{R}). About 70 prepupae were added to jars containing 200-300% excess of cut straws (scattered horizonally on the bottom of the jar), which were covered with a single circular piece of toweling. Jars were kept in a darkened incubator (same conditions as in above dietary trials).

RESULTS

The addition of 5% of either pollen, honey, or beeswax (PHW) to the Stoneville(SV) diet resulted in a significant increase in adult survival (Table 1). Adult survival on the basic diet averaged 27.4%. The addition of honey increased survival to 44.7% ($P < 0.05$). Fortification with either pollen, wax, or a combination of pollen, honey, and wax produced survival rates that did not differ significantly from the control diet (89.2%).

Males reared on the SV+5% pollen, SV+PHW, and control diet eclosed in a significantly shorter time (ca. 3-5 days, $P < 0.05$) than moths on the other three diets (Table 1). Average time to first emergence was slightly shorter for males (0.2-1.3 days) than that required by females, but this difference was not significant. Newly emerged virgin females weighed on average less when reared on the SV diet, than on the control diet (114 and 156mg, respectively; $P < 0.001$). During the mass rearing trial 78% of prepupae spun their cocoon inside the cut soda straws. The adult survival rate for larvae fed the Stoneville+5% pollen diet during this trial was estimated to be about 84%.

DISCUSSION

The striking increases in survival caused by small amounts of pollen, honey, or beeswax was not the result of an altered physical consistency, nor the addition of essential nutrients (Haydak 1936, 1940, Allegret 1964; Dadd 1966; Marston and Campbell 1973). Dadd (1966) suggested that the inclusion of beeswax served as a source of metabolic water. However, the basic Stoneville diet contains about 17% water and supports good larval growth (King *et al.* 1979). The 300% increase in survival with the addition of 5% beeswax to this diet suggests that beeswax performed an additional function.

Eischen *et al.* (unpublished) found in a preliminary test that newly hatched larvae preferentially chose artificial diets to which alcoholic extract of pollen was added. This suggests that pollen provided phagostimuli attractive to *G. mellonella*. Other observations support this view. Balazs (1958) reported that newly hatched larvae preferred honeycomb to an artificial diet, even though this diet contained honey and beeswax. He also noted that older larvae fed the same artificial diet chose honeycomb when given the opportunity. Haydak (1936) reported that larvae attacked old combs in those areas that contained pollen. We have on numerous occasions observed newly hatched larvae that have been given the Stoneville diet wander about the inner walls of their rearing container when food was nearby. Newly hatched larvae given a honey-pollen-wax diet were rarely seen away from the food. The natural history of this moth also lends support to a phagostimulatory hypothesis. Adult females oviposit in and around bee colonies; generally in crevices where eggs are protected from the bees (Paddock 1918, Nielsen and Brister 1977). Once hatched, the larvae must search for food. Though distances may be short, it would be adaptive to be able to locate food (which also serves as shelter) rapidly in the hostile interior of a honey bee colony.

The shorter times to eclosion of moths fed diets containing pollen indicate that even small amounts of pollen are effective in promoting development. Since pollen was localized on the upper surface of the diet mass, it seems unlikely that its consumption would have been uniformly distributed during larval growth. If the phagostimulatory hypothesis is true, then consumption and consequent beneficial effects occured during the earliest instars. From this it follows that an early pollen meal may supply a nutrient, perhaps protein, that allows faster development, while apparently wax and honey do not.

Prepupal acceptance of soda straws greatly facilitated the handling of prepupae and pupae. Large numbers of known age groups can be held in relatively small containers. This is convenient when storing prepupae under refrigerated conditions (ca. 15.5°C). We find that chilled, lightly spun prepupae are easy to use by fishermen, a slight squeeze on the straw prompts the prepupae to crawl out. Because male prepupae emerged from the diet slightly before females, the first harvest of prepupae results in a high percentage of males. This is an added benefit when separation of sexes is desired. Since these tests, we have successfully reared many thousand *G. mellonella* using this technique.

These findings should be of value to those who wish to preserve the genetic variation observed in wild stock or to increase the yield of *G. mellonella* in newly-established cultures (Bush 1975). However, cultures that have been reared for many generations on a particular artificial diet and consequently undergone selection for it may not show greatly improved survival. Nevertheless, under some conditions it could be prudent as well as cost effective to supplement artificial wax moth diets with small amounts of properly stored pollen or unprocessed honeycomb.

Table 1. Developmental characteristics of *Galleria mellonella* reared on an artificial diet fortified with honey, pollen, or beeswax

Diet	% adult survival $(\bar{X} \pm SE)$	days to 1st ♂ emergence $(\bar{X} \pm SE)$	days to 1st ♀ emergence $(\bar{X} \pm SE)$	adult ♀ weight $(\bar{X} \pm SE)$
Stoneville	27.4 ± 4.7 a[1]	42.7 ± 1.1 a	43.9 ± 0.8 a	114.2 ± 5.3 mg[2]
Stoneville + 5% honey	44.7 ± 6.0 b	43.3 ± 1.3 a	43.5 ± 0.8 a	---
Stoneville + 5% wax	89.6 ± 3.8 c	42.8 ± 0.7 a	43.7 ± 1.0 a	---
Stoneville + 5% pollen	80.8 ± 4.1 c	39.7 ± 0.8 b	41.0 ± 0.9 b	---
Stoneville + 5% honey, pollen, wax	82.5 ± 4.7 c	39.2 ± 0.8 b	39.4 ± 0.8 c	---
Honey, pollen, wax	89.2 ± 2.6 c	37.6 ± 0.7 b	37.8 ± 0.7 cd	156.0 ± 5.8

[1] Means in the same column followed by the same letter do not differ significantly at the 5% level according to Duncan's multiple range test.

[2] Means weights are significantly different ($P < 0.001$). Female weights on other diets were not recorded.

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NEW HOST RECORD FOR *ANISOTOMA BASALIS* (COLEOPTERA: LEIODIDAE) BREEDING IN SPOROCARPS OF THE SLIME MOLD *LYCOGALA FLAVOFUSCUM* (MYXOMYCETES: LICEALES)[1]

Quentin D. Wheeler, E. Richard Hoebeke[2]

ABSTRACT: Two breeding populations of the primitive staphylinoid beetle *Anisotoma basalis* (Leiodidae: Agathidiini) were found feeding within mature aethalial sporocarps of the uncommon slime mold *Lycogala flavofuscum* (Myxomycetes: Liceales) on the campus of Cornell University, Ithaca, New York, in 1983 and 1989. These discoveries represent the first documented insect association for this myxomycete.

An emerging pattern of host utilization in the agathidiine Leiodidae suggests that many species of these beetles are able to breed on a diverse range of host Myxomycetes (slime molds). Few instances of host specificity are suspected to date. The majority of species have only been associated with mature sporocarps (Blackwell 1984; Lawence, 1989; Lawrence & Newton, 1980; Newton, 1984; Wheeler, 1979), although a few records exist for both *Anisotoma* (Russell, 1979; Wheeler, 1980) and *Agathidium* (Newton, 1984; Wheeler, 1984a, 1984b, 1987) on plasmodia of host slime molds. Many records involve common myxomycetes that produce large fruiting bodies [e.g., *Fuligo septica* (L.) Wiggers] or dense masses of smaller fruiting bodies [e.g., *Stemonitis fusca* Roth]. The slime mold *Lycogala epidendrum* (L.) Fries, a small, puffball-like species, has also been recorded as an agathidiine host (Lawrence & Newton, 1980; Blackwell, 1984).

Myxomycete host records have been reported by Lawrence & Newton (1980), based on label data, field observations and from published accounts in the North American literature, for eight North American *Anisotoma*, including slime mold species of the genera *Comatrichia, Fuligo, Lycogala, Metatrichia, Stemonitis, Trichia* and *Tubifera*. Precise information on feeding habits and preferences, and microhabitats of the majority of leiodid beetles is scarce.

In this paper we provide evidence for a new adult and larval host record for *Anisotoma basalis* (LeConte) (Leiodidae: Agathidiini). Two breeding populations of this primitive staphylinoid beetle were found feeding within mature aethalial sporocarps of the uncommon slime mold *Lycogala flavofuscum* (Ehrenb.) Rost. These populations were discovered by one of us (ERH) on two separate occasions, one on a prostrate log and the other on a standing dead tree, along a wooded hillside on the

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Fig. 1. Mature aethalial sporocarp of *Lycogala flavofuscum*. Beetle exit holes through the peridium of the fruiting body are readily visible. Dime indicates scale.

Cornell University campus, Ithaca, New York (Tompkins Co.). These discoveries represent the first documented insect association for this myxomycete.

On 4 June 1983, a large sporocarp of *L. flavofuscum* (approx. 5.1 x 4.6 cm.) (Fig. 1) was found on the surface of a prostrate log (Fig. 2) along a wooded slope on the campus of Cornell University. Within this mature fruiting body a massive population of both larvae and adults of *Anisotoma basalis* was discovered. This population was observed and sampled for more than a week. Because we only partially disturbed the fruiting body, no complete census of the beetles was made. However, more than 200 larvae were collected and slide-mounted, and more than that number were collected into ethanol. We estimate that the total number of adult *A. basalis* was at least 100-200 and that the number of larvae probably exceeded 400-500.

Fig. 2. Microhabitat of the slime mold *Lycogala flavofuscum*. Arrow indicates position of fruiting body (of Fig. 1) on prostrate log.

Fig. 3. Mature aethalial sporocarp of *Lycogala flavofuscum*. An adult *Anisotoma basalis* is visible near exit hole of fruiting body. Scale line = 1.0 cm.

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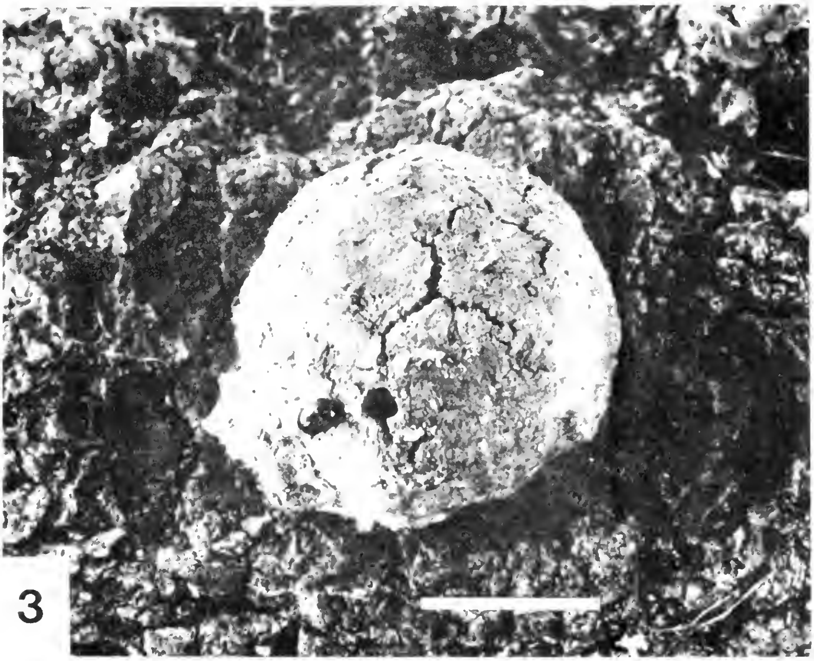

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Again on 21 June 1989, several meters from the original 1983 collection site, another smaller sporocarp of *L. flavofuscum* (approx. 2.1 x 2.5 cm.) was discovered on the trunk of a standing, dead basswood tree (*Tilia*), approximately 5 ft. above the ground. It, like the previous sporocarp, had also been penetrated by adult specimens of *A. basalis* (Fig. 3), but no larval specimens were observed.

Both sporocarps are deposited in the Cornell University Insect Collection as voucher specimens of the slime mold.

All three larval instars associated with adult *A. basalis* from this myxomycete host have been described by Wheeler (1990a), as the basis for a study on ontogeny (Wheeler, 1990b).

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ANTENNAL ANOMALY IN *OXYPODA OPACA* (COLEOPTERA: STAPHYLINIDAE) FROM NEW YORK[1]

E. Richard Hoebeke[2]

ABSTRACT: A specimen of *Oxypoda opaca*, collected in Tompkins Co., NY, in June 1988, was found to exhibit a teratological aberration of its left antenna, whereby the distal antennomeres (articles III-XI) are compressed into a short, club-like structure. This aberration is illustrated by scanning electron microscopy, and compared with appendage anomalies previously recorded in other *Oxypoda* species.

Instances of teratology (i.e., individuals exhibiting structural abnormalities) are not uncommon in many species of beetles (Coleoptera), especially among artificially reared specimens (Crowson, 1981). Teratological malformations have been studied and categorized for the Coleoptera in the monographic works of Balazuc (1948, 1969).

Among members of the family Staphylinidae, the phenomenon of teratology was reviewed in some detail by Frank (1981) who chronicled all recorded morphological aberrations, including the presence of supernumerary appendages, fusion or loss of appendages, anomalies of body segmentation and malformations of the thorax and male genitalia. Recently, Segers (1987) reported a case of triophthalmy and other teratological aberrations in the Staphylinidae, anomalies previously unreported for the family.

Because of a paucity of published information on teratological specimens in the largest of the staphylinid subfamilies, the Aleocharinae, it seems advisable to report on morphological abnormalities exhibited in specimens taken under natural conditions. Therefore, in this note I document a teratological specimen of the aleocharine *Oxypoda opaca* (Gravenhorst), a Palearctic species recently reported for the first time from North America (Hoebeke, 1989). This teratology, an antennal malformation, is thoroughly described and further illustrated with scanning electron photomicrographs. Additional literature on teratologies in members of the genus *Oxypoda* is summarized.

A single New York specimen was found to have an extreme aberration of the left antenna, a type of meiomely (following the classification and terminology of Balazuc, 1948). The antenna is 3-segmented; antennomeres III-XI are apparently compactly fused, resulting in a clubbed structure with no apparent segmentation (Figs. 1-3). The basal article (scape) is somewhat stouter than that of the normal antenna, but article

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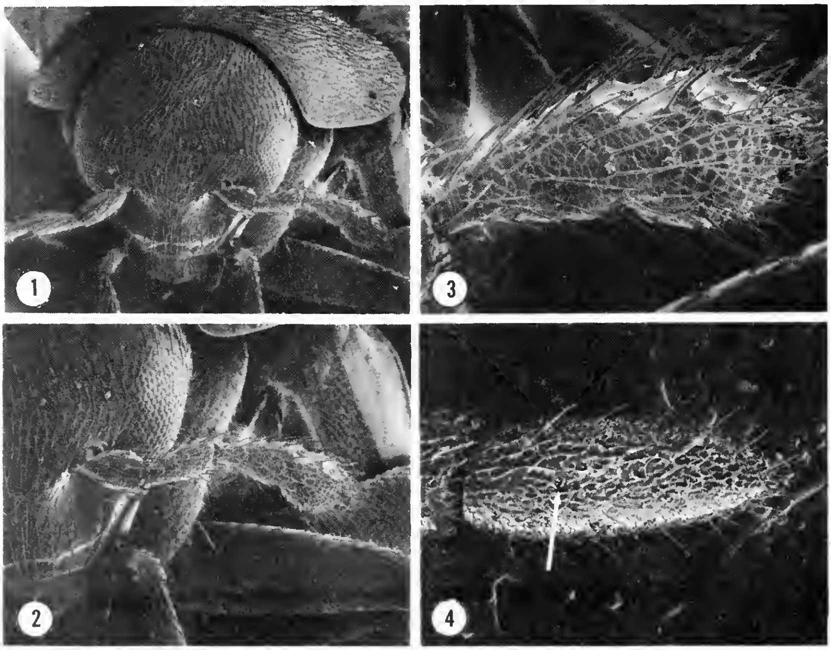
II appears to be of nearly normal dimensions. Visible at high magnification (540x), there are two large, craterlike structures, perhaps thermo- or hygroreceptors, in juxtaposition on the dorsal surface (Fig. 3). In addition to being strongly setose, the surface of the "club" is covered with microsculpture consisting of an imbricate network of distinct microlines. The overall length of the abnormal left antenna is 0.48 mm, compared to 1.17 mm for the normal right antenna.

The normal 11-segmented, right antenna is characterized as follows: basal article (scape) and articles II and III elongated; articles IV-X subquadrate to feebly transverse and not increasing much in length; and terminal article (XI) elongate, pointed apically and equal to or slightly longer than articles IX+X combined. The terminal article of the normal antenna bears a pair of rather small, inconspicuous coeloconica-type sensilla, probably thermo- or hygrosensitive in function. One sensillum is located on the dorsal surface (Fig. 4, arrow) while the other occurs on the opposite (ventral) side.



Figs. 1-4. Scanning electron photomicrographs of adult *Oxypoda opaca*. 1, Frontal aspect of head showing abnormal left antenna, 125x. 2, Closeup of abnormal left antenna, 208x. 3, Enlargement of "club" of abnormal left antenna, 540x. 4, Terminal article (XI) of normal antenna showing coeloconica-type sensillum (arrow) (dorsal surface), 350x.

It is not possible to ascribe the antennal aberration described above to any genetic mechanism (mutational) or to any other external factor (i.e., extreme environmental conditions, injury, etc.) acting on an earlier developmental stage such as the pupa.

Although the pair of sensilla on the apical segment of the normal antenna (Fig. 4, minute, coeloconica-type, dorsal/ventral in position) are very different from the pair of "sensilla-like" structures on the deformed antenna (Fig. 3, extremely large, crater-like, dorsal/dorsal in position), I surmise that these structures are probably homologous. Thus, it is the author's opinion that the deformed antenna does indeed represent an entire antenna and not a partial one, with the loss of intermediate or apical segments.

The coated specimen is deposited in the Cornell University Insect Collection. Complete collection data are as follows: NY: Tompkins Co., Town of Ulysses, N. of Jacksonville, 22 June 1988, E. R. Hoebeke. (male).

A search of the literature reveals 3 other references to teratology of appendages in *Oxypoda*. Uhmann (1919) reported a specimen of *O. opaca*, found near Dresden (E. Germany), with an abnormal right antenna. The distal antennomeres, beyond article V, were shorter in length and more compressed than the analogous articles of the normal left antenna. Segmentation, however, was still evident in the abnormal antenna. Keys (1936) documented a specimen of *O. opaca* from New Forest (S. England) with "four segments only to each of its anterior tarsi, whereby its tarsal formula was 4-5-5 instead of the 5-5-5 which is proper to the genus." Segers (1987) presented a case of symphysomely (the left antenna showing 2 partly fused articles) in a normal female of *O. brachyptera* (Stephens) collected from a pasture at Poeke (Belgium, 6-5-1982, trapped in pitfalls).

ACKNOWLEDGMENTS

I am grateful to J. Howard Frank (University of Florida, Gainesville), James K. Liebherr (Cornell University), and two anonymous reviewers for reading a draft of this paper and providing helpful comments.

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BOOK REVIEW

WORLD CROP PESTS. W. Helle, Editor in chief. 1989. Elsevier Publ. Co., Amsterdam, The Netherlands, and P.O. Box 1663, Grand Central Station, New York, NY 10163

VOL. 3A. FRUIT FLIES: THEIR BIOLOGY, NATURAL ENEMIES, AND CONTROL. A.S. Robinson & G. Hooper, eds 1989. $161.

This volume was not reviewed. The four major parts deal with Taxonomy and Zoogeography; Pest Status; Biology and Physiology; and Behavior.

VOL. 3B. FRUIT FLIES: THEIR BIOLOGY, NATURAL ENEMIES, AND CONTROL. A.S. Robinson & G. Hooper, eds. 1989.

This is the second of two volumes dealing with the frugivorous Tephritidae. It is divided into 5 sections concerned with Genetics, Rearing, Population detection, Ecology and Control. Under these basic headings the 43 contributing authors address topics from the specific ("ie. Cytoplasmic Incompatibility in *Rhagoletis Cerasi*") to the general (ie. "Life History Strategies of Tephritid Fruit Flies"). The graphics are well presented and the book attractively designed.

In addition to scope this volume has depth. The abundance of organized references alone is invaluable to anyone used to dealing with the cosmopolitan and often scattered fruit fly literature. Within minutes of opening the book, I had found interesting but unfamiliar data and papers. However, the reader should be warned that there was considerable delay between the writing of many of these chapters and publication so that there are fewer recent citations than the 1989 publication date would suggest.

With that caveat excepted, I believe this book would be an important reference to anyone with an interest in fruit flies. This includes not only those who are directly involved with fruit fly control but also those interested in the more "basic" endeavors of Ecology, Behavior, etc. I, for one, already find myself referring to one or the other of these volumes several times a day.

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A NEW SPECIES AND NEW RECORD OF THE WATER-PENNY GENUS *PSEPHENOPS* (COLEOPTERA: PSEPHENIDAE) FROM COSTA RICA[1]

Paul J. Spangler[2]

ABSTRACT: Members of the genus *Psephenops* have not been recorded previously from Costa Rica. A new species, *Psephenops prestonae*, from Costa Rica is described and compared to *Psephenops maculicollis* Darlington (1936) described from Colombia and here reported from Costa Rica. A diagnosis of *Psephenops maculicollis* is given and the distinctive aedeagus of each species is illustrated.

The aquatic larvae of water-penny beetles are usually common throughout the year in shallow streams with sand, gravel, and rocky substrates and a moderately fast velocity. The riparian adult psephenids, however, are short lived, elusive, and not commonly collected, especially not in series. Consequently, a number of species of water-penny beetles have been described from one or only a few adult specimens, as is this new species. The single male of *Psephenops prestonae,* n. sp., was collected by Warren E. Steiner and companions J.M. Hill & S.E. Frye.

I collected seven specimens of *Psephenops maculicollis* Darlington (1936) in San Isidro, Costa Rica, in 1967 but have not previously reported on them.

These are the first species of water-penny beetles known from Costa Rica and bring the number of water-pennies known from middle America to eight.

Psephenops prestonae, new species

Figures 1, 2

Holotype ♂ — Form and size: Body flattened, oblong; thorax narrowed anteriorly; elytra almost parallel sided, apices rounded. Length, 2.46 mm; greatest width, 1.26 mm.

Color: Covered with golden pubescence. Head black except genae behind eyes yellow brown. Maxillary palpal segments dark reddish brown. Labial palpal segments lighter reddish brown than maxillary palpus. Ventral surface of head dark reddish brown. Antennal segments all dark reddish brown. Pronotum black. Scutellum black. Elytron uniformly reddish brown. Prosternum dark reddish brown; mesosternum, metasternum, and abdomen blackish brown; hypomeron and epipleuron reddish brown. Coxae of all legs reddish brown; tibia and tarsi of all legs dark reddish brown.

Head: Frontal area shallowly depressed; punctures coarse, separated by ½ to 1 times puncture diameter. Clypeus almost on same plane as head. Labrum short, broad; shallowly emarginate apically. Eyes prominent, hemispherical. Antenna densely pubescent; extend-

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ing almost to base of pronotum; basal segment enlarged, 1/3 wider than and twice as long as segment 2; segment 3 about 1/3 longer than segment 4; segments 4—10 subequal; segment 11 slightly longer than segment 10. Maxillary palpus about 1/3 as long as antenna, 4 segmented; segment 1 shortest, about ¼ as long as segment 2; segment 2, a third longer than segment 3; segment 3 about 3/4 as long as segment 4; segment 4 moderately flattened, swollen, with an elongate sensory area on apex. Labial palpus very small, 3 segmented; segments 1 and 2 short, stout, subequal in length; segment 3 much narrower and about 1½ times as long as segment 2.

Thorax: Pronotum widest at base and about a third wider than long; discal area with moderately coarse and fine punctures intermixed; coarse punctures separated by ½ to 2 times puncture diameter; fine punctures separated by 1 to 3 times puncture diameter; disc moderately carinate on meson on posterior half and concave on each side of carina; base strongly bisinuate; anterolateral angles moderately rounded; posterolateral angles subacute; all borders narrowly rimmed. Scutellum subtriangular. Elytron widest slightly behind midlength; with fine and coarse punctures intermixed; fine punctures separated by ½ to 1 times puncture diameter; coarse punctures separated by 2 to 4 times puncture diameter. Prosternum short in front of procoxae. Prosternal process long and narrow, extending to midlength of mesocoxae, carinate on apex. Mesosternum with narrow, deep, longitudinal sulcus. Metasternum swollen, incised and concave between metacoxae; midline with narrow longitudinal sulcus on posterior two-thirds; shallowly and narrowly depressed on each side of midline. Leg with femur robust; tibia slender, slightly arcuate and slightly bent subapically. Protibia without distinct posterolateral denticle at apex. Tarsi with segments 1—4 broad, with dorsal surface pubescent and ventral surface densely pubescent. All legs with tarsal segments 1, 2, and 3 with large flat pubescent lobes. Tarsal claw moderately robust.

Abdomen: Sterna 5, 6, and 7 broadly subtruncate along posterior margins.

Genitalia: Trilobate and as illustrated (Figures 1 & 2).

Female. — Unknown.

Type data. — Holotype ♂: COSTA RICA: CARTAGO PROVINCE: Pejibaye, 24 Mar 1987, W. E. Steiner, J.M. Hill, S.E. Frye; deposited in the U.S. National Museum of Natural History, Smithsonian Institution.

Etymology: The specific epithet *prestonae* is named for Emily D. Preston, presently Director of the Stony Brook Nature Center and Sanctuary in Norfolk, Massachusetts, in appreciation of her strong interest in conservation activities.

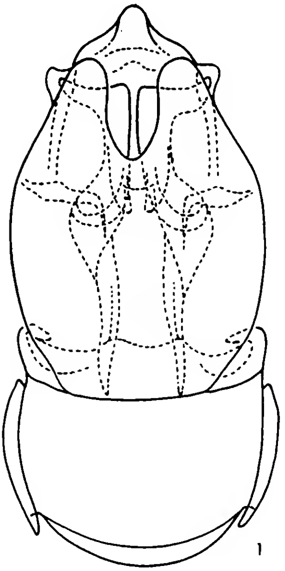
The completely rimmed pronotum, the protibia without an apical posterolateral denticle, and the distinctive aedeagus of *Psephenops prestonae* (Figures 1, 2) will distinguish it from the similar *P. maculicollis.*

Psephenops maculicollis Darlington, 1936

Figures 3, 4

Diagnosis: Head black. Pronotum reddish yellow, darker across base; with large, round shining, piceous mark on disc extending from apex to a point 2/5 from base and extending as a fine line on carina on meson almost to base; narrowly rimmed laterally and posteriorly. Scutellum reddish brown. Protibia with distinct, apical, posterolateral denticle. Aedeagus as illustrated (Figures 3, 4).

Specimens examined: COSTA RICA: SAN JOSE: San Isidro (1 mi S), Rio General, 1 July 1967, Paul J. Spangler, 6 ♂, 1 ♀; deposited in the National Museum of Natural History, Smithsonian Institution.



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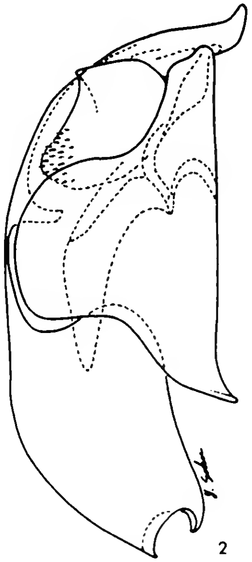

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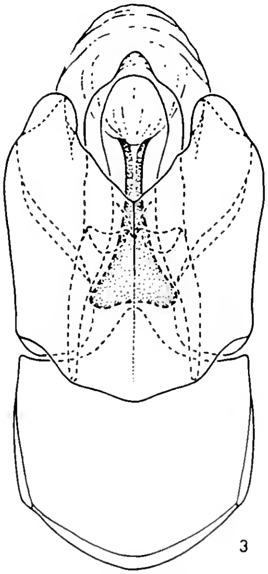

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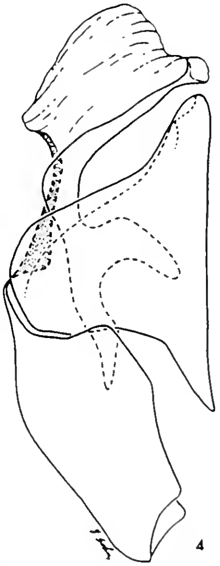

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Figures 1 and 2. *Psephenops prestonae*, new species, holotype, aedeagus. 1, ventral view; 2, lateral view.

Figures 3 and 4. *Psephenops maculicollis* Darlington, aedeagus. 3, ventral view; 4, lateral view.

ACKNOWLEDGMENTS

I thank the following individuals for their help in making this species known: Warren E. Steiner, for collecting and making available this new species and many other aquatic beetles for my research; Young T. Sohn, Smithsonian Institution Biological Illustrator, for the line drawings; and Phyllis M. Spangler, for typing the manuscript.

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NEW RECORD AND RANGE EXTENSION FOR *RHYACOPHILA WALLOWA* (TRICHOPTERA: RHYACOPHILIDAE) FROM ROCKY MOUNTAIN NATIONAL PARK, COLORADO[1]

Scott J. Herrmann[2]

ABSTRACT: *Rhyacophila wallowa* is reported for the first time from Colorado. This record represents a southeastern extension of the known range of the species. Current state distribution records of *R. wallowa* include OR, CA, WA, MT, ID, WY, UT and CO.

Three adult males of *Rhyacophila wallowa* Denning were collected in Rocky Mountain National Park (RMNP), Larimer County, Colorado, on 3 August 1984. The specific collection site in RMNP was at the confluence of Fall River and Chiquita Creek at an altitude of 2640 m amsl (8660 ft amsl) in T5N, R74W, Sll on the east side of the Continental Divide. The three adults were collected by the author with a standard sweep net at sunset. This is the first reported record of *R. wallowa* from Colorado.

Denning's (1956) holotype male was collected 15 July 1949 from the Wallowa River, Wallowa County, Oregon. Anderson (1976) and Wold (1974) reported several other Oregon sites in addition to some from Washington, Idaho, northern California and northern Wyoming. Wold's (1974) Wyoming record is a single metamorphotype male collected from the Gardner River, Yellowstone National Park, 12 July 1961. Baumann and Unzicker (1981) included *R. wallowa* in their checklist of Trichoptera of Utah, as did Newell and Potter (1973) and Roemhild (1982) of Montana. In Montana Roemhild (1982) commonly found this species in cold alpine streams east and west of the Continental Divide.

The first published record from Colorado represents a southeastern extension of the known range of *R. wallowa*; it also represents the sixteenth species of *Rhyacophila* to be reported from Colorado (Herrmann, Ruiter and Unzicker 1986). Other species of Trichoptera collected simultaneously with *R. wallowa* at the Fall River (RMNP) site included: *Rhyacophila hyalinata* Banks, *Rhyacophila harmstoni* Ross, *Ecclisomyia maculosa* Banks, *Oligophlebodes minuta* (Banks), *Onocosmoecus unicolor* (Banks), *Agrypnia deflata* (Milne) and *Hydropsyche oslari* Banks. Ruiter and Lavigne (1985) stated that little is known about the habits of this species. At the RMNP collection site Fall River is classified as a cold, lower montane, second-order stream and Chiquita Creek as a cold,

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lower montane, first-order stream.

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HPLABEL: A PROGRAM AND MICROFONT FOR THE GENERATION OF DATE/LOCALITY LABELS USING A LASER PRINTER[1]

D. Christopher Darling[2], R. C. Plowright[3]

ABSTRACT: A computer program for the direct generation of date/locality labels for pinned insect specimens is described. These labels are compared with those produced by offset printing and by reduced photocopying.

One of the major bottlenecks in the curation of insect collections is the generation of date/locality labels for specimens. For pinned and pointed specimens, these labels have to be small (approximately 25 characters per inch), permanent, and legible. Most insect collections now use a two-step process to produce labels. First, labels are printed either with a typewriter or a printer in a standard font (usually 10-12 characters/inch) and a paste-up board is assembled. A "stat" is prepared by photographically reducing the board to produce a master of the required size when the paste-up board is filled. Labels are then offset printed onto high quality paper (i.e. high rag content, acid neutralized). These labels are of excellent quality (Fig. 1d) but labels cannot be efficiently generated until a paste-up board is filled, which can result in a delay of many months in the preparation of the final labels. Some collections produce labels only 2 or 3 times a year. In addition, offset printing usually has a minimum run of at least 50 copies per original, resulting in many wasted labels for small lots of specimens.

These constraints on the efficient generation of date/locality labels have no doubt resulted in the loss of a great deal of valuable ecological and distribution data. Very general labels are often used, giving only a minimum of information, e.g. U.S.A., OR: Benton Co., June 1988, D.C. Darling. Often much more detailed information is contained in field notes, but these data often fail to become associated with specimens because of inefficiencies in label production, and are ultimately lost. One solution is to produce "generic" labels for collecting localities and to add a second label with more specific ecological information, such as floral associations, hosts, or collecting method. There are at least two problems with this approach: double labelling is time consuming and affords an additional opportunity for mislabelling; and insect speci-

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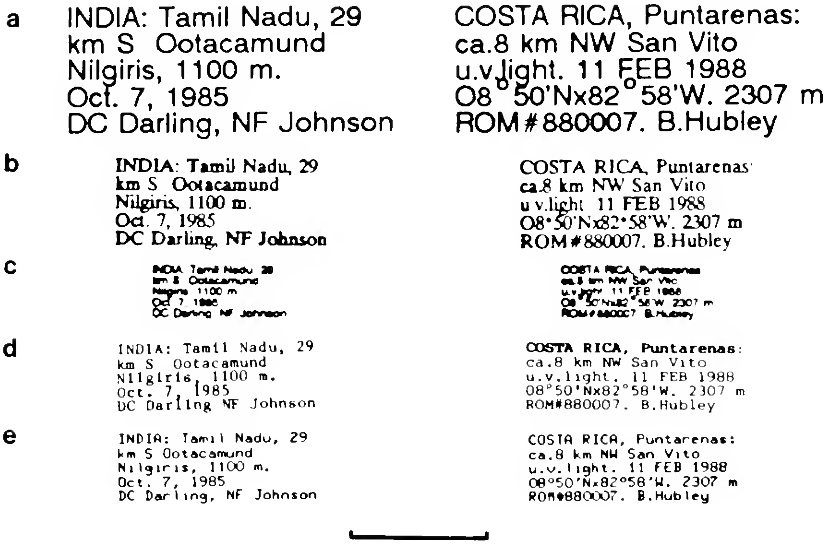
mens can quickly become cluttered with labels.

Many collections and collectors have experimented with producing date/locality labels with reducing photocopy machines. When printed on high quality paper these labels have the required permanence and can be produced quickly, but usually with considerable wastage of paper. Two reductions of 64% are necessary to produce labels of the correct size and the final labels lack the clarity of offset printed labels (Fig. 1b,c). These labels are generally regarded as unacceptable by major museums as a standard curatorial procedure.

Computer programs that have been published for generating insect labels on a microcomputer are either very basic (Kissinger 1982) or primarly concerned with the mechanics of generating multiple copies of labels and storing and managing files of labels (Ellis *et al.* 1985). These programs streamline the production of output suitable for assembling paste-up boards but do not generate labels directly. Labels must still be reduced for offset printing or with a photocopy machine.

Laser printing technology is ideally suited to the production of labels



a

INDIA: Tamil Nadu, 29
km S Ootacamund
Nilgiris, 1100 m.
Oct. 7, 1985
DC Darling, NF Johnson

COSTA RICA, Puntarenas:
ca.8 km NW San Vito
u.v.light. 11 FEB 1988
08°50'Nx82°58'W. 2307 m
ROM#880007. B.Hubley

b

INDIA: Tamil Nadu, 29
km S Ootacamund
Nilgiris, 1100 m.
Oct. 7, 1985
DC Darling, NF Johnson

COSTA RICA, Puntarenas
ca.8 km NW San Vito
u.v.light 11 FEB 1988
08°50'Nx82°58'W. 2307 m
ROM#880007. B.Hubley

c

d

INDIA: Tamil Nadu, 29
km S Ootacamund
Nilgiris, 1100 m.
Oct. 7, 1985
DC Darling NF Johnson

COSTA RICA, Puntarenas:
ca.8 km NW San Vito
u.v.light. 11 FEB 1988
08°50'Nx82°58'W. 2307 m
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e

INDIA: Tamil Nadu, 29
km S Ootacamund
Nilgiris, 1100 m.
Oct. 7, 1985
DC Darling, NF Johnson

COSTA RICA, Puntarenas:
ca.8 km NW San Vito
u.v.light. 11 FEB 1988
08°50'Nx82°58'W. 2307 m
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Figure 1: A comparison of date/locality labels. a, laser printer with smallest commercially-available font, 6 point Helvetica. b, HP laser printer (10 point Times Roman) and two photocopy reductions of 64% (40% of original) with Kodak Ektaprint 150. c, laser printer (6 point Helvetica) and two photocopy reductions of 64% (40% of original) with Kodak Ektaprint 150. d, offset printing. e, HPLABEL. Scale line, 1 cm.

for pinned or pointed specimens. The printing process results in extremely high quality labels which should have excellent long term permanence under normal storage conditions. There is, however, some concern about the permanence of laser printed labels for specimens stored in alcohol or when labels are exposed to various reagents and high temperatures [see Insect Collection News, 2(2):26-27 (1989)]. Microcomputers and laser printers (LaserJet series II) are quickly becoming a standard feature of most museum and university departments. Unfortunately, the smallest available fonts (6 point) are too large to directly generate date/locality labels (Fig. 1a). Alternatively, commercially-available desktop publishing programs are available to generate labels directly. These tend to be rather cumbersome, requiring considerable word processing skills, and cannot be incorporated easily into programs for generating multiple copies of individual labels. For example, Fancy Font can generate high quality 3 point labels. We present here an edited microfont and computer program (HPLABEL) for the direct production of date/locality labels using an IBM-PC (or compatible) microcomputer and Hewlett-Packard LaserJet Series II printer.

The microfont is an edited version of a public domain font supplied to us by Henry Spencer (Department of Zoology, University of Toronto). A BASIC program was written by CP to streamline the generation of labels. The program uses either BASICA or GWBASIC and prompts the user for up to 5 lines of label data. After previewing the label, the user is asked how many copies of the label are required. The program then prompts for additional labels. The labels are stored in a buffer and printed to efficiently use label paper.

Figure 1 compares labels produced by HPLABEL (Fig. 1e) with standard labels generated by offset printing (Fig. 1d) and with labels generated by a reducing photocopy machine (Fig. 1c). Although not as sharp as offset printing, we think that the HPLABELS are acceptable for the routine labelling of specimens. These labels are clearly superior to those produced by a 40% reduction of either 10 point (Fig. 1b) or 6-point fonts (Fig. 1c). With these reduced labels the letters run together making the labels difficult to read and the labels are either too large (Fig. 1b) or too small and illegible (Fig. 1c).

This program is currently being used for label production in the Department of Entomology, Royal Ontario Museum. A copy of the font, program and operating instructions is available by sending a formatted 5.25 inch diskette to DCD.

ACKNOWLEDGMENTS

We thank Henry Spencer (Department of Zoology, University of Toronto) for supply-ing the initial font, Allma Edwards (Department of Entomology, American Museum of Natural History) for bringing Fancy Font to our attention, and David Grimaldi and James Woolley for comments on the manuscript.

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BOOK REVIEW

WORLD CROP PESTS. W. Helle, Editor in chief. 1989. Elsevier Publ. Co., Amsterdam, The Netherlands, and P.O. Box 1663, Grand Central Station, New York, NY 10163

VOL. 2. APHIDS: THEIR BIOLOGY, NATURAL ENEMIES, AND CONTROL. A.K. Minks & P. Harrewijn, eds. 1989. Vol. 2A 450 pp., $176; Vol. 2B 382 pp., $169; Vol 2C 322 pp., $145.

Vol. 2A contains chapters on morphology and systematics; anatomy and physiology; reproduction, cytogenics, and development; biology; aphids and their environment; evolution; and structures of population and species.

2B includes two long chapters on techniques and natural enemies.

2C also contains just two chapters: Damage by aphids and control of aphids. The latter includes, among the nine subjects, biological control, host plant resistance, and behavioral modification. The black & white photographs, tables and graphs are not numerous, but are of high quality. Comprehensive lists of references follow each chapter. Slight deficiencies in coverage of North American papers are more than compensated for by the inclusion of European papers that are rarely seen here.

The series title implies that these large-format (8 1/2" x 12") books may only be of interest to economic entomologists. However, a broad range of subjects, by a large number of world authorities, is included. The series will be useful reference to workers in many subdisciplines of entomology, in addition to those concerned with arthropod control.

The sample (Vol. 2C) that I received contains up-to-date reviews and syntheses of the vast world literature. The scope and depth are most ambitious. The cost is not as high as it appears because the large format includes approximately 30% more information per page than the average (6" x 9") book.

Volumes 1 (Spider mites) has also been published, and several others are in preparation.

- William H. Day,
Beneficial Insects/Lab., USDA
Newark, DE

MICROCYLLOEPUS FORMICOIDEUS (COLEOPTERA: ELMIDAE), A NEW RIFFLE BEETLE FROM DEATH VALLEY NATIONAL MONUMENT, CALIFORNIA[1]

William D. Shepard[2]

ABSTRACT: *Microcylloepus formicoideus* sp. nov. is described from Travertine Springs, Inyo Co., California. A survey of local permanent springs indicates that the species only exists at the type locality. Relationships with other congeners is discussed.

Microcylloepus was erected in 1935 by Hinton for the sole species *Stenelmis pusillus* LeConte. Since then, 24 other species have been added to the genus (Brown 1981). *Microcylloepus* is essentially a Neotropical element that has invaded the Nearctic. Within the US occur five described species and perhaps several undescribed species. The eastern *M. pusillus* has had four subspecies described but they represent only color morphs. Populations have been found that have all the morphs co-occuring. In the western Nearctic several species have been taken, particularly from warm springs in the Basin and Range desert. Also in the western US occurs *M. similis* Hinton which has long been considered to be a subspecies of *M. pusillus*. Although it resembles *M. pusillus* in many aspects, it is a valid species, as is seen with a side-to-side comparison and when examining the genitalia.

In the course of a survey of the riffle beetles of Death Valley two new species were discovered. One is described here; the second presents a more complicated problem requiring more analysis and will be described later.

Microcylloepus formicoideus new species

Body: Body elongate, parallel-sided (Fig. 1); 1.29-1.53 mm in length, 0.50-0.56 mm in width. Surface coarsely punctate and coarsely asperate; sculpturing very pronounced. Dorsum, head and hypomera black; sterna and legs rufous; antennae and palpi testaceous. Legs projecting well beyond sides of body.

Head: Head withdrawn into prothorax up to eyes. Dorsum densely granulate and punctate; setae thick, arcuate, decumbent and separated by approximately half their length. Genae and postocular areas smooth; setation fine, dense and decumbent. Frons with fronto-clypeal suture almost straight; angles slightly obtuse, raised, and continuing around base of antennae. Clypeus with apex broadly arcuate; angles broadly rounded. Labrum with apex straight, sides diverging slightly to base; surface shiny and alutaceous; setation sparse, fine and straight on disc and apically dense, coarse and curved. Mandibles

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[1] Received October 30, 1989. Accepted March 7, 1990.

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with 3 short teeth; prostheca present; lateral lobe large. Maxillae with 4-segmented palp, last segment 2.5 times as long as wide, segments 1-3 subequal and half the length of the last; galea digitiform, apically with several stout curved setae; lacinia elongate-rectangular, fused to stipes, medially with several stout setae, apically with many stout setae with curved tips forming a multitiered brush; cardo subrectangular and divided by an oblique suture. Labium with 3-segmented palpi borne on short palpigers; mentum and submentum with numerous setae; prementum reduced to palpiger; ligula apically with 20-25 cultriform setae. Antennae 11-segmented with pedical and scape longer and wider than following segments except for eleventh which is twice as long as penultimate and cultriform.

Pronotum: Surface densely granulate and punctate, granules separated by own width, punctae smaller and contiguous. Length slightly greater than greatest width. Sides bisinuate, explanate and convergent both apically and basally; margins dentate; apices projecting beyond anterior margin. Disc in basal half with Y-shaped carina connecting to sublateral carinae; moderately convex in apical half; median longitudinal depression in middle half with length 3 times width. Sublateral carinae broken at one-half; basal pieces apically swollen.

Scutellum: Shape ovoid, widest near base; surface flat and granulate.

Elytra: Surface densely granulate and punctate; setation as on dorsum of head. Striae with punctae basally very large and nearly confluent, becoming smaller apically but extending almost to apex. Second, fourth and sixth intervals flat, almost obliterated basally by large punctae. First intervals slightly raised. Third, fifth and seventh intervals carinate, seventh interval carinae reaching almost to apex, third interval carinae reaching just past one-half, fifth interval carinae intermediate in length. Fifth and seventh intervals joined at humeri which are only slightly wider than base of pronotum. Epipleura extending almost to apex.

Wings: Only short basal portions remain.

Prosternum: Surface granulate with widely spaced setae. Anterior margin straight across middle with sides broadly rounded dorsally; margin projecting under head and covering most of mouthparts. Anterior half of prosternum strongly directed ventrally. Prosternal process depressed in middle and apically broadly rounded. Prosternal carinae prominent, broadly V-shaped and forming raised margins of prosternal process. Hypomera densely granulate and coarsely asperate. Episterna strongly directed dorsally.

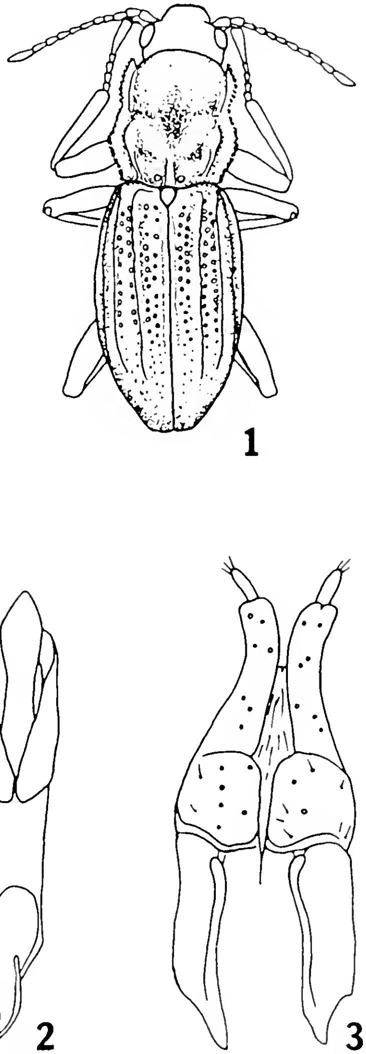
Mesosternum: Surface as on prosternum. Disc depressed and pentagonal; median longitudinal sulcus present on apical half; posterior margin raised and slightly arcuate. Mesosternal carinae prominent and bordering mesocoxal cavities.

Metasternum: Surface and sculpturing as in mesosternum. Median longitudinal sulcus deeper than mesosternal sulcus, cleft-like and in apical half of metasternum. Posterior margin arcuate. Metasternal carinae broadly divergent from base.

Legs: Legs long and narrow. Pro- and mesocoxae globular; metacoxae transverse. All coxal cavities open. Femora and tibiae long, subequal to pronotal length. All surfaces granulate, except for tarsomeres which have only scattered granules. Tarsi with two ventral rows of short, coarse setae. Last tarsomere with ventral apex prolonged into a tooth about as long as broad.

Abdomen: First sternite with prominent carinae strongly divergent in anterior half, then parallel or slightly convergent to posterior margin; disc anteriorly depressed and sloping up to posterior margin of sternite, asperate and with scattered large granules; sides directed dorsally. Second, third and fourth sternites similar; medially asperate with scattered large granules, number of granules declining posteriorly. Fifth sternite with only a few granules medially; lateral margins produced into teeth which clasp epipleura.

Genitalia: Male with median lobe constricted medially and broadly attenuated apically; parameres almost parallel-sided, apices curving under median lobe (Fig. 2). Female with sinuate baculi; hemisternites as long as broad; styli relatively short and curved (Fig. 3).



Figs. 1-3. *Microcylloepus formicoideus* sp. nov. 1, adult, dorsal view. 2, male genitalia. 3, female genitalia.

Tomentum: Occurs on genae, femora, medial surface of distal half of tibiae, pro- and mesepimera, lateral portions of meso- and metacoxae, and lateral portions of all abdominal sternites.

DIAGNOSIS

M. formicoideus is readily distinguished from all other North and Central American congeners by its small size and relatively long legs (these characters give the ant-like appearance that suggested its name). Also very diagnostic is the lack of distinct elytral humeri, a result of brachyptery (H. P. Brown, pers. comm.). This character is shared with *M. angustus* Hinton from Mexico (Hinton 1940). The latter is somewhat larger and possesses a distinctly different aedeagus. The male genitalia of *M. formicoideus* have parameres resembling those of *M. thermarum* Darlington while the median lobe is similar to that of *M. inaequalis* (Sharp) and *M. moapus* La Rivers. However, the genital characters involve subtle differences and Hinton (1940) notes that " a number of species may have the structure of the male genitalia identical."

TYPE LOCALITY

The type locality is: CA, Inyo Co., Death Valley National Monument (DVNM), 2.5 miles (4 km) east of Death Valley (along US Highway 190), Travertine Spring. The spring heads are numerous and their outflows combine while flowing southward toward the highway. Upon reaching the highway all flow is channeled into a concrete-lined canal that crosses under the highway and parallels it westward toward Furnace Creek Inn, the local hotel. *M. formicoideus* occurs in the spring heads and along the stream course almost to the road. Initially *M. formicoideus* occurs alone in the springhead but it is eventually replaced along the stream course by another congener.

An extensive survey of other DVNM water sources showed this to be the only locality where *M. formicoideus* occurs. The benthic community along the spring outflows is remarkably diverse and may represent the most diverse aquatic insect fauna in DVNM. This area and community certainly deserve protection and preservation. Texas Spring (which is closer to the hotel, campgrounds, date-palm orchard and visitors' center) has been completely diverted to human water uses. Whatever community was there is now lost. Because of the proximity of the two springs, and the great likelihood that their outflows were contiguous, their communities were probably the same. Thus the benthic community in Travertine Spring probably represents the only remaining portion of a much larger community.

TYPES

Holotype male, allotype female and 37 paratypes collected 23/I/1984 by WDS from Furnace Creek canal, a concrete canal diverting water to Furnance Creek Wash from Travertine Springs. Additional paratypes from the type locality include 53 collected by WDS on 16/IV/1984, 134 collected by Hugh Leech on 25/XII/1962, and 26 collected by Raymond Bandar on 25/XII/1962. The holotype, allotype and several paratypes will be deposited in the National Museum of Natural History at the Smithsonian Institution. Additional paratypes will be deposited in the collections of Harley P. Brown (Norman, OK), Louisiana State University (Baton Rouge, LA), William D. Shepard (Sacramento, CA), Death Valley National Monument museum (Death Valley, CA), the California Department of Food and Agriculture (Sacramento, CA) and Monte L. Bean Museum at Brigham Young University (Provo, UT). The Leech and Bander paratypes are in the collection of the California Academy of Sciences (San Francisco, CA).

ETYMOLOGY

The name *M. formicoideus* is chosen to note the slender body and long legs which give individuals an ant-like appearance.

DISCUSSION

In Brown (1972) this species keys to couplet # 70 which separates *M. browni* (Hatch) from *M. moapus*. *M. formicoideus* can be distinguished from *M. browni* by its smaller length and width. *M. formicoideus* can be distinguished from *M. moapus* by several characters: smaller size; black versus brown dorsal color; elytra with more pronounced carinae and punctae, surface more asperate and less shiny; anterior portion of prosternum more strongly directed ventrally. In Hinton's (1940) work on Mexican elmids, *M. formicoideus* keys to *M. angustus* from which it can be distinguished by several characters: general surface densely granulate; longer carina on third intervals; sides of prosternal process not parallel; metasternal carinae strongly divergent; first abdominal sternite with carinae parallel posteriorly.

M. thermarum is a closely related species from which *Microcylloepus formicoideus* varies in its more pronounced elytral sculpturing. In *M. thermarum* the third elytral intervals are only slightly prominent, the fifth intervals are flat and the seventh intervals have "fine, inconspicuous costae" (Darlington 1928).

This new species, with its putative close relationship with *M. moapus*, *M. thermarum*, and *M. angustus*, recalls La Rivers' (1949) prediction of intervening forms indicating all to be just intergrading populations of one species. While close examination reveals character differences equivalent to those between other species of *Microcylloepus*, one is led to wonder about the effects of the similar habitats in which these species live. Hinton (1940) doesn't mention the habitat for *M. angustus*, but all the rest come from warm springs. The relatively uniform warm temperatures may well alter developmental pathways leaving morphological variation canalized. Sweeney (1984) indicates that higher tempertures may maximize larval developmental rates leading to smaller than normal adults. Another species inhabiting warm springs in the Owens Valley of California has lost temporal synchronization of pupation (WDS, unpublished data). Alternatively, one may assume that this species group represents a different lineage from that including *M. pusillus*, which exists throughout the eastern half of the US. The genus is sorely in need of revision. Only then can questions of the source of variation in *Microcylloepus* be properly answered.

ACKNOWLEDGMENTS

Hugh Leech kindly loaned specimens from his collection and copies of portions of his personal field notes. Both Hugh Leech and Harley P. Brown provided copies of their correspondence regarding this species. The California Academy of Sciences provided space and equipment to study their specimens. The staff of Death Valley National Monument provided access to collecting sites, much information and other valuable assistance without which this work could not have been accomplished. Part of this study was accomplished during a summer research position at the University of Oklahoma. I thank H. P. Brown and C. B. Barr for reviewing the manuscript.

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SOCIETY MEETING OF MARCH 28, 1990

EVOLUTION AND HYBRIDIZATION OF ADMIRAL BUTTERFLIES

Dr. Austin P. Platt, Speaker

Insect taxonomists beware! If all groups are as interesting and complex as the butterfly genus *Limenitis*, most disputes between lumpers and splitters may never be resolved. Only in recent years, more than a century after the principal morphological types were described, has a reasonable understanding of the relationships among admiral butterflies emerged. As Nobelist Arthur Kornberg once said, "I have yet to see a complicated problem which, when looked at in the right way, doesn't become more complicated."

Dr. Austin P. Platt of the University of Maryland, Baltimore County, has studied the genetics and speciation of admiral butterflies for more than two decades. These well known and widely distributed butterflies include the viceroy, *Limenitis archippus*; the banded purple, *L. arthemis arthemis*; the red-spotted purple, *L. a. astyanax*; Weidemeyer's admiral, *L. weidemeyerii*; and Lorquin's admiral, *L. lorquini*. The latter four are really allopatric races of a single "super species" which, except for *arthemis* and *styanax*, rarely hybridize in the wild. Subspecies of the viceroy, *L. a. archippus* and *L. a. floridensis*, are mimics respectively of the monarch, *Danaus plexippus*, and the queen, *D. gilippus*. Similarly the red-spotted purple and Lorquin's admiral are thought to be mimics of the pipevine swallowtail, *Battus philenor*, and the California sister, *Adelpha bredowii*. Based on cladistic analyses and considerations of geographical distribution, all mimetic forms of *Limenitis* are probably derived from an ancestral form resembling the northern banded purple.

The banded phenotype is widespread in related genera and is controlled by a single autosomal gene. Genetic analyses of natural and laboratory hybrids between various species and subspecies of *Limenitis* indicate that several genes modify the banding pattern. Dr. Platt offered the intriguing hypothesis that the distinctive nonmimetic transvese black band on the hind wing of the monarch-like viceroy represents the vestige of a dark-margined white band that has collapsed as the result of modifying genes. The plausibility of this hypothesis was strengthened by comparing the wing patterns of hybrids between the viceroy and each of the members of the *L. arthemis* super species group that were displayed by Dr. Platt (See Bull. Ent. Soc. Am. (1983) 29(3): 10 - 20).

In addition to a discussion of the evolutionary relationships within *Limenitis*, Dr. Platt discussed their interesting life cycle. The eggs are commonly laid on willow or aspen leaves. They look like minature geodesic domes. The larvae that hatch from them establish characteristic feeding stations. In response to photoperiod, halfgrown 3rd instar larvae accumulate glycerol as a natural antifreeze and retreat to hibernacula in which they overwinter. These leaf-enclosed structures are easy to recognize and can be collected for population studies.

Dr. Platt's talk at the University of Delaware was attended by seventeen members and four guests.

- Harold B. White
Corresponding Secretary

THE STATUS OF *PISON DOGGONUM* (HYMENOPTERA: SPHECIDAE)[1]

Arnold S. Menke[2]

ABSTRACT: *Pison doggonum*, originally described from Mexico, is a member of the western Pacific island fauna and may be a synonym of *P. iridipenne*.

Pison doggonum Menke was described in 1988 from a single female specimen labelled simply "Mejico, Mus. Drews." It now appears that the holotype had erroneous locality data. Recently while examining some *Pison* from islands in the western Pacific Ocean I noted that specimens of *P. iridipenne* Smith looked similar to *doggonum*. *Pison iridipenne* occurs in Hawaii, Fiji, Samoa, Society Islands, Tuamotu Archipelago, Bolabola Is., Marquesas, Bismarck Archipelago, and islands in Micronesia (Krombein, 1949, Bohart and Menke, 1976, Tsuneki, 1982). I borrowed the holotype of *doggonum* from the Zoologisk Museum in Copenhagen, and compared it with material of *iridipenne* identified by Karl Krombein. The two taxa appear identical and *doggonum* may be a junior synonym, although Krombein (1949) suggests that *iridipenne* is possibly a complex of species in which the males offer the best differences. For that reason I think it would be premature to synonymize *doggonum* with *iridipenne*. In any event, *diggonum* should be considered as a member of the western Pacific insular fauna, and not the Neotropical Region.

The discovery just related underscores the fact that describing new species from single, ancient specimens with meagre locality data is a risky, unwise business.

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DISTRIBUTIONAL NOTES ON NORTH AND CENTRAL AMERICAN DILARIDAE (NEUROPTERA)[1, 2]

Kevin M. Hoffman[3]

ABSTRACT: *Nallachius americanus* is recorded from South Carolina and central Georgia and a male of *Nallachius pulchellus* is reported from Costa Rica. An emendation is made to the existing key for New World Dilaridae to accomodate the presence of a forked costal crossvein in each forewing of the *N. pulchellus* specimen.

The sixteen species of New World Dilaridae are rarely-collected neuropterans of which only three are known from North and Central America (Adams 1979, Penny 1981). *Nallachius americanus* (McLachlan) has been recorded from Puerto Rico, Venezuela, and the eastern United States (the District of Columbia, Florida, Georgia, Indiana, Kentucky, Maryland, Michigan, Pennsylvania, Texas and Virginia) (Gurney 1947, MacLeod and Spiegler 1961, Adams 1970, Lawson and McCafferty 1984); *Nallachius championi* (Navás) is known from only one locality in Guatemala (Adams 1970); and *Nallachius pulchellus* (Banks) has been recorded from Cuba and the southwestern United States (Arizona) (Alayo 1968, Adams 1970). The present paper records *N. americanus* from South Carolina and central Georgia, *N. pulchellus* from Costa Rica, and provides an emendation to the existing key for New World Dilaridae to accomodate the presence of a forked costal crossvein in each forewing of the Costa Rican specimen of *N. pulchellus*. All specimens are deposited in the Clemson University Arthropod Collection (CUAC), Department of Entomology.

New United States records for *Nallachius americanus*

GEORGIA: Crawford County, approximately 5 miles SSE of Roberta at Spring Creek, 8.IX.1983, UV light trap, S.W. Hamilton and R.W. Holzenthal, 1♂; SOUTH CAROLINA: Aiken County, Aiken State Park, 7.VII.1988, UV light trap, K. M. Hoffman, 1♂; Kershaw County, Spears Creek at U.S. Route 601, 2.VI.1988, UV light trap, K. M. Hoffman and J. D. Spooner, 1♂; Pickens County, Clemson University Experimental Forest surrounding Lake Issaqueena, Wildcat Creek, elevation 235 m., 12-20.VI.1988, Malaise trap. K. M. Hoffman, 1♂; same collection data except 27.VI.-4.VII.1988, 1♂.

The only previous record for Georgia was from Decatur County in the extreme southwestern corner of the state, well within the Upper Coastal Plain. The Crawford County locality extends the range of this species in

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[2] Technical Contribution No. 2993 of the South Carolina Agricultural Experiment Station, Clemson University.

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Georgia to the Sandhills region near the center of the state. The South Carolina localities in Aiken and Kershaw Counties are likewise within the Sandhills, whereas the Pickens County locality is in the upper Piedmont.

New record for *Nallachius pulchellus*

COSTA RICA: Guanacaste, Parque Nacional Guanacaste, Maritza, Río Tempisquito, 10.958 N, 85.497 W, 19-20.VII.1987, elevation 550 m., at light, R. W. Holzenthal, J. C. Morse, P. J. Clausen, 1♂.

This record represents the first dilarid reported from Costa Rica and confirms the prediction of Adams (1970) that this species would eventually be found in Central America. The specimen was identified by comparing the genitalia both with the description and figures of Adams (1970) and with the cleared genitalia of the holotype in the Museum of Comparative Zoology (MCZ), Harvard University. However, a problem was encountered when using the key of Adams (1970) because the second character used to distinguish *N. pulchellus* in couplet 6 is "costal veinlets simple," and each forewing of the Costa Rican specimen has a distinctly forked costal crossvein at half length. Furthermore, this crossvein is in approximately the same location as a forked costal crossvein figured by Alayo (1968, Fig. 10B) for a male *N. pulchellus* from Cuba. In view of the variation in this character, the phrase "costal veinlets simple" should be deleted from couplet 6 in the key by Adams (1970) and from couplet 8a in the key by Penny (1981), which was modified from the key by Adams. These deletions will not affect the second halves of these couplets and will actually alleviate some confusion, because costal veinlets were not used as characters in the second halves.

ACNOWLEDGMENTS

Gratitude is extended to Scott R. Shaw, MCZ, Harvard University, for the opportunity to examine the holotype of *N. pulchellus*. I thank Albert W. Johnson, J. Ben Kissam, and John C. Morse, Clemson University, for their helpful comments on this manuscript. Examination of the holotype of *N. americanus* was made possible by a grant from the Ernst Mayr Fund of the MCZ, and the South Carolina dilarids were collected during surveys funded by the South Carolina Heritage Trust Program and the U.S. Fish and Wildlife Service. This support is gratefully acknowledged. The collection of *N. pulchellus* in Costa Rica was conducted on National Science Foundation Grant BSR-8512368.

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BOOK REVIEW

THE ANTS. Bert Hölldobler and Edward O. Wilson. 1990. Belknap Press of Harvard University. 732 pp. $65.

CONTENTS: Introduction; Classification (139 pp.) including keys, illustrations of world genera; Colony formation and structure (36 pp.); Behavior (s.l.) (338 pp.); Communities (17 pp.); Symbiosis (120 pp.); Specialized predators, fungus growers, and harvesters (50 pp.); Weaver ants (11 pp.); Study methods (4 pp.); Glossary, bibliography, index (83 pp.)

This is an overwhelming narrative of the lives of ants, crammed with facts and ideas and glorious illustrations. There is no way that I can comment on specific facts and theories in this book; there are simply too many of them, and one cannot review an elephant by critically examining a few hairs. Suffice it to say that if you are a biologist you must have this book for the sheer excitement of its brilliantly detailed revelation of a bizarre and somehow symbolic world, like one of the busier visions of Hieronymus Bosch. If you are a myrmecologist you will just have to get used to lugging around a 7-lb. volume, because it will be difficult to study, or even think about ants, without this book at hand.

In an age of books that are edited hodgepodges of disparate authors, *THE ANTS* is unique in both its exhaustive coverage and its cohesion. I wish I could say it was a practical model for scientific writing, but the fact is that few of us are up to such a tour de force. Anybody who has attempted to meld information from a dozen references into a succinct and literate paragraph knows the difficulty of such a task; Hölldobler and Wilson do this, apparently effortlessly, for hundreds of pages, utilizing thousands of different references. Enormous numbers of studies are briefly described, with the inclusion of exactly the primary data one might need to draw one's own conclusion, even though the authors have supplied their personal interpretations. In other words, the authors, experts though they are, write for an audience presumed to have its own initiative and powers of deduction In another eschewal of arrogance, the authors avoid sarcastic treatment or unceremonious dumping of the less plausible theories that circulate through myrmecology. Throughout the book there is an emphasis on fascinating unanswered questions, thereby providing both foundation and direction for future work.

To write such a book, one must, at least temporarily, deliver oneself over to obsession. Thus, though "communites" of ants and ant-plant symbioses are carefully analyzed, there is relatively little coverage of the role of ants in entire ecological communities, and almost an avoidance of the dreadful topic of ants as the principle fodder of a host of other animals, including many vertebrates. The limitations of sociality are hardly explored, so after reading the book one might wonder how there can be more than a million species of arthropods not apotheosized into sociality. Still, it is an obsession that is never tedious, always creative. Even the statement (Chapt. 1) that humans and ants represent the summits of evolution in vertebrates and arthropods respectively, manages to create a rather endearing new hybrid bias: antopocentrism.

To see this book is to covet it, and the price is modest. *THE ANTS* is destined to become as widely distributed as its extraordinary subjects.

FIRST UNITED STATES RECORD OF *ASCALOBYAS* (NEUROPTERA: ASCALAPHIDAE), A RANGE EXTENSION FROM NORTHEASTERN MEXICO TO TEXAS[1]

Roy C. Vogtsberger[2]

ABSTRACT: A female specimen of *Ascalobyas albistigma* (Neuroptera: Ascalaphidae), collected west of Juno in August, 1973 from Val Verde Co., Texas, was discovered in the Midwestern State University (Texas) insect collection. This is the first record of this genus in the United States and extends its known range by approximately 575 miles (925 km.).

While identifying the Neuroptera in the Midwestern State University insect collection, the author discovered a very large and peculiar owlfly in the collection. The specimen was collected west of Juno in Val Verde Co., Texas in August, 1973 by H. L. Horry, graduate biology student. The specimen was probably caught with an aerial net, since the habitat on the collection label read "air".

The Texas specimen was readily assigned to the ascalaphid subfamily Haplogleniinae, since the eyes were entire and not divided by a transverse sulcus. According to the literature, *Ascaloptynx* (or *Neuropteryx*) had previously been the only members of this subfamily known to occur in the United States. The distinguishing feature of this genus in the New World, besides the entire eyes, is the petiolate wings, with forewings having a prominent thumb-like projection on the posterior margin near the base of each wing. Penny (1981) placed *Ascaloptynx* in the tribe Verticillecerini.

Since the specimen in question lacks petiolate wings and the prominent thumb-like projections, it is assigned to the tribe Haplogleniini. Penny (1981) recognized three genera of American Haplogleniini: *Amoea, Ascalobyas*, and *Haploglenius*. The Texas specimen was assigned to *Ascalobyas* on the basis of the antennae being shorter than half the length of the forewing, costal field of forewing and apical fourth of all wings being dark brown, and the yellowish-white pterostigmas. Penny (1981) presented *Ascalobyas* as a new genus because the old genus name, *Byas* Rambur, 1842 was preoccupied.

Weele's (1908) monograph with descriptions of the two known species of *Byas* (=*Ascalobyas*) mentions the type species, *microcerus* Rambur, as an eastern and Antillean species and a western species, *albistigma* (Walker). He suggested they could be combined under one species,

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[1] Received July 6, 1989. Accepted January 2, 1990.

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because the terminalia are superficially quite similar, and the extremely small differences are never constant. However, he chose to maintain them as two distinct species due to lack of transitional forms from the intermediate region of the two species' distributions. Measurements of the Texas specimen (Table 1) and color descriptions most nearly coincide with those given by Weele (1908) for the western *albistigma*, which would be logical for a Texas locality.

The northernmost published record for *Ascalobyas albistigma* (Walker), 1853 is San Pedro Sula, Honduras (Weele, 1908). Penny (1981) reported that "*Ascalobyas* is presently known from two species ranging from northern Brazil to Panama," but mapped the distribution of *Ascalobyas* to extend northward to San Pedro Sula, Honduras. The statement, therefore, was probably an error and should have read, "...from northern Brazil to Honduras". This makes the Texas specimen a 1343 mile (2161 km.) range extension from the northernmost published record for the species.

Oliver Flint (pers. comm., 1989), curator of Neuropteroids at the National Museum of Natural History, Smithsonian Institution, reports several examples of the species from well into northeastern Mexico in the NMNH collection. The northernmost specimens are from El Salto Falls on the San Luis Potosi-Tamaulipas border near El Naranjo and, previous to the Texas specimen, were considered to represent the northern range extent for the genus. Therefore, the Val Verde record is a northern range extension of *Ascalobyas albistigma* by approximately 575 miles (925 km.) from El Salto Falls in northeastern Mexico to Val Verde Co., Texas, a new record for the United States. The owlfly, damaged in transit to the Smithsonian Institution as a dried specimen to be compared with the Mexican specimens, has been relaxed and is now preserved in alcohol in the Midwestern State University insect collection.

TABLE 1 - Length measurements (in mm.) of body, wings, and antennae of *Ascalobyas* females.

	Total body	Forewing	Hindwing	Abdomen	Antennae	Reference
microcerus	36	44	41	23	21	Weele 1908
albistigma	36-38	42-44	38-43.5	24	19-20	Weele 1908
Texas specimen	38	43	39	26	18	

ACKNOWLEDGMENTS

I wish to thank Oliver S. Flint, Jr. for his taxonomic expertise and valuable comments, Elsa Galbraith for her excellent translation of Weele's German monograph of the Ascalaphidae (1908), Norman Horner, Fred Stangl, Jr., and anonymous reviewers for critically reviewing earlier drafts of this manuscript, and Horner for making the Texas specimen of *Ascalobyas* available for study.

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SOCIETY MEETING OF APRIL 25, 1990

PATTERNS IN NATURE

Dr. Richard Weber, Speaker

Dr. Richard Weber, entomologist from the University of Delaware and eminent insect photographer, treated his audience of 21 members and 30 guests to a unique experience. Not only did he show them remarkable pictures of insects but he also regaled them with his world view, quick wit, and playful humor. While many seek to learn and emulate Dick Weber's technical skills, it was evident that technique, though important, was peripheral to the real essence of his photography. Pretty pictures come to life when they tell a story or provoke a question. As Albert Szent-Gygörgyi said, "See what others have seen, but think what no one has ever thought." Dick Weber's success comes from photographing what he thinks.

It was not possible to be passive in the audience because questions, banter, and repartee were part of the show. "What's going on here? What good are cryptic or aposematic coloration against night predators? Does anyone know the name of this plant? Has anybody seen this? Can you imagine the smell I put up with photographing maggots on that rabbit carcass? Did you ever see a bird dropping that looked like an insect? Look at that, a fly eating a wasp!" These were part of the barrage of illustrated, thought-provoking comments and anecdotes from an evening that was memorable for other reasons as well.

Prior to Dr. Weber's talk, President Roger Fuester presented the annual Calvert Prize to Jennifer Reynolds for her science fair project, "Does the color of light affect the reproduction of *Drosophila melanogaster*?" She and the first and second runners up, Kimberly Wallace and Chaitanya Rao, displayed their insect-related projects. Margot Livingston, the first Calvert Prize recipient in 1987, was present for the ceremony.

In addition to the Calvert Prize, special certificates of appreciation were presented to unsuspecting members of the Society for their great commitment and continuing contributions to the Society. Howard P. Boyd, president from 1977-1981 and editor of *Entomological News* since 1974, described his association with AES as one of the most rewarding and enjoyable activities of his life. Mildred Morgan, office secretary since 1979, also received a certificate of appreciation. She confided that she almost quit after three weeks but that Howard Boyd convinced her to stick it out a "bit longer." Both expressed their heartfelt thanks to the Society for the honor. Jesse Freese, treasurer since 1969, was also honored but was unable to attend the meeting.

(Continued on page 163)

BIOLOGICAL NOTES ON *DROSOPHILA GUTTIFERA* (DIPTERA: DROSOPHILIDAE), A CONSUMER OF MUSHROOMS[1]

Britt Bunyard, B. A. Foote[2]

ABSTRACT: Information is given on the life history and larval feeding habits of *Drosophila guttifera*, a species previously considered to be strictly mycophagous. Laboratory rearings indicate that larvae of this species can be polyphagous.

Patterson and Stone (1952) listed *Drosophila guttifera* Walker, a wide ranging species in the eastern and midwestern states, as "being so rare as to have nothing known about its life cycle." However, they felt that it was probably mycophagous.

The purposes of the present study were to elucidate the life history of *D. guttifera*, describe its larval feeding habits, and to determine whether the species is truly mycophagous.

MATERIALS AND METHODS

Adult flies were reared from larvae occurring in sporophores of gill-bearing mushrooms collected in an old field that is part of the Kent State University campus in Portage County, Ohio. Sporophores were placed in breeding containers containing a layer of moistened peat moss to allow emergence of adults. To establish a laboratory colony, adults emerging from the field-collected mushrooms were transferred to breeding jars containing pieces of the commercial mushroom *Agaricus bisporus* Singer. Adults emerging from commercial mushrooms were then placed in vials containing Instant Drosophila Medium (Carolina Biological Supply) and allowed to cycle. Subsequent rearings utilized such "unnatural" foods as decaying lettuce, bananas, and tomato juice.

We determined oviposition preference by offering females different food substrates and recording the number of eggs deposited on each substrate. For this study, an isoline was developed by allowing a virgin female to mate with only one male. All adults used in the preference tests were of this isoline reared on Instant Drosophila Medium.

The substrate was nutrient agar to which was added (while still liquid) homogenized aliquots of four different food sources: commercial mushroom, iceberg lettuce, tomato juice, and banana. Each of the liquid mixtures of food and agar was poured into a sterile petri plate and

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[1] Received November 1, 1989. Accepted January 5, 1990.

[2] Department of Biological Sciences, Kent State University, Kent, Ohio 44242

allowed to solidify. The ratio of sustrate to agar was 10:1 as measured by volume. Plates of pure agar were also poured to the same heights as those with food. Once solidified, four 2.0 cm diameter discs were cut from each of the agar plates. A disc taken from each of the food/agar plates were placed in holes of corresponding diameter and depth in the plain agar plates. As a control, discs of pure agar were used. Ten gravid, non-anesthetized females were then added to all test plates and allowed to oviposit for 24 hrs. at 27° C. Adults were then removed, and the number of eggs occuring on each substrate counted. Each test was replicated five times. Females were not used in subsequent tests.

Voucher specimens have been deposited in AMNH and USNM.

RESULTS AND DISCUSSION

Adults of *D. guttifera,* were reared only from sporophores of *Collybia dryophila* (Bull. ex Fr.) Kummer (Tricholomataceae) and *Psilocybe polytrichophila* Pk. (Strophariaceae) out of 44 different species of field-collected mushrooms held in emergence chambers (Bunyard and Foote, 1990). Life history data obtained for flies reared on Instant Drosophila Medium are given in Table 1.

Adult flies were successfully reared from all four food substrates as well as from plain agar on which a culture of baker's yeast was actively growing. In contrast, all larvae placed on pure agar died before forming puparia.

Tests to determine preference of oviposition site (Table 2) showed mushrooms to be the preferred food substrate. The lettuce substrate was also frequently selected, but the banana and tomato juice substrates were poorly utilized.

The laboratory rearings, particularly the frequent use of rotting lettuce as an ovipositional site, lead us to suggest that *D. guttifera,* may be capable of utilizing decaying plant material in nature and thus is not necessarily restricted to a fungal diet. Of course, countering that suggestion is the fact that adults have only been reared under natural conditions from larvae feeding in mushrooms.

Table 1. Life history data from *Drosophila guttifera* reared on Instant Drosophila Medium at 27° C. (Mean and 1 S. D.)

Incubation Period	3-4 days (x = 3.2 ± 0.5, n = 30)
Larval Period	4-5 days (x = 4.4 ± 0.4, n = 40)
Prepupal Period	2.0 days (n = 4)
Pupal Period	5-8 days (x = 6.0 ± 1.0, n = 28)
Adult Longevity	28-45 days (x = ± 3.8, n = 23)

Table 2. Results of oviposition preference tests. Tests were conducted at 27° C for 24 hrs. and involved 50 females.

Number of eggs laid on each substrate				
mushroom	banana	tomato	lettuce	agar
185	13	15	125	12

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(Continued from page 160)

In notes of local entomological interest Dr. Paul Schaefer followed up on a discussion at the November meeting. He showed a number of photographs by Dwight Kuhn of Dexter, Maine showing *Polistes* wasps that had been parasitized by the strepsipteran, *Xenos peckii.* Few in the audience had ever seen a strepsipteran, let alone pictures of the fleeting, free-living adult male mating with the grub-like parasitic female still within the abdomen of the host wasp! We all came away realizing that this odd insect is more common than first thought and no doubt paper wasps will be examined more closely this summer as a result.

Harold B. White,
Corresponding Secretary

PROPYLEA QUATUORDECIMPUNCTATA: ADDITIONAL U. S. RECORDS OF AN ADVENTIVE LADY BEETLE (COLEOPTERA: COCCINELLIDAE)[1]

A. G. Wheeler, Jr.[2]

ABSTRACT: The distribution of *Propylea quatuordecimpunctata*, an Old World aphidophagous coccinellid known in North America from Quebec, New York, and Vermont, is extended to Maine. Occurrence of this adventive predator is attributed to spread of populations along the St. Lawrence River in Quebec rather than to intentional releases for biocontrol purposes. The native and exotic plants on which *P. quatuordecimpunctata* was collected in Maine and at an additional site in Vermont are listed; probable aphid prey are noted.

The Palearctic coccinellid *Propylea quatuordecimpunctata* (L.) feeds on numerous European aphid species associated with diverse crops and habitats. Evaluated in Oklahoma for its biocontrol potential against the greenbug, *Schizaphis graminum* (Rondani) (Rogers *et al.* 1972 a,b), it was released in Delaware, New Jersey, and Oklahoma beginning in 1970. Attempts to establish this predator were unsuccessful (Gordon 1985, Dysart 1988).

At about the time that *P. quatuordecimpunctata* was imported from France by the U. S. Department of Agriculture (Rogers *et al.* 1971), an established population was detected in North America during 1968 near Ste. Foy, Quebec (Chantal 1972). Its fortuitous introduction into eastern Canada thus predated intentional releases in the United States.

Subsequent collections in Quebec, mostly along the St. Lawrence River, led Larochelle and Larivière (1980) to suggest that it had been introduced with ship traffic associated with the St. Lawrence Seaway. Dysart (1988) and Schaefer and Dysart (1988) concurred that this coccinellid probably was accidentally introduced into the New World. By 1987, *P. quatuordecimpunctata* had been collected in 14 counties in Quebec, Chittenden and Grand Isle counties in northern Vermont, and at Plattsburgh (Clinton County) in northeastern New York (Dysart 1988). Gordon's (1985) diagnosis and illustration of the adult facilitate recognition of this distinctive species in the Nearctic fauna.

Larochelle and Larivière (1980) and Dysart (1988) suggested that this aphidophagous coccinellid, having adapted to Quebec's harsh climate, probably will spread throughout most of North America. Herein, I extend the known Nearctic distribution to Maine, cite an additional Ver-

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[2] Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, PA 17110-9408.

mont record, and give ecological notes on these collections. Voucher specimens have been deposited in the insect collections of Cornell University, Ithaca, New York (CUIC), and Pennsylvania Department of Agriculture, Harrisburg (PDA).

Propylea quatuordecimpunctata: Additional U.S. Records

On 11 June 1988, I collected seven adults on the University of Vermont campus at Burlington, Chittenden County. Two were beaten from terminals of tatarian honeysuckle, *Lonicera tatarica* L., infested with the aphid *Hyadaphis tataricae* (Aizenberg); five were collected from an ornamental cinquefoil, *Potentilla parvifolia* Lehm.

In 1989, I swept four adults on 3 July from hairy vetch, *Vicia villosa* Roth, along Old Coldbrook road near exit 44 of I-95 at Hampden (Penobscot County), Maine. The most likely prey species on vetch was the pea aphid, *Acyrthosiphon pisum* (Harris). Two days later an adult was collected in Houlton (Aroostook County), Maine, by beating branches of speckled alder, *Alnus rugosa* (DuRoi) Spreng., infested with the woolly alder aphid, *Paraprociphilus tessellatus* (Fitch).

R. V. Flanders called my attention to a previous Maine record, one not formally published but cited in the National Pest Happenings newsletter [5 (3): 4, 1989], issued by the Texas Agricultural Extension Service. One adult was collected 7 June 1988 on raspberry at Monmouth (Kennebec County), by M. P. Tully.

DISCUSSION

Schaefer and Dysart (1988) noted that *P. quatuordecimpunctata* is being propagated and redistributed by the USDA APHIS Biological Control Program. No recoveries, however, have been made from any of the release sites, including those in Maryland and Pennsylvania (P. W. Schaefer, personal communication) and North Falmouth, Massachusetts (R. V. Flanders, personal communication). The Maine records probably can be attributed to natural dispersal of the well-established Quebec populations rather than to intentional releases or to a separate introduction with European commerce. The Penobscot County collection near Bangor extends the known U. S. distribution about 350 km east of the Plattsburgh, New York - Burlington, Vermont area. The Houlton site in Aroostook County lies about 240 km from the nearest population recorded in Quebec; Monmouth (Kennebec County) is about 230 km from the nearest Quebec population.

ACKNOWLEDGMENTS

I thank P. W. Schaefer (USDA, Beneficial Insects Research Lab., Newark, Delaware) for allowing me to use recent information relating to releases of *P. quatuordecimpunctata* in eastern North America, R. V. Flanders (USDA Biological Control Lab., Niles, Michigan) for informing me of the Cape Cod releases and the previous Maine record, R. D. Lehman (PDA, BPI) for confirming my identification, and Lehman and K. Valley (PDA, BPI) for reviewing the manuscript.

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ADDITIONS TO THE PAPILIONOIDEA (LEPIDOPTERA) OF THE REVILLAGIGEDO ISLANDS, MEXICO[1]

John W. Brown[2]

ABSTRACT: Five species of butterflies are reported from the Revillagigedo Islands, Mexico, for the first time: *Phoebis agarithe* (Pieridae); *Chlorostrymon simaethis*, *Leptotes marinus*, and *Hemiargus ceraunus* (Lycaenidae); and *Danaus gilippus* (Nymphalidae). These new records increase to ten the number of Papilionoidea recorded from this archipelago.

The Revillagigedo Archipelago is comprised of four islands located approximately 500 km SSW of Cabo San Lucas, Baja California Sur, and about 600 km W of Cabo Corrientes, Jalisco. Politically, the islands belong to the state of Colima, Mexico. The islands are oceanic and volcanic in origin. Socorro is the largest and most diverse topographically; Clarion and San Benedicto are considerably smaller; and Roca Partida is little more than a rock jutting from the sea (Palacios-Vargas, Llampallas, and Hogue 1982).

Vazquez (1958, 1959, 1960) cited five butterfly taxa from the Revillagigedos, four of which represent endemic subspecies: *Battus philenor insularis* (Vazq., 1956) (Papilionidae), *Strymon melinus clarionensis* (Heid., 1933) (Lycaenidae), *Strymon columella clarionica* (Vazq., 1958) (Lycaenidae), and *Erynnis funeralis* (Scudder & Burgess, 1870) (Hesperiidae), all from Clarion; and *Strymon columella socorroica* (Vazq., 1958) (Lycaenidae) from Socorro. Palacios-Vargas *et al.* (1982) added a sight record of the widespread Neotropical *Phoebis sennae* (Linnaeus, 1758) (Pieridae) from Socorro. The purpose of this note is to present the first records of five additional species of Papilionoidea from Socorro Island, and the first capture record of *Phoebis sennae*. All of these are widespread Neotropical species that occur commonly on the Mexican mainland. Depositories are abbreviated as follows: LACM, Natural History Museum of Los Angeles County, Los Angeles, California; SDNHM, San Diego Natural History Museum, San Diego, California. All specimens were determined by the author.

PIERIDAE

Phoebis sennae (Linnaeus): Socorro Island, Bahia Braithwaite, 1M, 16 April 1987, D. K. Faulkner (SDNHM). The specimen is best referred to *P. sennae marcellina* (Cramer), the common mainland subspecies.

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[1] Received December 4, 1989. Accepted January 11, 1990.

[2] Entomology Section, Natural History Museum of Los Angeles County, 900 Exposition Blvd., Los Angeles, CA, 90007

Phoebis agarithe (Boisduval): Socorro Island, Bahia Braithwaite, 1M, 16 April 1987, D. K. Faulkner (SDNHM). Identification of the specimen is based on the straight, unbroken discal line of the ventral forewing (Brown 1929; Howe 1975). The single specimen is in poor condition inhibiting subspecific assignment.

LYCAENIDAE

Chlorostrymon simaethis (Drury): Socorro Island, 3200', 12F, 15 April 1955, E. Y. Dawson (LACM). The specimens are phenotypically indistinguishable from *C. simaethis sarita* (Reakirt), the common Mexican mainland subspecies (Nicolay 1980; Johnson 1989).

Leptotes marinus (Reakirt): Socorro Island, Bahia Braithwaite, 2M, 1F, 16 April 1987, D. K. Faulkner (SDNHM).

Hemiargus ceraunus (Fabricius): Socorro Island, 3200', 1F, 18 April 1955, E. Y. Dawson (LACM). I follow Nabokov (1945) and Clench (1965), treating *H. ceraunus* as distinct from *H. hanno* (Stoll). Intra-population variability in *H. ceraunus* inhibits meaningful use of trinomials in this species.

NYMPHALIDAE

Danaus gilippus (Cramer): Socorro Island, naval base at Cornwallis Bay, 1F, 27 November 1988, K. Kaiser & J. Johnston (LACM).

DISCUSSION

No butterfly species has been recorded from either San Benedicto or Roca Partida. Of the ten species recorded from Socorro (n=7) and Clarion (n=4), it is surprising that only one is known from both islands, i.e. *Strymon columella*, represented by an endemic subspecies on each island. It is likely that the absence of additional taxa in common to both islands reflects insufficient sampling rather than ecological equilibria.

ACKNOWLEDGMENTS

I thank David K. Faulkner (SDNMH) and Charles L. Hogue (LACM) for allowing me to examine specimens in their care and for providing helpful comments on the brief manuscript. I also thank Robert K. Robbins and Lee D. Miller for critically reviewing the paper.

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BOOK REVIEW

BIRD BLOW FLIES (*PROTOCALLIPHORA*) IN NORTH AMERICA (DIPTERA: CALLIPHORIDAE) WITH NOTES ON THE PALEARCTIC SPECIES. 1989. C.W. Sabrosky, G.F. Bennett, T.L. Whitworth. Smithsonian Institution Press, Washington, D.C. and London. 312 pp. $16.95.

This monographic revision of a blowfly genus whose larvae feed upon the blood of nestlings of many passerine birds in both enthralling and very informative. This is the third revision of the genus in the last 60 years. In the last previous treatment of its included species, Hall (1948. The Blowflies of North America. Thos. Say Foundation, p 179-201) flatly declared that "*Protocalliphora* . . . does not occur in North America." The current authors have painstakingly settled this matter. Although misidentified type specimens and designated lectotypes have led to some confusion concerning the proper generic name, North American usage and the current work will certainly establish *Protocalliphora* as the correct generic name of the bird blowflies. Species in the genus possess a fascinating biological association with birds, and their larvae have unique anatomical attributes to facilitate their 'parasitic' mode of feeding. While Hall (1948) recognized 10 species, this work recognizes 26 species, 15 of which are described as new, and 2 species that are now known to be Holarctic in distribution, *P. chrysorrhoea* and P. *braueri*. Each species treated here is given a complete description, including a diagnosis, description of male and female, descriptions of the immature stages, particularly the puparium, the material examined, with the type series for new species, distribution informatioin, and ecology and biology, along with appropriate remarks. These descriptions present admirable models of what every entomologist would desire to have in a revision. Unfortunately, larval cephalopharyngeal skeletons and the prothoracic fringe of the mature larvae are not illustrated; one must refer to Hall (1948, Pl. 38) for these details. Also, the details of the posterior spiracles and the integumentary armature from the puparia are not easily resolved in the halftone illustrations. Certainly, this work will be useful to entomologists, ornithologists, ecologists, and field workers. After over 30 years of work, study, and compilation, the authors have presented an excellent book.

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INVERTEBRATE POPULATIONS IN THE NESTS OF A SCREECH OWL *(OTUS ASIO)* AND AN AMERICAN KESTREL *(FALCO SPARVERIUS)* IN CENTRAL NEW YORK[1]

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ABSTRACT: Screech owl *(Otus asio)* nest material from a tree hole in Syracuse, N.Y., contained 22,991 arthropods of 61 species. Arthropod density was 131/g dry weight of nest material. An American Kestrel (*Falco sparverius*) nest in a nest box in Jamesville, N.Y., yielded 26,553 invertebrates of 93 species. Arthropod density was 38/g dry weight of nest material. Lists of the species found and their populations are presented, and their trophic and symbiotic relationships are discussed. Bird parasite levels were extremely low. Litter fauna was dominant in the screech owl nest, while stored products fauna was dominant in the Kestrel nest.

Nests of birds harbor a wide variety of invertebrates,, including soil and litter, parasitic, predatory and coprophilic organisms. Numerous studies have demonstrated that birds' nests are reservoirs of domestic and stored products pests as well, containing populations of carpet beetles (Dermestidae), clothes moths (Tineidae), house dust mites (Pyroglyphidae), stored products mites (Glycyphagidae), and poultry mites (Macronyssidae) (Woodroffe and Southgate, 1951; Woodroffe, 1953, 1954; Baker *et al.*, 1956). Nests of birds of prey (Falconiformes and Strigiformes) serve as a habitat for necrophilic arthropods as well as other nidicoles, since they contain carrion and regurgitated pellet remnants of their prey (Philips and Dindal, 1977).

The check-lists of Hicks (1959, 1962, 1971) serve as excellent guides to the literature on insects in birds nests, and they demonstrate how poorly raptor nest fauna is known. Prior to this study, only six species of invertebrates were known from eastern screech owl (*Otus asio* (L.)) nests (Baker, 1904, Bequaert, 1955, Gehlbach and Baldridge, 1987; Linsley, 1944; Robinson, 1941; Vaurie 1955) and only eight species were known from American kestrel (*Falco sparverius* L.) nests (Balgooyen, 1976, Bequaert, 1955; Capelle and Whitworth, 1973; Hill and Work, 1947; Roest, 1957; Williams, 1947). The objective of this study was to investigate the invertebrate community of a screech owl and a kestrel nest, and to determine the levels of parasites, pest, and other species infestation in them.

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METHODS

Eastern screech owls occur in mixed woodlands east of the Rocky Mountains, feeding on small vertebrates and invertebrates and roosting and nesting in hardwood tree hollows or occasionally in nest boxes (Hekstra, 1973; Karalus and Eckert, 1974). In 1975, screech owls were observed nesting and roosting in a tree hole 9m high in a white oak (*Quercus alba* L.) in Oakwood Cemetery, Syracuse, New York. On 12 March 1976, a 175 g dry wt. sample of nest material was collected from the tree hole. At this time the hole was being used by the owls, but egg-laying had not yet taken place. Most of the sample material was placed in modified Tullgren funnels (Murphy, 1962) for extraction of microarthropods, and weighed when dry. The rest was placed in culture dishes so that nidicolous insect larvae could be raised to adults for identification. On 16 June 1976, after nesting was over, a second small sample of nest material was collected and used for invertebrate extraction. Although the March sample removed most of the litter from the tree hole, it did not ruin the hole as a nest site, since the owls nested there in 1976 and 1977 as they had several years previously.

American kestrels inhabit open country in North and South America, like the screech owl feeding on small vertebrates and invertebrates and nesting in tree holes or nest boxes (Brown and Amadon, 1968). On 24 June 1976, the day after the nestlings fledged, we collected an American kestrel nest (705 g dry wt.) in a nest box 5m high in a dead tree in Jamesville, New York. The nest material was processed in the same way as the screech owl nest.

RESULTS

The March screech owl nest sample included as much of the nest debris as could be obtained through the tree hole. The material consisted mainly of bits of oak leaves and small twigs. Small amounts of grass, woodchips, dirt, eggshell, excreta, feathers and pellet material (chitin, hair and bones) were also present. Prey remains included a skull and jaw of *Microtus pennsylvanicus* (Ord.). Funnel extraction yielded 22,991 microarthropods of 61 species (Table 1). Fifteen species of insects were found, but 99% of the individuals were mites. Arthropod density was 131/g dry wt. of nest; individual species and their populations are given in Table 2.

The June screech owl postnesting sample containing basal material from the nest hole was not analyzed in detail. A survey of the June nest fauna revealed that almost all of the species present were also present in the March sample. Relative populations were quite different, but that is probably more the result of the site disturbance in March - removing so much of the litter in the hole - than the result of changes associated with the nesting cycle. Two species were present in June that were not observed in March - *Dendrophaonia scabra* G. -T. (Diptera: Muscidae) and *Trox variolatus* Mels. (Coleoptera: Trogidae).

The American kestrel nest was composed mainly of sawdust with bits of sticks, leaves, moss, grass, wood, excreta, chitinous prey remains, pellets of hair, bone and chitin and several prey feet. Identifiable prey remains included two skulls of *Microtus pennsylvanicus* (Ord.) and many fragments of the carabid beetle *Calosoma frigidum* Kirby. One avian skull was found, probably that of a sparrow. The nest sample contained 26,553 individuals of 93 species (Table 1). Thirty-one species of insects were found, but 90% of the individuals were mites. Arthropod density was 38/g dry wt.; individual species and their populations are given in Table 3.

BIOLOGICAL ANNOTATIONS ON COLLECTED TAXA

Screech Owl Nest Fauna

Ramusella clavipectinata (Mich.), the numerically dominant species in this nest community, is a widespread oribatid mite fungivore which Mahunka (1986) found to be very abundant in Hungary. Conditions in the tree-hole full of highly decomposed leaf litter were near optimal for this mite, judging by its tremendous population. The nest oribatids are part of the humus fauna involved in the decomposition of the nest material.

The astigmatic mites found included nest humus and animal remains fauna, with several new genera and species (Fain and Philips, 1977a, 1977b, 1978a, 1979, 1981). *Fuscarus* was previously known only from rodent nests, and nothing was known of its food habits (Krantz, 1978). We observed fungal spores as gut contents of all stages of *Fusacarus tenuipes* (Fain and Philips), and the fungus species was the same as that eaten by *Oppia* and *Acotyledon*.

Acotyledon paradoxa Ouds. was previously known only from phoretic deutonymphs and a protonymph. The discovery of all stages of this species has enabled taxonomists to clarify the systematic position of the genus. This species has been found on a bat and in granaries in the Soviet Union, and in mouse nests in the U.S.A. (Fain and Philips, 1978c).

Histiogaster robustus Wdrg. is known from trees (Woodring, 1966b). Other species in the genus have been found associated with bark beetles.

The histiostomatids collected were represented mainly by the entomophilic nonfeeding hypopus stage. Development of this stage from protonymphs may have been triggered by the extraction process. Histiostomatids were not common in the nest leaf litter, but were abundant in the basal hole debris of the postnesting sample. One species of *Myianoetus* is known to be phoretic on *Muscina stabulans* (Fall.) (Hughes and Jackson, 1958). In the June sample we observed 20 *Histiostoma pauciputeolum* Fain and Philips hypopodes on the head, legs, and abdomen of a *Trox variolatus* Mels. beetle larva. An adult *T. variolatus* carried 53 of these hypopodes, almost all on the legs. In the March sample, one histerid beetle adult of *Dendrophilus xavieri* Mars. bore 20 of these hypopodes, mainly on the elytra and abdomen. Feeding stages of histiostomatid mites generally strain microorganisms from wet substrates (Krantz, 1978).

Besides *Histiostoma* hypopodes, the adult trogid beetle carried 137 hypopodes of *Euglycyphagus*, on the pronotum, metasternum, elytra and abdomen. *Euglycyphagus* is fungivorous to some extent and, like the histiostomatids, was most abundant in the basal debris. Histiostomatid and glycyphagoid mites have not previously been found on trogid beetles, although Fain and Philips (1978b) have described a new species of winterschmidtiid mite from Australian trogid beetles.

Sapracarus tuberculatus Fain and Philips, known only from this nest, may be a strict nidicole or general tree-hole dweller. Its entomophilic hypopus indicates a phoretic relationship with some insect. This mite is presumably detritivore, but no gut contents were visible in the specimens examined.

Echimyopus is a mite genus known as deutonymphs from hair follicles and skin galls of Central American rodents and marsupials (Fain, 1969; Fain *et al*., 1973; Fain and Lukoschus, 1976). One previous record of the genus exists for North America, from squirrel hosts (Whitaker *et al.* 1975). Adults and nymphs of this genus had not previously been found (Fain and Philips, 1981).

Orycteroxenus hypopodes occur on mammal hair, and the occurrence of one hypopus of *O. soricis* (Ouds.) can be correlated with our finding of prey remains of one of its hosts, *Microtus pennsylvanicus* (Fain, 1969; Fain and Whitaker, 1973). *Neoxenoryctes* hypopodes also are pilicolous, and the nymphs and adults are at least partly fungivorous.

The chigger *Miyatrombicula cynos* Ewing is known from raccoons and squirrels (Ewing, 1937; Whitaker *et al*., 1975). All stages of this mite were found in the nest, and over half of the larvae were engorged. Since many chiggers show little host specificity, it is possible tht the screech owl could be an acceptable host for this species, but more likely the hole had been used by squirrels previously, and the owls had only recently taken possession again for nesting.

Tarsocheylus paradoxus Berl. is known from tree-holes and rotting bark (Atyeo and Baker, 1964). Pyemotids, scutacarids, tarsonemids, and tydeids are all soil and litter groups, which pierce and suck fluids from fungi and/or nematodes (Moore *et al.*, 1988). *Proctotydaeus* is an insect associate (Andre, 1980) and may have reached the nest on moths, since Treat (1961) found one species phoretic on noctuid moths. Cheyletids are common nest predators, and Woodroffe (1953) observed that the acarid mite *Tyrophagus* is preferred prey for *Cheyletus eruditus* (Schr.); perhaps in this nest it was mainly preying on *Acotyledon*, the most abundant acarid mite present.

The mesostigmatic mites found included gamasine parasites of birds and mammals, gamasine predators, and uropodine fungivores. Species of *Laelaps*, *Haemogamasus*, *Hyperlaelaps*, and *Androlaelaps fahrenholzi* (Berl.) are small mammal parasites with many hosts (Whitaker and Wilson, 1974). *Androlaelaps casalis* (Berl.) has been described as a mammal and bird ectoparasite common in bird nests (Wilson and Bull, 1977., Rosen *et al.* 1985), but McKinley (1963) concluded that this species did not pierce mammal or avian skin, and actually fed on other mites, such as acaridids, and their eggs.

Hypoaspis, Blattisocius, and *Proctolaelaps* are common nest predators. The size difference in the three *Dendrolaelaps* species suggests possible differences in prey size classes. Many ameroseiids feed on fungi or pollen, but can also be predators (Krantz, 1978). They occur in litter as well as mammal nests. Among the uropodines, *Metagynella parvula* Camin is known only from tree-holes (Camin, 1953). Its phoretic relationships, if any, are unknown. One deutonymph of *Trichouropoda martini* Hirschmann was phoretic on the histerid beetle *Dendrophilus xavieri* Marseul. *Trichouropoda martini* is known from a red squirrel (*Tamiasciurus*) nest (W. Hirschmann, pers. comm.). *Uroseius* deutonymphs have been found in passerine nests phoretic on trogid beetles (Sixl, 1971).

The pseudoscorpion *Acuminochernes crassopalpus* (Hoff) is a predator that has been previously recorded from treeholes (Park and Auerback, 1954) and mammal nests (Muchmore, pers. comm.). Chernetid pseudoscorpions posses several adaptations for colonizing nests and treeholes, including phoresy and the ability to store sperm for prolonged periods (Jones, 1975).

Most of the fly larvae are known scavengers on animal remains, but scenopinid larvae prey mainly on tineid moth larvae. The cecidomyid larvae were probably saprovores associated with the decaying nest plant matter.

Beetles associated with treeholes rather than birds' nests included the curculionid adult and the melandryid, tenebrionid and staphylinid larvae (Borror *et al.*, 1981). *Xylodromus* is a new staphylinid record for New York (Moore and Legner, 1975). The histerid beetles were the largest predators in the nest.

Only a few fleas were found, and both species are mammal parasites.

Orchopeas howardi (Baker) is most commonly found on tree squirrels and *O. leucopus* (Baker) prefers *Peromyscus* (Main, 1970). *Ixodes marxi* Banks, the single tick found, is also a tree squirrel parasite (Bequaert, 1945).

The single psocopteran appears to be an accident. It may have been windborne or reached the nest on a bird or mammal, as phoresy occasionally occurs in psocopterans (Mockford, 1967). The only wasp found, *Synergus*, was extracted from a gall on one of the nest leaves.

The ectoparasites found included the squirrel tick, the squirrel flea, a squirrel chigger, three parasitic mesostigmatic mite species known from squirrels, and an astigmatic mite genus known from squirrels. Also, the nest contained many mammal nest associates such as *Fusacarus* and *Neoxenoryctes*. Oakwood Cemetry abounds in gray squirrels (*Sciurus carolinensis* Gmelin), and it seems inevitable that this tree-hole would be occasionally visited by squirrels when not used by the owls. In 1977, the owls again nested in this hole, as they had for several previous years, but in 1978 squirrels took over the hole and the owls did not nest there.

Squirrel use of the hole explains the many squirrel parasites found. We believe that the hosts of *Echimyopus orphanus* Fain and Philips and *Neoxenoryctes* is the gray squirrel, and that these other genera like *Fusacarus* will also be found in gray squirrel nests.

This nest community was characterized by very high species richness and very low equitability. The variety of food sources in the tree-hole nest provide a habitat for many species which colonize the hole deliberately or accidentally, and the protected microenvironment seems to provide nearly optimal conditions for some species.

American Kestrel Nest Fauna

The kestrel nest invertebrate community was very different from the screech owl nest community. Of 93 species in the kestrel nest, only 12 were also present in the screech owl nest. These species - 9 mites, a histerid beetle, a sphaerocerid fly, and a psocopteran - included no avian parasites and were small components of both nests, comprising only 8% of the individuals in the screech owl nest, and 4% of those in the kestrel nest. Four of the mites are parasitic or phoretic on rodents. Three additional species may be common to both nests. Lack of adults of the scenopinid fly, the tineid moth in the kestrel nest, and the uroseiid mite in the screech owl nest, prevented complete identification.

Diversity in the kestrel nest was lower than in the screech owl nest. Although species richness was higher than that of the screech owl nest, equitability was lower, as was arthropod density. In this nest, a new species of *Lardoglyphus*, a genus known from dried fish, butchers' offal, and hides (Hughes, 1976) was highly numerically dominant. This species was fungivorous to some extent, and the hypopodes were phoretic on *Dermestes pulcher* LeConte (Philips and Norton, 1978). It seems to have some degree of host specificity. A nest box in a tree 18m from this kestrel nest was examined and preliminary inspection has revealed neither *Lardoglyphus falconidus* Philips and Norton nor its dermestid host species. Another genus of dermestid was present, as were the species of *Lepidoglyphus* and *Cheyletus* which occurred in this kestrel nest.

Other genera of acarid mites in this nest with entomophilic hypopodes were *Histiogaster*, *Michaelopus*, *Sancassania*, and *Schwiebea*. *Michaelopus corticalis* (Michael) has been found under dead tree bark and in nests of several avian orders (Fain, 1982), and is probably saprophagous like *Sancassania* and *Schwiebea*. *Schwiebea terrana* Jacot was originally collected from pine litter and inhabits dead wood (Woodring, 1966a).

Histiostomatid mite hypopodes were found phoretic on *Trox seaber* (L.) in this nest, as they were on the other species of trogid beetle in the screech owl nest. Thirteen hypopodes were found under the wings of the trogid, in crevices at the border of the thoracic and abdominal regions of the body. Twelve hypopodes were *Histiostoma* species number three, and one was *Hexanoetus conoidalis* Fain and Philips. *Hexanoetus conoidalis* was present in adult and immature stages in the screech owl nest. *Histiostoma* species number 3 is identical to the *Histiostoma* species B found by Philips *et al.* (1983) under the elytra of four specimens of *Trox aequalis* Say in a saw-whet owl (*Aegolius acadicus* (Gmelin)) nest in Connecticut.

Two species of feather mites were found in the nest. The specimens of *Dubininia* in the pellet sample may have been regurgitated with a pellet or may have dropped off from a kestrel in the nest, as this genus is a parasite of the Falconiformes as well as other birds. *Analges* probably was derived from prey.

Lepidoglyphus fustifer (Ouds.) is a European stored products species. It has not previously been recorded from North America (Hughes, 1976) and the hypopus stage was not previously known from this species. We have observed fungal spores in the gut of many of our specimens.

As with the screech owl nest, a few *Orycteroxenus* hypopodes were found, as well as evidence of predation on *Microtus*. *Glycyphagus hypudaei* (Koch) hypopodes are phoretic on *Microtus* and many other small mammals. *Myocoptes japonensis* Radford is a parasite whose type host is *Microtus pennsylvanicus* and type locality is Ithaca, N.Y. (Fain and Hyland, 1970). *Dermacarus sciurinus* (Koch), another mammal associate, is known from a *Peromyscus* nest (Fain and Whitaker, 1973).

Tytodectes cerchneis Fain was previously known only from one badly damaged specimen found on *Falco tinnunculus* L. in Rwanda, Africa

(Fain 1967). The hypoderid mites are a poorly known group, and the life cycle of very few species is completely known. The hypopus is a subcutaneous parasite of birds, and the other immature stages are not active. The adults are very short-lived and nonfeeding nidicoles (Fain and Bafort, 1967).

The finding of *Tytodectes* represents a new U.S. record. Both *Falco sparverius* and *F. tinnunculus* also have a nasal mite species in common, and it would be interesting to survey falcon nasal, subcutaneous, and other mites and compare that data with concepts in falcon taxonomic relationships.

Nanacarus is a new New York record. This genus contains a number of fungivorous species which inhabit polypore fungi (O'Connor, 1984).

Among the prostigmatic mites present were two mammal parasites -a nymphal myobiid mite and a *Demodex*, as well as tarsonemid and tydeid soil and litter species. There was no mammal carrion in the nest, so we believe the parasites either came off prey in the nest before the prey was eaten, or survived the bird's digestive tract and came out in regurgitated pellet or fecal material.

Cheyletus trouessarti Oudemans was the most abundant predatory mite in the nest. Cheyletids are often associated with infestations of acarid mites (Baker, 1949) and we believe this species was probably feeding mainly on the abundant *Lardoglyphus* in this nest. Anystids are very mobile predatory mites which often feed on phytophagous insects and mites. The one larvae found may have wandered into the nest box from the tree the box was on, as these mites are long-legged rapid movers (Krantz, 1978).

As with the screech owl nest, the mesostigmatic mites included gamasine mammal parasites, gamasine predators, and uropodine fungivores, but there were no gamasine avian parasites. *Poecilochirus necrophori* Vitzth. is known to be phoretic on the silphid beetle *Nicrophorus* (Chmielewski, 1977) and the presence of four on *Nicrophorus pustulatus* Hers. explains how this mite reached the nest. This mite probably preys on nest fly larvae. *Macrocheles muscaedomesticae*, another immature dipteran predator (Peck and Anderson, 1969), is known to be phoretic on muscid flies (Evans and Browning, 1956; Chmielewski, 1977). *Copriphis* is a predatory gamasine which is phoretic on scarabaeid dung beetles. Two females were found under the wings of *Trox scaber* near the thorax/abdomen border. This species is identical to the species of "*Eviphis*" found by Philips *et al.* (1983) under the elytra of *Trox aequalis* in a saw-whet owl nest in Connecticut. *Copriphis* has been considered by some taxonomists to be a synonym of *Eviphis*, but we agree with those regarding it as a distinct genus. *Ameroseius apodius* Karg was discovered by Karg (1971) in compost in Germany, and has not previously been found in the

U.S.A. *Trichouropoda falconis* was recently described as a new species from this nest by Hirschmann and Wisniewski (1988). *Trichouropoda* species number one was found as a phoretic deutonymph attached by anal stalk to tibia IV of an adult histerid beetle, *Carcinops pumilio* Erichson.

Very few oribatid mites were present in this nest, which was dominated by animal remains fauna. Other humus fauna species were equally scarce - one collembolan, one enchytraeid, two earthworms, and a few Psocoptera. To our knowledge, earthworms have only been previously recorded from nests of one bird - the rook (*Corvus frugilegus* L.) in Britain (Coombs, 1960). Earthworm presence in a kestrel nest may be due to prey escape, since kestrels prey on earthworms (Balgooyen, 1976). Clubionid spiders hunt both on the ground and in foliage (Kaston, 1972), and probably entered the nest while foraging on the tree.

Histerids again were the largest predators in the nest. While the food of many species of staphylinids is not known, Koskel and Hanski (1977) classify all aleocharines and staphylinines (like *Philonthus*) as carnivores. *Nicrophorus* may prey on maggots, as well as eating carrion (Steele, 1927). Lathridiid and tenebrionid fungivores are very common in birds' nests and *Tenebrio molitor* L. is a stored products pest (Woodroffe and Southgate, 1951).

Calosoma frigidum Kirby is a new prey record for the American kestrel (Philips, 1977). This carabid beetle was known to be preyed upon by only one bird - the ruffed grouse (*Bonasa umbellus* (L.)) (Larochelle, 1975), but this demonstrates the paucity of knowledge on avian insect predation.

Allen (1973) has noted that this carabid preys upon several important insect pests, and its habit of tree foraging may make this species more susceptible to kestrel predation than cryptozoic ground carabids, particularly when, as Allen observed, large numbers of this carabid beetle occur during major infestations of forest insect pests.

The trogid and dermestid beetles eat hair and feathers in animal remains like carrion and raptor pellets. *Trox scaber* (L.) is known from mammal nests and nests of several other birds, including the screech owl (Vaurie, 1955). Unidentified species of *Dermestes* were recorded from kestrel nests by Balgooyen (1976). *Nicrophorus* feeds on fresher carrion than *Dermestes*.

Scavenging dipteran larvae occurred as in the screech owl nest, but in much greater numbers and in greater variety, with muscid and scatopsid flies present. Two families of avian parasitic flies inhabited this nest. The biting midges (ceratopogonids) suck blood, but the food habits of the nidicolous milichiid *Carnus hemapterus* Nit. have been a subject of debate. Bequaert (1942) has quoted the observations of earlier workers who discovered that it fed on blood and that it fed on skin and feather secretions. Borror *et al.* (1981) consider it to be blood-sucking. Lloyd and Philip (1966) agreed with Bequaert that the mouthparts are not adapted for piercing host skin.

One parasitoid cynipid wasp inhabited this nest, but the hosts of many species of *Pseudeucoila* are not known (Muesebeck *et al.*, 1951). The mymarid wasp is a parasite of insect eggs (Borror *et al.* 1981). Many braconid wasps are parasites of lepidopteran larvae (Borror *et al.* 1981). *Lasius* ants nest in rotting logs and stones and cultivate aphids (Arnett, 1985). The three nest anoplurans can be attributed to the birds' mammalian prey. The two flea larvae could not be specifically identified.

DISCUSSION

These raptor nest data present a considerably different picture of the nest community than previous studies. Although Nordberg (1936) found oribatid mites of many species in his European raptor nests, very few species occurred in our nests. Nordberg found mainly feather mites among the astigmatic mites in his nests, but our nests contained a wide variety of astigmatic mites. The prostigmatic and mesostigmatic mite components of raptor nests are also much more diverse than were previously realized. In particular, no mammalian-associated mites had been reported from raptor nests. Our expectations that they would be found still did not encompass the actual extent of the mammal nest and parasite fauna in raptor nests.

The mite family Pyroglyphidae is very common in birds' nests (Woodroffe, 1953; Krantz, 1978), but has never been previously found in raptor nests, and only three specimens were found in our nest samples. Its scarcity in the kestrel nest is even more surprising considering its abundance in a tree swallow (*Iridoprocne bicolor* (Vieillot)) we examined which was in a nestbox only 200 m away. More samples are needed to confirm this apparent preference for nonraptor nests - perhaps the raptor nest moisture and carrion create an unattractive environment. Woodroffe (1953) noted that these mites are tolerant of low humidities and occur in very dry nests. Some nest pyroglyphids also occur in house dust and cause house dust allergy (Krantz, 1978).

Referring to mites in bird nestbox debris, Herman (1936) stated that "an estimate of billions in each nest seems conservative". He correctly judged the importance of the mites, if not their actual density. Nevertheless, the densities of arthropods in the screech owl and kestrel nests are high. Park *et al.* (1950) studied the tree-hole fauna of elm, sugar maple, and beech trees, and arthropod densities ranged from 4.4-5.5/g. Ryder and Freitag (1974) examined ring-billed gull *(Larus delawarensis* Ord) nests of weights similar to the screech owl and kestrel nests, and densities averaged 1.5-1.7 arthropods/g.

The oribatid mite density in the screech owl nest appears to be unmatched in any other reported nest. Gembestky and Andrechikova (1969) examined 32 nests of 7 passeriform species and collected only 98 oribatid specimens. Bukva *et al.* (1976) found 979 oribatids in 278 small mammal nests, and Kramarova and Mrciak (1971) collected 13,364 from 303 small mammal nests.

Kramarova and Mrciak studied the invertebrate groups in small mammal nests as we did with the raptor nest groups. Some additional numbers from their 303 nests provide a useful comparison: 20,556 astigmatic mites; 110,575 mesostigmatic mites; 679 prostigmatic mites; 71 pseudoscorpions; 22,213 Collembola. Vysotskaya and Nosek (1974) studied 43,796 Collembola from 464 small mammal nests.

The dominance of gamasine mites, especially parasites, in small mammal nests has also been shown by Drummond (1957) and Allred and Roscoe (1957). Judging from our data, astigmatic or oribatid mites can be dominant in raptor nests, and although a variety of mesostigmatic mites occur, they are not present in tremendous numbers.

Park and Auerbach (1954) found that collembolans made up 27% of the tree-hole fauna they studied. Considering their abundance in small mammal nests and treeholes, the scarcity of collembolans in the raptor nests examined is surprising. Further study is needed to determine the frequency of Collembola in many raptor nests.

Woodroffe and Southgate (1951) studied passerine nests and observed a succession of invertebrates. Avian ectoparasites dominated during initial nest construction and occupation. After birds left the nest, scavenging invertebrates were dominant as feather debris and excreta decomposed. The final stage of decomposition of the nest material was dominated by humus fauna. If the nest was used as a winter roost and reused the next year, the nest acted as a refugium and the scavenging fauna persisted. Open, exposed nests decomposed faster and the scavenging stage was reduced or absent. Differences in the fauna of nests of different bird species were correlated with differences in the composition of the nests.

This pattern is not consistent for all birds' nests. Freitag and Ryder (1973) found almost no ectoparasites in their ring-billed gull nests. Saprophagous mite populations peaked after gull egg-laying, while predatory mite populations peaked at or after egg-hatching (Freitag *et al.*, 1974).

Trophic category estimates of the raptor nest fauna are given in Table 4. There is no evidence that the raptor nests followed Woodroffe's scheme, as very few avian ectoparasites were found. However, the scavenging animal remains fauna was dominant in our samples taken immediately after falconiform nesting. The effects of screech owl nesting upon the nest humus fauna were not observed because of our disturbance of the site. It is possible that this fauna could have remained dominant throughout the entire nesting period, but an increase in the animal remains fauna would still be expected as that food source became more abundant.

Hagvar (1975) described coleopteran succession in raptor nests. Nests used every year grow larger, older material decomposes, and the number of niches increases. Old nests in use have the largest species richness, and large old nests can remain humid in the center even during droughts.

Succession in raptor nests is complicated by the many variables in nest location and use. Nests may be used in other seasons and years by other roosting species, and raptors may share their nests with a variety of other vertebrates (Wilson, 1925; Sumner, 1933; Zarn, 1974).

Detailed investigations of raptor nest fauna are needed to elucidate the intricate interrelationships in this microcommunity. Many raptors are marginal or endangered species, and we need to know what, if any, invertebrates may be a source of mortality and how frequently this occurs. When nest trophic interactions are well known, biological control measures against undesirable invertebrates may be possible.

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Table 1. Invertebrates in the nests of a screech owl and an American kestrel.

Group	Screech Owl		% of	American Kestrel		% of
	species	individuals	total individuals	species	individuals	total individuals
Arachnida						
Acari						
Acaridida	12	5,720	24.88	20	19,692	74.16
Actinedida	11	4,168	18.13	8	4,015	15.12
Gamasida	17	625	2.71	15	238	.90
Ixodida	1	1	.004			
Oribatida	4	12,214	53.13	15	49	.18
Araneida				1	1	.005
Pseudoscorpionida	1	119	.52			
Insecta						
Anoplura				1	3	.01
Coleoptera	5	27	.12	13	485	1.83
Collembola				1	1	.005
Diptera	4	93	.40	9	2,007	7.56
Hymenoptera	1	1	.003	4	7	.03
Lepidoptera	2	18	.08	1	2	.01
Psocoptera	1	1	.003	1	48	.18
Siphonaptera	2	4	.02	1	2	.01
Oligochaeta				3	3	.01
Total	61	22,991		93	26,553	

Table 2. Arthropod species populations in a screech owl nest.

Class Arachnida		
Order Acarina		
Suborder	Acaridida	
Family	Acaridae	
	Acotyledon paradoxa Oudemans	3,746
	Histiogaster robustus Woodring	9
Family	Euglycyphagidae	
	Euglycyphagus intercalatus Fain and Philips	150
Family	Glycyphagidae	
	Echimyopus orphanus Fain and Philips	12
	Fusacarus tenuipes Fain and Philips	614
	Neoxenoryctes reticulatus Fain and Philips	1,053
	Orycteroxenus soricis soricis (Oudemans)	1
Family	Hemisarcoptidae	
	Sapracarus tuberculatus Fain and Philips	59

Family	Histiostomatidae	
	Comyianoetus denticulatus Fain and Philips	34
	Histiostoma pauciputeolum Fain and Philips	30
	Miyanoetus micromaculatus Fain and Philips	2
	Hexanoetus conoidalis Fain and Philips	10
Suborder	Actinedida	
Family	Cheyletidae	
	Cheyletus eruditus (Schrank)	166
Family	Pyemotidae	
	Bakerdania sp. 1	252
	Bakerdania sp. 2	28
	Brennandania sp.	20
Family	Scutacaridae	
	Imparipes sp.	13
Family	Tarsocheylidae	
	Tarsocheylus paradoxus Berlese	4
Family	Trombiculidae	
	Miyatrombicula cynos Ewing	869
Family	Tarsonemidae	
	Tarsonemus sp.	1,287
Family	Tydeidae	
	Proctotydaeus sp.	17
	Microtydeus sp.	4
	Tydeus sp. 1	1,508
Suborder	Gamasida	
Family	Ameroseiidae	
	Kleemannia sn. sp.	45
Family	Ascidae	
	Blattisocius dentriticus (Berlese)	15
	Proctolaelaps pomorum (Oudemans)	33
Family	Digamasellidae	
	Dendrolaelaps sp. nr. *marylandae* (Hurlbutt)	11
	Dendrolaelaps sp. nr. *pini* Hirschmann	24
	Dendrolaelaps sp. nr. *presepum* (Berlese)	13
Family	Laelapidae	
	Androlaelaps casalis casalis Berlese	8
	Androlaelaps fahrenholzi (Berlese)	3
	Haemogamasus reidi Ewing	2
	Hyperlaelaps microti (Ewing)	1
	Hypoaspis lubrica Voigts and Oudemans	109
	Laelaps alaskensis Grant	2
Family	Metagynuridae	
	Metagynella parvula Camin	2
Family	Polyaspinidae	
	Uroseius sp.	26
Family	Trematuridae	
	Trichouropoda martini Hirschmann	318
	species 1	12
	species 2	1
Suborder	Ixodida	
Family	Ixodidae	
	Ixodes marxi Banks	1

Suborder	Oribatida	
Family	Damaeidae	
	Epidameus canadensis (Banks)	1
Family	Oppiidae	
	Ramusella clavipectinata (Michael)	12,056
Family	Oribatulidae	
	Scheloribates sp.	153
Family	Parakalummidae	
	Protokalumma n. sp.	4
Order Pseudoscorpionida		
Family	Chernetidae	
	Acuminochernes crassopalpus (Hoff)	119
Class Insecta		
Order Coleoptera		
Family	Curculionidae	
	Phloeophagus variolatus Drury	1
Family	Histeridae	
	Dendrophilus xavieri Marseul	11
Family	Melandryidae	
	Scraptinae sp.	8
Family	Staphylinidae	
	Xylodromus sp.	4
Family	Tenebrionidae	
	Neatus tenebrioides (Palisot)	3
Order Diptera		
Family	Cecidomyiidae	
	Lestodiplosis sp.	19
Family	Milichiidae	
	Leptometopa sp.	34
Family	Scenopinidae	
	Scenopinus sp.	1
Family	Sphaeroceridae	
	Leptocera (*Coproica*) n. sp.	39
Order Hymenoptera		
Family	Cynipidae	
	Synergus sp.	1
Order Lepidoptera		
Family	Noctuidae	
	Epizeuxis americalis (Guenee)	2
Family	Tineidae	
	Tinea sp.	16
Order Psocoptera		
Family	Liposcelidae	
	Liposcelis bostrychophilus Badonnel	1
Order Siphonaptera		
Family	Ceratophyllidae	
	Orchopeas howardi howardi (Baker)	3
	Orchopeas leucopus (Baker)	1

Table 3. Invertebrate species populations in a American kestrel nest.

Phylum Annelida		
Class Chaetopoda		
Order Oligochaeta		
Family	Enchytraeidae	
	species 1	1
Family	Lumbricidae	
	Dendrobaena rubida (Savigny)	1
	Lumbricus sp.	1
Phylum Arthropoda		
Class Arachnida		
Order Acarina		
Suborder	Acaridida	
Family	Acaridae	
	Histiogaster carpio (Kramer)	1
	Lardoglyphus falconidus Fain and Philips	18,581
	Michaelopus corticalis (Michael)	1
	Sancassania sp.	1
	Schwiebea terrana Jacot	8
Family	Analgidae	
	Analges sp.	4
	Dubininia sp.	2
Family	Glycyphagidae	
	Dermacarus sciurinus (Koch)	1
	Glycyphagus hypudaei (Koch)	1
	Lepidoglyphus fustifer Oudemans	870
	Orycteroxenus soricis soricis (Oudemans)	2
Family	Hemisarcoptidae	
	Nanacarus n. sp.	3
Family	Histiostomatidae	
	Hexanoetus conoidalis Fain and Philips	1
	Histiostoma sp. 1	157
	Histiostoma sp. 2	13
	Histiostoma sp. 3	12
	Miyanoetus n. sp.	16
Family	Hypoderidae	
	Tytodectes cerechneis Fain	12
Family	Myocoptidae	
	Myocoptes japonensis Radford	1
Family	Pyroglyphidae	
	Dermatophagoides sp.	6
Suborder	Actinedida	
Family	Anystidae	
	species 1	1
Family	Cheyletidae	
	Cheyletus trouessarti Oudemans	1,859
Family	Demodicidae	
	Demodex n. sp.	1
Family	Myobiidae	
	species 1	1

Family	Tarsonemidae	
	Tarsonemus sp. 1	1,232
Family	Tydeidae	
	Coccotydaeolus sp.	1
	Tydeus sp. 1	703
	Tydeus sp. 2	217
Suborder	Gamasida	
Family	Ameroseiidae	
	Ameroseius apodius Karg	7
Family	Ascidae	
	Blattisocius tarsalis (Berlese)	2
	Proctolaelaps sp.	2
Family	Digamasellidae	
	Dendrolaelaps sp. nr. *presepum* (Berlese)	51
Family	Eviphididae	
	Copriphis sp	2
Family	Laelapidae	
	Androlaelaps fahrenholzi (Berlese)	3
	Hyperlaelaps microti (Ewing)	5
	Laelaps alaskensis Grant	9
Family	Macrochelidae	
	Macrocheles muscaedomesticae (Scopoli)	4
Family	Parasitidae	
	Poecilochirus necrophori Vitzthum	119
Family	Polyaspinidae	
	Uroseius lagenaeformis (Berlese)	6
Family	Trematuridae	
	Trichouropoda martini Hirschmann	15
	Trichouropoda falconis Hirschmann and Wisniewski	10
	Trchouropoda sp. 1	1
Suborder	Oribatida	
Family	Achipteriidae	
	Anachipteria sp.	2
Family	Cymbaeremaeidae	
	Scapheremaeus sp.	2
Family	Eremaeidae	
	Eremaeus sp.	1
Family	Oppiidae	
	Oppiella nova (Oudemans)	5
Family	Oribatellidae	
	Oribatella sp.	1
Family	Oribatulidae	
	Eporibatula sp.	1
	Oribatula tibialis (Nicolet)	1
	Phauloppa pilosa (Banks)	6
	Scheloribates sp. 1	9
	Zygoribatula frisae (Oudemans)	1
Family	Oripodidae	
	Oripoda sp.	2
Family	Parakalummidae	
	Protokalumma depressa (Banks)	3

Family Phthiracaridae	
Phthiracarus setosellum Jacot	7
Family Tectocepheidae	
Tectocepheus velatus (Michael)	6
Order Araneida	
Family Clubionidae	
species 1	1
Class Insecta	
Order Anoplura	
Family Hoplopleuridae	
species 1	3
Order Coleoptera	
Family Dermestidae	
Dermestes pulcher LeConte	26
Family Histeridae	
Carcinops pumilio Erichson	49
Dendrophilus punctatus (Herbst)	2
Dendrophilus xavieri Marseul	9
Euspilotus sp.	4
Gnathoncus sp.	5
Margarinotus merdarius (Hoffman)	1
larvae	278
Family Lathridiidae	
Lthridius minutus (L.)	3
Family Silphidae	
Nicrophorus pustulatus Herschel	1
Family Staphylinidae	
Aleocharinae sp.	17
Philonthus sp.	1
Family Tenebrionidae	
Tenebrio molitor L.	92
Family Trogidae	
Trox scaber (L.)	1
Order Collembola	
Family Entomobryidae	
Willowsia buskii Lubbock	1
Order Diptera	
Family Ceratopogonidae	
Culicoides sp. nr. *piliferus* Root and Hoffman	7
Culicoides sp. nr. *travisis* Vargas	1
Family Milichiidae	
Carnus hemapterus Nitzsch	38
Leptometopa latipes (Meigen)	1,509
Family Muscidae	
Fannia sp.	2
Muscina stabulans Fallen	7
Family Scatopsidae	
Coboldia fuscipes (Meigen)	4
Family Scenopinidae	
Scenopinus sp.	5
Family Sphaeroceridae	
Leptocera (*Coproica*) n. sp.	434

Order Hymenoptera		
Family	Braconidae	
	species 1	1
Family	Cynipidae	
	Pseudeucoila sp.	1
Family	Formicidae	
	Lasius alienus (Foerster)	1
Family	Mymaridae	
	species 1	4
Order Lepidoptera		
Family	Tineidae	
	species 1	2
Order Psocoptera		
Family	Liposcelidae	
	Liposcelis bostrychophilus Badonnel	48
Order Siphonaptera		
	species 1	2

Table 4. Trophic classification of raptor nest fauna.

	% individuals per nest	
Category	Screech Owl	American Kestrel
Animal remains saprovores	27.65	82.19
Nest material saprovores	60.01	8.35
Predators	8.47	9.11
Parasites of vertebrates	3.87	.33
Parasites of invertebrates	0	.02

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BIOGEOGRAPHIC AFFINITIES OF THE EPHEMEROPTERA OF THE BLACK HILLS, SOUTH DAKOTA[1, 2]

W. P. McCafferty[3]

ABSTRACT: Records of mayfly species in South Dakota are few in number. Most records are from the Black Hills region of southwestern South Dakota. Twelve new species records (genera *Caenis, Callibaetis, Dactylobaetis, Epeorus, Nixe, Paraleptophlebia, Siphlonurus, Tricorythodes*) are also based on collections from the Black Hills. The diversity of the mayfly fauna in the Black Hills is relatively low, with only 19 species in seven families known. The species mix consists of some widespread North American species, but also western continental species and eastern continental species whose respective easternmost and westernmost range limits meet in the Black Hills. The somewhat insular nature of this small montane region may explain low numbers of species, and its proximity to the main body of Rocky Mountains may explain the presence of its western component. Eastern species represented are primarily northeastern North American species with disjunct, probably relict, populations now isolated in the lower Appalachian Mountains, the Ozark-Ouachita Mountains, and the Black Hills.

Very few published records of Ephemeroptera species in South Dakota have been established. Species previously reported from the Black Hills region of southwest South Dakota are included in Table 1. The Black Hills region referred to herein includes Custer, Fall River, Lawrence, and Pennington Counties (Fig. 1). The previous records were given by Morihara and McCafferty (1979) for the Baetidae, and by Allen and Edmunds (1965) for *Ephemerella inermis*. Examination of additional materials of all of these previously reported species has substantiated their presence.

Even fewer records have been established for areas of South Dakota outside of the Black Hills region. In recent revisions, Bednarik and McCafferty (1979) recorded *Stenonema mediopunctatum arwini* from the Yellowbank River in extreme northeastern South Dakota, and Kondratieff and Voshell (1984) recorded *Isonychia rufa* from Sioux Falls in the southeast corner of the state. There are new state records of mayflies based on species I have examined from eastern South Dakota, but these will be published as part of revisionary studies now in progress.

Two primary factors have prompted the present report. First, it has become increasingly important to survey the North American fauna with respect to documenting biodiversity. Second, the Black Hills region is important biogeographically since, as will be discussed below, it con-

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tains one of the most unusual mixes of mayfly faunal elements found in North America.

All species records for the Black Hills region reported by Morihara and McCafferty (1979) and all but one reported here for the first time (Table 1) have been based on collections made by me and by A. V. Provonsha and B. L. Heath in June, 1975 (Sites 2-17 in Table 2 and Fig. 1). Site 1 (Table 2 and Fig. 1) was collected in November, 1977, by an unknown collector. All larvae upon which data in Table 1 are based are deposited in the Purdue Entomological Research Collection, West Lafayette, Indiana.

In addition to a list of species taken in the Black Hills region, Table 1 indicates numbered collection sites where each species was found. These sites are plotted on a map of the region (Fig. 1) and are detailed in Table 2. Also included in Table 1 is an indication of the general North American distribution of each of the Black Hills species.

A rather striking pattern of biogeographic affinity is found for a large proportion of Black Hills species. Black Hills records represent the extreme range margin for 13 of the 19 species listed. Ten of the species are western continental or eastern continental species whose respective easternmost or westernmost fringes of their ranges apparently include the Black Hills. For the three other species, the Black Hills distribution is apparently along their northern or northeastern range margin.

Among the Baetidae, the species listed as widespread are generally distributed with a broad east-west transcontinental pattern. In the case of *Callibaetis fluctuans* and *Diphetor hageni*, these transcontinental patterns are somewhat restricted north and south, with either a mid-latitude or more northern pattern, respectively. *Fallceon quilleri* is widespread but only as far east as Illinois (Burks 1953, as *B. cleptis*) and Louisiana (Lager 1985) and is mainly southwestern and south-central in distribution. *Fallceon quilleri* may actually represent a complex of more than one species, but requires further systematic study (Waltz and McCafferty 1987a). In the case of *Callibaetis pictus*, although the range is signified as western in Table 1, it also extends into some south-central states as far east as Texas. Those species listed as eastern generally have midwestern as well as more eastern distributions.

Baetis brunneicolor, *B. flavisriga*, and *B. intercalaris* are eastern species whose westernmost distribution limits are represented by disjunct populations in the Black Hills. *Acentrella insignificans* and *Dactylobaetis cepheus* are western species whose easternmost limits appear to be in the Black Hills. With respect to *D. cepheus*, this may have been the species that Lehmkuhl (1976) reported as *Dactylobaetis* sp. from Saskatchewan. Whereas biogeographic affinities of *Dactylobaetis* are Neotropical

(Traver and Edmunds 1968), those of *Acentrella* are Holarctic (Waltz and McCafferty 1987b). The Black Hills are along the northern fringe of the known ranges of *Callibaetis fluctuans* and *C. pictus*. *Fallceon quilleri* has been reported from Saskatchewan (Lehmkuhl 1976), but the Black Hills distribution may be disjunct and along its northeastern range margin. Eventually, the *Callibaetis* species probably will be found in Saskatchewan.

The Heptageniidae is the only other family with more than one species listed for the region. *Epeorus grandis* and *Nixe criddlei* are western species whose eastern limits are apparently the Black Hills. Records of the latter species from Fort Collins, Colorado (Traver 1935) are nearly as far east.

Of the remaining species, *Caenis amica* is widespread and ubiquitous (Provonsha 1990), and *Tricorythodes minutus* is also widespread except for its absence from the Southeast (Berner 1977). *Siphlonurus columbianus* and *Ephemerella inermis* are western species whose eastern limits are apparently the Black Hills, although *E. inermis* is reported from Saskatchewan (Lehmkuhl 1976), and I have seen *S. columbianus* from north-central Colorado. Hilsenhoff (1987) reported that either *E. inermis* or a sibling of it occurs in Wisconsin. I would not expect this species in Wisconsin, given its absence in places such as Manitoba and Minnesota (Flannagan and Flannagan 1982, Lager *et al.* 1982), but I have not studied the Wisconsin material. *Paraleptophlebia mollis* is a mainly northeastern species whose previous westernmost known distribution included Manitoba and Minnestoa (Flannagan and Flannagan 1982, Lager *et al.* 1982).

In conclusion, there are at least three aspects of the Black Hills mayfly fauna that are noteworthy. First, the diversity of species is relatively small. This perhaps could be explained by the fact that the region is a somewhat insular montane area. Its isolation from other montane areas may be an obstacle to dispersal for many mayfly species.

Second, the Black Hills represent the easternmost limits for certain western species. The montane nature of the region would perhaps explain the presence of such species that have populations located proximally in the main body of the Rocky Mountains and that are relatively good dispersers.

Third, and what might appear to be the most difficult to explain, four eastern species have westernmost limits in the Black Hills. *Baetis brunneicolor* and *B. flavistriga* are, however, mainly northeastern and upper midwestern in distribution (Morihara and McCafferty 1979) as is the *Paraleptophlebia mollis* (Traver 1935). Although mainly lowland species in their primary range, their range extensions outside of this area are disjunct in montane areas: Unzicker and Carlson (1982) reported *B. brunneicolor* from North Carolina; Peters and Warren (1966) reported *B. flavistriga* (as *B. levitans*) from the Ozark Mountains of Arkansas, and Berner (1977) reported this same species from Tennessee and North Carolina; and Traver (1937) confirmed *P. mollis* from North Carolina, and McCafferty and Provonsha (1978) found it in the Ouachita Mountains of Arkansas. This type of pattern in North America probably indicates a relict distribution, where certain cold-water species have become restricted to northeastern regions and isolated in certain disjunct montane areas outside the Northeast as a result of glacial events during the Pleistocene.

Although the distribution of *Baetis intercalaris* is similar to the three other eastern, Black Hills species, this species is found in more divese lowland and upland locations in the East, including areas such as Florida and Alabama (Morihara and McCafferty 1979). The western disjunction in this instance is therefore more difficult to interpret. The species does occur in the lower Appalachians and the Ozarks (Morihara and McCafferty 1979), but these are not disjunctions. Perhaps the species has been a better post-glacial disperser, and since it appears more ubiquitous, perhaps will be found in lowland areas adjacent to, and east of, the Black Hills. This apparent anomaly, however, may not actually exist if it is an artifact of our inexact taxonomy. *Baetis flavistriga* and *B. intercalaris* are closely related and morphologically cryptic as larvae, being separable only by color pattern (Morihara and McCafferty 1979). Therefore, it is possible that what we have determined to be *B. intercalaris* in the Black Hills is a color variation of *B. flavistriga* that resembles *B. intercalaris* in other areas. *Baetis ochris* is another closely related and similar species that may be involved.

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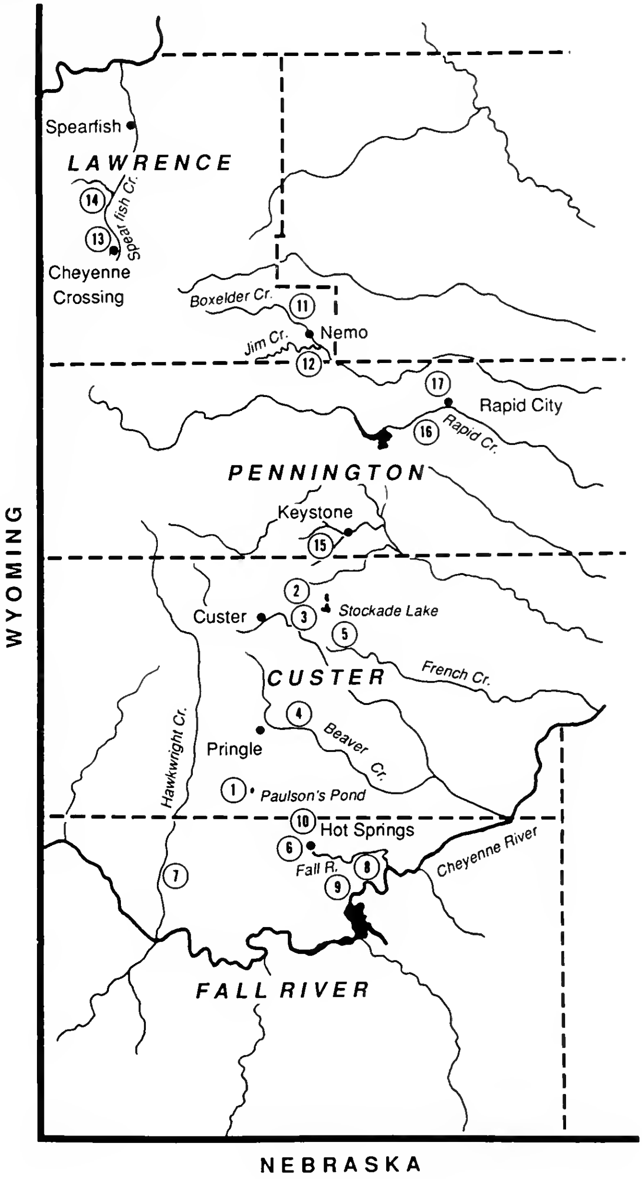

Fig. 1. Black Hills region of southwest South Dakota, with plotted mayfly collection sites.

Table 1. Distribution of the Ephemeroptera species of the Black Hills region of South Dakota. Asterisked species are newly reported for South Dakota. Numbers refer to sites plotted in Fig. 1. and detailed in Table 2.

SPECIES	SITES	N.A. DISTRIBUTION
Baetidae		
Acentrella insignificans	6	west
Baetis brunneicolor	5, 15	east
Baetis flavistriga	5, 11, 15, 16, 17	east
* *Baetis intercalaris*	11, 16, 17	east
Baetis tricaudatus	6, 11, 12, 13, 14, 16	wide
* *Callibaetis ferrugineus*	2	wide
* *Callibaetis fluctuans*	10	wide
* *Callibaetis pallidus*	1	wide
* *Callibaetis pictus*	3, 7	west
* *Dactylobaetis cepheus*	6	west
Diphetor hageni	12, 16	wide
Fallceon quilleri	6, 8	wide
Caenidae		
* *Caenis amica*	17	wide
Ephemerellidae		
Ephemerella inermis	4, 11, 12, 16	west
Heptageniidae		
* *Epeorus grandis*	13, 14, 15, 16	west
* *Nixe criddlei*	5	west
Leptophlebiidae		
* *Paraleptophlebia mollis*	11, 12, 15, 16	east
Siphlonuridae		
* *Siphlonurus columbianus*	15	west
Tricorythidae		
* *Tricorythodes minutus*	5, 8, 9, 11, 15	wide

Table 2. Details of Black Hills mayfly collection sites.

1. Custer Co, Paulson's Pond, 8 mi SW Pringle.
2. Custer Co, Bismark Lake Campground.
3. Custer Co, Stockade Lake at US 16A.
4. Custer Co, Beaver Cr 1 mi E Rifle Pit Historical Site.
5. Custer Co, French Cr at Hazelrodt Picnic Grounds.
6. Fall River Co, Hot Brook at Chataqua Park, Hot Springs.
7. Fall River Co, Hawkwright Cr at Red Canyon.
8. Fall River Co, Fall R at US 385 nr confluence of Cheyenne R.
9. Fall River Co, Cheyenne R at US 385.
10. Fall River Co, Fall Creek Reservoir 2 mi N Hot Springs.
11. Lawrence Co, Boxelder Cr at Boxelder Forks Campground 1 mi W Nemo.
12. Lawrence Co, Jim Cr 3 mi S Nemo.
13. Lawrence Co, Spearfish Cr 1 mi N Cheyenne Crossing at US 14A.
14. Lawrence Co, Iron Cr at US 14A 12 mi S Spearfish.
15. Pennington Co, Grizzly Bear Cr at Keystone.
16. Pennington Co, Rapid Cr at mouth of Dark Canyon.
17. Pennington Co, Rapid City at light.

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ANTHOPOTAMUS, A NEW GENUS FOR NORTH AMERICAN SPECIES PREVIOUSLY KNOWN AS *POTAMANTHUS* (EPHEMEROPTERA: POTAMANTHIDAE)[1, 2]

W.P. McCafferty, Y.J. Bae[3]

ABSTRACT: Comparative studies of all life stages of potamanthid mayflies worldwide have indicated that North American species historically placed in the genus *Potamanthus* are generically distinct from all Palearctic *Potamanthus*, including the type of the genus, the European species *P. luteus* (Linn.). Close phylogenetic relationships of the Nearctic species of Potamanthidae are with East Asian genera, but not Palearctic *Potamanthus*. The new genus *Anthopotamus* [type species = *A. verticis* (Say), new combination] is therefore established for the Nearctic fauna of Potamanthidae. A brief synopsis of the new genus is provided, and a biogeographic origin of the new genus is suggested.

The genus *Potamanthus* Pictet in North America was most recently reviewed by McCafferty (1975). Although the classification (McCafferty and Edmunds 1979) and the phylogeny (McCafferty 1979) of Potamanthidae within the higher groups of Ephemeroptera have been recently presented, the systematics within the family have not been studied comprehensively. Members of this clearly monophyletic family, commonly known as hacklegills (McCafferty 1981), are distributed in the Holarctic and Oriental Realms, with several genera occurring in East Asia, but only *Potamanthus* occurring in North America. We are currently conducting a revisionary study of both species and genera of the Potamanthidae. This has been possible only by bringing together material from throughout the world for comparative study.

Potamanthus, as it has been constituted, is known from North American and Eurasia. The type of the genus is *P. luteus* (Linn.), a common European species that was first described in *Ephemera* in 1767. We have studied adults and larvae of Nearctic and Palearctic *Potamanthus* in detail, including *P. luteus*. Our comprehensive comparisons with other potamanthids from the entire range of the family clearly show that species in North American are distinct from *P. luteus*. The degree of demarcation is equivalent to, or more than, that found in well-established, valid genera in the family. Asian species of *Potamanthus* do, however, agree with the type concept of the genus. Thus, the North American species constitute a separate and distinct grouping that require classification

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in a new genus. The most compelling reason for removing the Nearctic species from *Potamanthus* is our finding that they are phylogenetically removed from Palearctic *Potamanthus* and are instead more closely related to other East Asian genera.

Because ecological and behavioral data dealing with various North American potamanthid species are about to be made available for publication (Bae and McCafferty unpublished, D.C. Tarter, pers. comm.) and publication of the family revision will not be forthcoming for at least another two years, it is appropriate to report this systematic finding and make a new generic name available at this time. Therefore, a new genus is established herein and a brief synopsis and discussion of the taxon is given.

Anthopotamus, new genus

Type Species. *Potamanthus verticis*(Say), 1839:42, orginally as *Baetis*.

Species Included. *Anthopotamus diaphanus* (Needham), *A. distinctus* (Traver), *A. inequalis* (Needham), *A. myops* (Walsh), *A. neglectus* (Traver), *A. rufous* (Argo), *A. verticis* (Say), and *A. walkeri* (Ide), all NEW COMBINATIONS.

Distribution. Eastern half of North America.

Etymology. The name *Anthopotamus* is a masculine name taken from the Greek *anthos* (flower) and *potamos* (river). The allusion to a "river flower" is analogous to the other generic names in Potamathidae, which also denote river flowers.

Diagnosis. Larvae of *Anthopotamus* have long, well-developed mandibular tusks, highly developed mouthpart setation, and well-developed rows of long setae on the foretibiae (see Fig. 3 in McCafferty 1975 and Fig. 7.42 in McCafferty 1981). *Potamanthus* larvae, on the other hand, have rudimentary tusks and poorly developed mouthpart and foretibiae setation in comparison (e.g. see Fig. 1b in Macan 1979). Adults of *Anthopotamus* can be distinguished from those of *Potamanthus* by the generally smaller compound eyes of the males (ratio of eye diameter to dorsal distance between compound eyes is less than 0.2), as well as a much longer prothorax, and generally lighter coloration.

Relationships. Our cladistic analysis, details of which will be published as part of the revisionary monograph, indicate that the Old World genus *Potamanthus* (sensu novum) represents an ancestral, early branching lineage within the Potamanthidae. Its sister lineage contains all other Potamanthidae, a grouping consisting of East Asian genera as well as *Anthopotamus*. Within this later lineage, *Anthopotamus* is intermediate in position between the more ancestral *Potamanthodes* and the more derived *Rhoenanthus*. *Anthopotamus* is not closely related phylogenetically to *Potamanthus*, wherein its species were previously included.

Most probably, an *Anthopotamus*-like ancestral lineage spread to North America via Beringia in pre-Pleistocene times. Vicariance of this

Holarctic, Arcto-Tertiary distribution would have probably paralleled the phyletic split into a Nearctic "*Anthopotamus*" lineage and the Palearctic "*Rhoenanthus*" lineage. If more derived elements of Potamanthidae were very widespread in the Holarctic during the Tertiary, then perhaps glacial events during the Pleistocene would explain the present absence of this element in Europe and western North America. Such Arcto-Tertiary and subsequent patterns are well documented in plant and animal genera, e.g. see review of Pielou (1979).

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CYTOLOGY OF *LEPTOGLOSSUS ZONATUS* (HEMIPTERA: COREIDAE)[1]

Richard J. Packauskas[2]

ABSTRACT: The diploid chromosome complement of *Leptoglossus zonatus* (Dallas) males is shown to consist of 21 chromosomes: 18 autosomes, 2 microchromosomes, and an X chromosome. There are two large homologous pairs (4-5 microns in length). The remaining autosomes and the X chromosome range from 2-3 microns in length, and the microchromosomes (which are round) are 1 micron in diameter. Major meiotic events of the species are briefly characterized.

The Coreidae is a very large and diverse family, and many species within it have been examined cytologically. Most coreids investigated have a pair of microchromosomes and an XO sex mechanism. The chromosomes are holokinetic (diffuse centromeric), as are those of all Hemiptera (Thomas 1987). Coreid chromosome numbers range from 2n = 13 to 2n = 28; the most common number is 2n = 21 (Ueshima 1979). The genus *Leptoglossus* Guérin belongs in the coreine tribe Anisoscelidini, some of whose members have been investigated cytologically (Piza 1945, 1956; Wilson 1907, 1909).

Here I examine the cytology of *Leptoglossus zonatus* (Dallas) and relate this to previous studies. The chromosome number of this species has never been published, nor have meiotic events in this genus been characterized.

MATERIALS AND METHODS

The figures and observations were based upon preparations made from 3 male fifth instars collected in Panama and alcohol preserved (70% ethyl) in August of 1987. A modification (Jane O'Donnell, unpubl.) of a technique (Ueshima 1963) for preparation of alcohol-preserved specimens was used with good results even after a year of storage: 1) testes were dissected out in alcohol and placed for 12 hours in the fixative isopropyl carnoy (3 parts pure isopropyl alcohol, 1 part glacial acetic acid); 2) they were transferred to glacial acetic acid and heated gently over an alcohol lamp for 5-10 minutes; 3) the preparation was allowed to cool to room temperature, and then placed in a drop of aceto-carmine; 4)

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a cover slip was applied and the material squashed with a few hard taps of a pencil eraser. All preparations were subsequently mounted in Diaphane to make them permanent (Sharma and Sharma 1972). Drawings were made with the aid of an ocular grid, and measurements with an ocular micrometer.

OBSERVATIONS

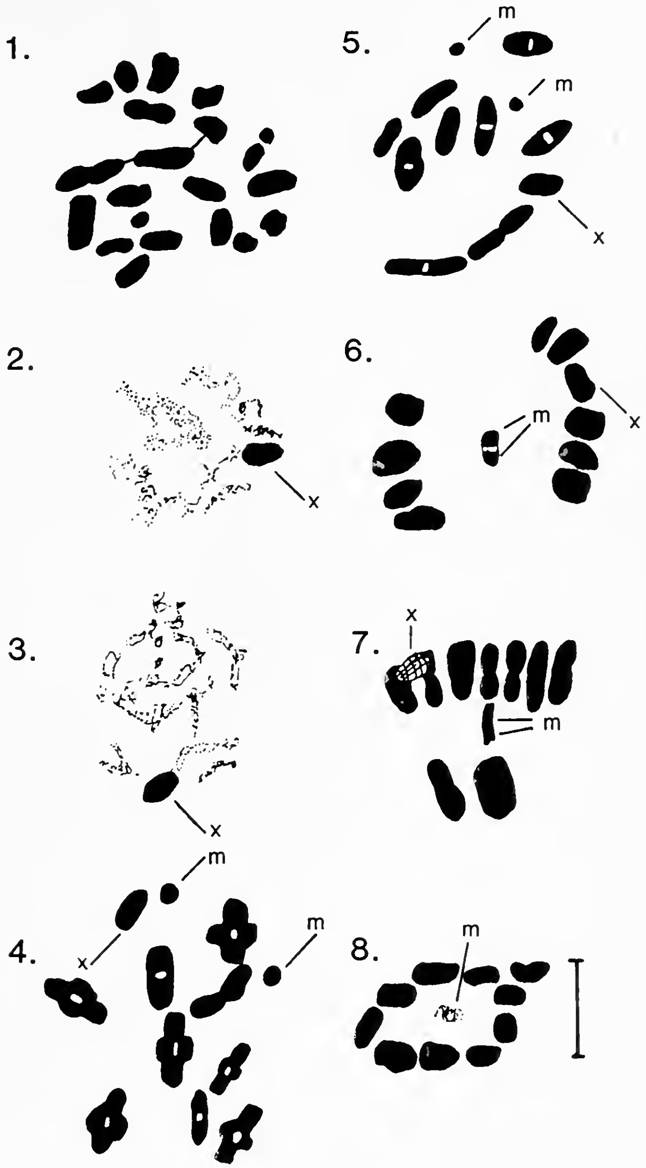
Observations were recorded as drawings; only brief explanatory comments are offered.

Spermatogonial phases are easily seen in *L. zonatus*, but these are not always easily analyzed. The spermatogonial chromosomes do not spread well in a squash and can only be counted in broken cells, but they are nevertheless useful in establishing a diploid count. Figure 1 is of a spermatogonial phase, and shows 21 chromosomes.

Prophase events are also not easily analyzed in the Heteroptera (Ueshima 1979), but are useful in establishing the size and shape of the sex chromosomes. Figures 2 and 3 clearly show a single heteropyconotic chromosome (the X chromosome).

Cells which are found in early diakinesis show chiasmata formation among the autosomes. Figure 4 shows terminalization of chiasmata among homologs of each of the autosomes. The microchrosomes (m) are plainly visible as the two smallest chromosomes. The X chromosome (x) can now be determined by comparison with Figures 2 and 3. Nine homolog pairs can be seen, as can the X chromosome and the two microchromosomes. Figure 5 shows late diakinesis, when terminalization of chiasmata is complete and the autosome homologs have reached their maximal lengths for this stage. This stage was the most useful in establishing a count. Thus, in *L. zonatus* we clearly see 9 pairs of autosomes, the X chromosome, and two microchromosomes, for a total of 21. Chromosomes were measured in 7 cells in late diakinesis. Two of the autosome homolog pairs were consistently larger than the rest, 4-5 microns in length. The remaining autosome pairs and the X chromosome were 2-3 microns in length, and the microchromosomes (which are round) were 1 micron in diameter.

In metaphase I (Figures 6 and 7), the autosome pairs and the X chromosome formed a ring around the two closely appressed microchromosomes. Finally, in a metaphase II (Figure 8), the same type of ring formed around the single diffuse microchromosome.



Figures: 1. spermatogonial phase, 2. prophase, zygotene, 3. prophase, leptotene = diplotene, 4. early diakinesis, 5. late diakinesis, 6. metaphase I, polar view, 7. metaphase I, lateral view, 8. metaphase III, polar view. m = michrochromosome, X = X chromosome. Scale bar = 5 microns.

DISCUSSION

Other species of *Leptoglossus* have been looked at cytologically, including *L. dilaticollis* Guerin (Piza 1956), *L. gonagra* (Fabricius) (Piza 1945), *L. phyllopus* (Linnaeus) (Wilson 1909), and *L. stigma* (Herbst) (Piza 1956). All have a diploid complement of 21 chromosomes in the male (18A + 2m + X). *Leptoglossus zonatus*, therefore, falls into this already established pattern.

These observations do not depart significantly from the more detailed description of meiotic events in *Coreus marginatus* L. (a member of the tribe Coreini) (Nokkala 1986); but the procedure and drawings herein should provide a novice entry into this neglected field of cytology. Only chromosome numbers were reported in all previous studies of this genus. It is hoped that the brief characterization of meiotic events within this species and the finding of disparate chromosome sizes will prove to be of value in further analysis of the cytology and the complex evolutionary history of this diverse and cytologically poorly known family.

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NEW IASSINAE (HOMOPTERA: CICADELLIDAE) FROM MEXICO AND PERU[1, 2]

H. Derrick Blocker[3]

ABSTRACT: Two new species of Iassinae, *Gargaropsis (Curistuva) poravis* and *Baldriga deornitha*, are described from Mexico. These were taken from foodballs regurgitated from the crops of swifts that were captured and released unharmed in Chiapas, Mexico. Another new species of Iassinae, *Garlica freytagi*, is described from Peru.

Two new species of Iassinae from foodballs regurgitated from the crops of white-collared swifts, *Streptoprocne zonaris* (Apodiformes: Apodidae) that were captured and released unharmed are described from Chiapas, Mexico. This population of swifts was located at Cueva el Chorreadero, 12km N.E. of Chiapa de Corzo, Chiapas. Three species were represented by the three specimens of Iassinaer recovered. These were: *Gargaropsis (G.) confinis* Blocker, *G. (Curistuva) poravis,* n. sp., and *Baldriga deornitha*, n. sp. Specimens were in excellent condition, although some appendages were missing and the body was often coated with saliva or mucus which often coats these foodballs. In addition, a new species, *Garlica Freytagi*, is described from specimens collected in Peru.

Gargaropsis subgenus *Curistuva* Blocker

Gargaropsis (Curistuva) Blocker, 1979:14. Type species: *Gargaropsis adibilis* Blocker by original designation.

Four species are presently assigned to this subgenus:

adibilis Blocker, 1975:561. Mexico.
filialis Blocker, 1975:563. Mexico.
poravis Blocker, new species. Mexico.
wilburi Blocker, 1975:564. Mexico.

Gargaropsis (Curistuva) poravis, n. sp.

(Figs 1-3)

Length of male 4.8 mm; head width 1.5 mm; pronotal width 1.9 mm. Female unknown.

Color stramineous, body and wings covered with small dark brown spots, larger dark brown areas on scutellum and claval area at apex of forewings; face, legs, and venter of thorax with some fuscous marking.

Vertex length slightly longest medially; anteclypeus not attaining margins of genae; vein in appendix of forewing evanescent apically; hind femoral chaetotaxy 2-2-1 with one of second pair reduced.

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Pygofer process acute apically; style bifid apically (fig. 1); connective straplike; aedeagus with shaft tapered apically (fig. 2), bifid apically in dorsal view with apical processes slender, curved cephalad (fig. 3), dorsal apodeme with arms broadly U-shaped.

Holotype male, from Mexico, Chiapas, Chiapa de Corzo, 3 vi-16 vii 1985 (D. F. Whitacre), food of (Aves) *Streptoprocne zonaris*, in The University of Kansas collection.

Gargaropsis (Curistuva) poravis is related to *adibilis* and keys to this species in Blocker (1975). It can be distinguished by the wider, apically tapered shaft of the aedeagus and by the shape of the apex of the style.

Baldriga Blocker

Baldriga Blocker, 1979:15. Type species: *Baldriga knutsoni* Blocker by original designation.

Six species are presently assigned to this genus:

deornitha Blocker, new species. Mexico.
galida Blocker, 1982:641. Mexico.
knutsoni Blocker, 1979:15. Mexico.
nielsoni Blocker, 1982:640. Panama.
painteri (Blocker), 1975:563. Mexico.
rutasaca Blocker, 1979:16. Brazil

Baldriga deornitha, n. sp.

(Figs. 4-6)

Length of male 6.6 mm; head width 2.2 mm; pronotal width 3.0 mm. Female unknown.

Color stramineous dorsally; body and forewings with numerous fuscous dots; venter of thorax fuscous.

Vertex parallel-margined; anteclypeus attaining margin of gena; hind femoral chaetotaxy 2-1-1 or 2-1 (in same specimen).

Pygofer processes acute apically; style abruptly narrowed near apex, unique (fig. 4); connective straplike, slightly arched in lateral view; aedeagus with shaft excavated in lateral view (fig. 5), apex not bifid in dorsal view (fig. 6), apical processes exceeding width of shaft.

Holotype male, from Mexico, Chiapas, Chiapa de Corzo, 3 vi-16 vii 1985, (D. F. Whitacre), food of (Aves), *Streptoprocne zonaris*, in The University of Kansas collection.

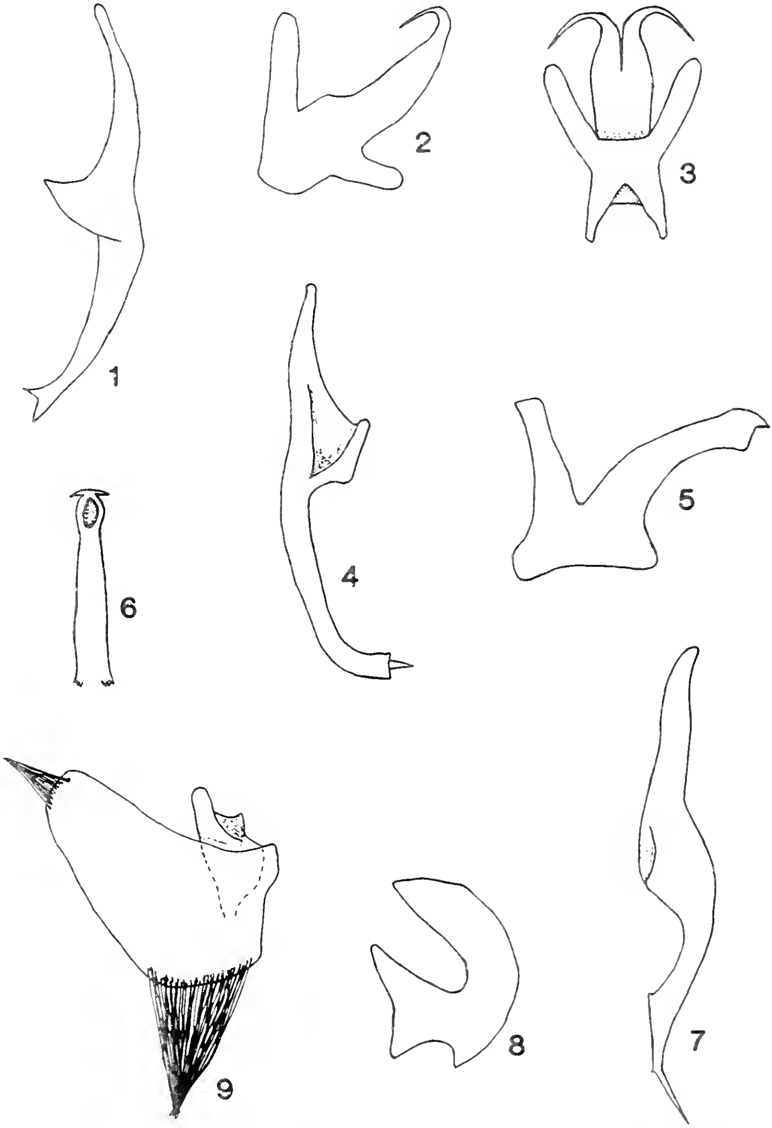
Baldriga deornitha is related to *painteri* but can be distinguished by its larger size and the unique shape of the apex of the style.

Garlica Blocker

Garlica Blocker, 1976:519. Type species: *Garlica hepneri* Blocker by original designation and monotypy.

Five species are presently assigned to this genus:

exila Blocker, 1979:25. Brazil
freytagi Blocker, new species. Peru.
hepneri Blocker, 1976:519. Panama.
margina Blocker, 1982:645. Panama.
punctulata (Linnavuori), 1956:20. Brazil.



Figs. 1-9. 1-3. *Gargaropsis (Curistuva) poravis*. 1. Style, broad aspect. 2. Aedeagus, lateral view. 3. Aedeagus, dorsal view. 4-6. *Baldriga deornitha*. 4. Style, broad aspect. 5. Aedeagus, lateral view. 6. Shaft of aedeagus, dorsal view. 7-9. *Garlica freytagi*. 7. Style, broad aspect. 8. Aedeagus, lateral view. 9. Plate, ventral view.

Garlica freytagi, n. sp.

(Figs. 7-9)

Length of male 4.5 mm; head width 1.9 mm; pronotal width 2.0 mm. Female unknown.

Color stramineous with darker brown pattern on vertex, pronotum, and scutellum; numerous dark setae on forewing, appendix and 1st apical cell bordered anteriorly by fuscous veins; face with fuscous lines on either side of midline.

Vertex parallel-margined, not as wide as pronotum; ocelli more than 5X their diameter from eye; hind femoral chaetotaxy 2:2:1 with one of second pair reduced; sternum VIII elongate, extending beneath genital segment.

Pygofer with short fringe of microsetae on caudoventral margin and small tuft of microsetae on inner surface at same location; plates with two tufts of microsetae (fig. 9); pseudostyles inconspicuous, membranous; (styles with apex elongate, tapered, with two small spine-like processes (fig. 7); connective rectangular; aedeagus with shaft bulbous in apical 1/2 (fig. 8).

Holotype male, PERU, Madre de Dios, along Manu de dios River, 12 ° S, 25 Aug 1988, Manu Nat. Park, Cocha Salvador, at light (T. Myers), in The California Academy of Sciences collection. Three male paratypes, same data, at The University of Kansas, The American Museum of Natural History, and The University of Kentucky.

Garlica freytagi, n. sp. is related to *exila* but can be distinguished by the shape of the plates that are widest at the base and the presence of a small tooth on the foot-shaped style apex. I take pleasure in naming this species for my longtime and trusted colleague, Paul Freytag.

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NOTIOPHILUS PALUSTRIS (COLEOPTERA: CARABIDAE), A EURASIAN CARABID BEETLE NEW TO NORTH AMERICA[1]

A. Larochelle[2], M.-C. Larivière[3]

ABSTRACT: The Eurasian carabid beetle *Notiophilus palustris* is recorded for the first time for North America. Forty-four specimens have been found in Nova Scotia and Prince Edward Island, Canada, in 1967 and 1987. While macropterous forms are rare in Europe, individuals found in North America seem all to be macropterous, suggesting a recent immigration.

The insect collection of the Nova Scotia Museum of Science (Halifax) contains one specimen of the Eurasian carabid beetle *Notiophilus palustris* (Duftschmid, 1812), collected by Ken Neil from Nova Scotia: Halifax Co., Armdale, 1.VII.1967. Forty-three individuals of this species have also been discovered from the following localities: Nova Scotia: Pictou Co.: Merigomish Island, 20.VII.1987 (25 exx.). Prince Edward Island: Kings Co.: Basin Head, 13.VII.1988 (one ex.); Panmure Island Provincial Park, 15.VII.1987 (one ex.); Red Point Provincial Park, 15.VII.1987 (one ex.); Souris Beach Provincial Park, 14.VII.1987 (one ex.). Queens Co.: Lord Selkirk Provincial Park, 14.VII.1987 (one teneral ex.); Wood Island Provincial Park, 13.VII.1987 (13 exx.). This is the first record of this Eurasian carabid for North America.

All specimens have been found on sandy sea beaches, under vegetal debris. According to Lindroth (1985), the species is hygrophilous and usually occurs in rather shady places on humus-rich ground; it is found in deciduous woods among the litter and in mosses as well as in open habitats such as meadows and marshes, with high and dense vegetation. In Europe, it is most common in spring when reproduction takes place, but also in fall when the new adult generation emerges.

Notiophilus palustris has apparently been accidentally introduced into North America, perhaps transported by ship. The species seems to be well established in the Atlantic Provinces of Canada as demonstrated by the large number of individuals found in numerous collecting localities and the presence of a teneral individual which indicates that breeding occurs locally. While macropterous forms are rare in Europe

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(Lindroth, *loco citato*), all specimens examined (at least 20) have fully-developed inner wings; this condition suggests a recent immigration into North America. Moreover, the area has been well surveyed in the past and while the beetle is conspicuous, it has never been recorded. This carabid should spread rapidly in northeastern North America due to its fully-developed, probably functional, wings and its eurytopic characteristics.

The species is characterized as follows: Broad, black with shiny cupreous luster; entire tibiae, base of palpi and four basal segments of antennae pale; anterior diverging frontal furrows; eyes very large; head wider than prothorax; pronotal sides strongly constricted basally and rounded. Second elytral interval just behind the middle, more than three times as wide as third interval; each elytron with two dorsal punctures and two preapical punctures; intervals not reticulated; striae densely and deeply striated, especially behind shoulder. Body length: 5-6.1 mm.

In Lindroth's key (1961) to North American *Notiophilus*, the species will trace to Couplet 8 modified in the following manner:

8. Tibiae black. Elytra with 2. interval hardly broader than the following two together .... *N. simulator* Fall
\- Tibiae yellowish brown. Elytra with 2. interval at least as broad as the three following together.. 9

9. Second and third elytral striae obliterated before apex. Elytra quite dark or with ill-defined pale apical vitta.. 9.1
\- Second and third elytral striae evident to apex. Elytra always with well defined pale apical vitta. .... *N. biguttatus* (Fabricius)

9.1 Each elytron with 2 dorsal punctures. Head much wider than prothorax which is strongly constricted basally. 5-6.1 mm. Nova Scotia and Prince Edward Island .... *N. palustris* (Duftschmid)
\- Each elytron with a single dorsal puncture. Head as wide as prothorax which is devoid of basal contriction. Smaller: 3.4-4.7 mm. Eastern United States....*N. novemstriatus* LeConte

ACKNOWLEDGMENTS

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A NEW *MASTOGENIUS* (COLEOPTERA:BUPRESTIDAE) FROM JAMAICA[1]

Gary V. Manley[2]

ABSTRACT: A new species of *Mastogenius (M. howdenorum)* is described from Jamaica, West Indies. The genus is widely scattered in the West Indies, but this is the first species from Jamaica.

A series of *Mastogenius* specimens given to me recently by Dr. H. Howden (Carleton University) proved to be undescribed. The species is similar to *M. coyolensis* Manley from Honduras.

Mastogenius howdenorum
Manley, new species
(Figs. 1, 2 & 3)

HOLOTYPE, male: Elongate oval, shining, pronotum and elytra equally clothed with dense long whitish recumbent pubescence, dorsal surface uniformly aeneus, pronotum slightly brighter than elytra, ventral surface uniformly black, legs slightly reddish laterally, tarsi brownish-red.

HEAD slightly convex, faint shallow round depression on frons, surface coarsely punctate, clothed with recumbent hairs; eyes with inner margins parallel, not converging toward each other at apex; antenna serrate from fourth segment, extending beyond the pronotum, clothed with scattered hairs, segment four more than twice the length of segment three.

PRONOTUM uniformly convex, wider than long, narrower at apex than at base, widest near middle; sides broadly arcuately diverging from apical angles to near middle, then obliquely converging to posterior humeral angles; anterior margin slightly broadly emarginate; posterior margin truncate, straight; marginal and submarginal carina more widely separated near middle of pronotum, marginal carina not reaching anterior border of pronotum, sloping almost to submarginal carina and ending just prior to anterior margin of pronotum; surface uniformly, densely punctate; densely clothed with moderately long white setae.

SCUTELLUM black, triangular, and smooth.

ELYTRA convex, slightly flattened along median suture, as wide as pronotum at base; sides nearly parallel from humeral angles to near middle, then arcuately converging to tips, which are truncate; oblique transverse depression near bases; surface irregularly punctate, crenulate, densely clothed with relatively long white setae.

UNDERSIDES uniformly black, convex, punctate; abdomen clothed with scattered recumbent white setae; last sternite punctate, truncate at apices, clothed with scattered setae of various lengths; prosternum punctate, scattered hairs most common near the middle, without antennal grooves; posterior margin of hind coxal plates strongly sinuate, inner margin wider than external margin.

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SIZE: length, 2.6 mm; width, 1.1 mm (humeri).
ALLOTYPE, female: no significant differences were observed except the female has shorter antennae, not extending beyond the pronotum.
TYPES: Holotype male, Jamaica, Try. Duncans, VII-19-1966, A.T. Howden (HAHC, Ottawa). Allotype female and 3 male paratypes collected at the same locality and date as the holotype. Paratypes in Howden and Manley collections.

This species is similar to *M. coyolensis* Manley from Honduras and keys to the species in Manley, 1987. *Mastogenius howdenorum* differs from *M. coyolensis* in the following ways: *M. howdenorum* is smaller and less elongate, the pronotum is more uniformly rounded on lateral margins and widest at or just behind the middle, the disk of the pronotum is more uniformly convex, and the species is more densely pubescent on both the pronotum and elytra.

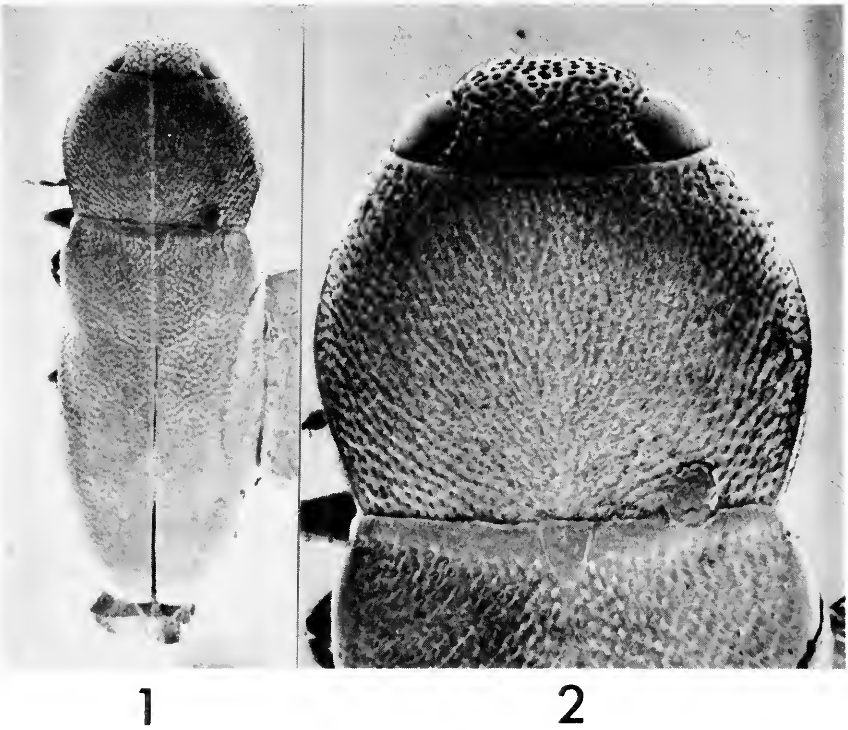

Figure 1-2. Dorsal view and pronotum, *Mastogenius howdenorum*.

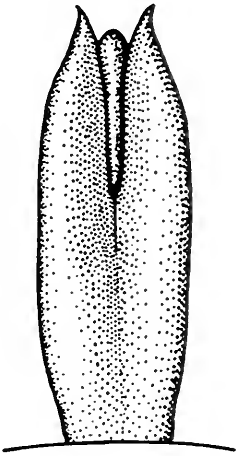

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Figure 3. Dorsal view of male genitalia, *Mastogenius howdenorum*.

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MARKING CASSIDINAE (COLEOPTERA: CRYSOMELIDAE) LARVAE IN THE FIELD FOR POPULATION DYNAMICS STUDIES[1]

M.A. Garcia, L.M. Paleari[2]

ABSTRACT: Marks on the exuviae held by caudal fork, a permanent structure in Cassidinae larvae, can provide a simple method for the study of larval population dynamics in this group.

Population-dynamics studies of insects are usually restricted to adults, which can be easily individualized by some kind of mark. Many mortality factors act on juvenile stages, however, and need to be studied. Since any mark directly placed on larvae or nymphs can only be seen until ecdysis occurs to the following instar, various indirect methods have been described to study the population-dynamics of the immature insects. Approximate correlation or indices of equivalence with population sizes at different times during insect development can be obtained by measures of damage, counts of exuviae or collecting feces of the immature insects (see Southwood 1978). These indirect methods can supply good correlations for some species. Another method developed by Kiritani and Nakasuji (1967) improved estimates of staged specific mortality rates for a population developing through various life stages. A drawback of this method is the fixed sampling pattern that modifies the population size and makes it difficult to obtain good estimates.

Cassidinae larvae offer a special opportunity for studies on population dynamics of juvenile insects. One of their characteristics is the accumulation of the exuviae and some feces attached to the caudal fork, constituting a permanent structure called the annex by Buzzi (1988). This structure can be present even on pupae and is suitable for marking.

The mobility of the caudal fork permits the annex to be adjusted over the insect's body, giving a camouflaged aspect. The side of the annex that is in contact with the larva's body is smooth and it is possible to count the series of exuviae on it. Marks can be placed on this side of the annex, without any modification of the larval aspect, giving little or no effect on the probability of attack by natural enemies or survival of the young insects in the field.

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A population of *Charidotis punctatostriata* larvae was marked in Campinas, São Paulo, Brazil, in a fallow field where the host plant *Pyrostegia venusta* (Bignoniaceae) was abundant.

Marks were made using white nail polish, but a special marking pen could just as well have been used, with each larva receiving its own number.

Larvae of *C. punctatostriata* from the same egg mass show a tendency to remain together. This made it easy to mark groups of different instars, placing the white spot over the more recent exuviae attached to the annex. The small white spot could only be seen when the larva spontaneously raised the annex or when this movement was provoked touching it with a brush.

The five instars of *C. punctatostriata* larvae found in the fallow field were observed and counted daily until they moulted to the next instar, when they were collected and reared further in the laboratory, while the observations continued.

None of the marks was lost in a month of observations. During this time all the marked larvae completed their development in the laboratory, disappeared by predation in the field, were mummified by parasitoids or died by disease (table 1). These data will be analysed and discussed in a separate paper about the field biology of *C. punctatostriata*.

Table 1. Survival of *Charidotis punctatostriata* (Coleoptera: Chrysomelidae: Cassidinae) larvae marked in the field. (number of individuals)

IN THE FIELD			LATER IN LABORATORY		
Instar marked	Number marked	Surviving to next instar	Mumified by parasites	Died by diseases	Surviving to adults
1	60	14	0	8	6
2	50	12	2	4	6
3	50	38	8	5	25
4	51	34	23	2	9
5	51	34	9	2	23

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A NEW DISTRIBUTIONAL RECORD FOR THE SAND-BURROWING MAYFLY *DOLANIA AMERICANA* (EPHEMEROPTERA: BEHNINGIIDAE)[1]

William L. Jacobs[2]

ABSTRACT: The sand-burrowing mayfly, *Dolania americana* is reported for the first time from the St. Croix River at the Wisconsin/Minnesota border. This record extends the range of this unique species far northward from its known typical southeastern blackwater habitats. A possible dispersal route for this species from the southeastern Coastal Plain into the St. Croix River system is briefly discussed.

The only North American member of the sand-burrowing mayfly family Behningiidae, *Dolania americana* Edmunds and Traver has been previously reported from Alabama (Wester and Folkerts 1987), Florida (Schneider 1966), Georgia (Benke *et al.* 1984), Louisiana (Dakin and Felder 1981), North Carolina (Finn and Herlong 1980), and South Carolina (Edmunds and Traver 1959, Harvey *et al.* 1980). The biology of this mayfly is relatively well-known. Its preferred habitat is clean, shifting sand rivers and large streams (Peters and Peters 1977, Tsui and Hubbard 1979, Fink 1986, and Peters *et al.* 1987).

On July 24, 1989, one nymph was collected from the St. Croix River. The collection site was near Soderbeck Landing, St. Croix National Scenic Riverway (Burnett County, Wisconsin). This site was approximately 70m upstream from the confluence of the Snake River, which originates in Minnesota. This nymph was collected with a Surber square foot sampler at a depth of 70-85cm. Due to drought conditions, the river was unseasonably low. The primary substrate consisted of fine grain sand (0.0625-0.125mm size range) and water pH was 7.4. Another specimen was collected August 21, 1989 at the same site. The two nymphs measured 5mm and 7mm body length respectively, indicating a 2 year life cycle.

Previous macroinvertebrate studies of the St. Croix National Scenic Riverway have yielded no *Dolania*. Additionally, no nymphs were collected during studies of a major Wisconsin tributary, the Namekagon River. The current benthic macroinvertebrate study of the St. Croix River involved collections every two weeks from late May until the end of September. Samples were taken upstream and downstream of the following tributaries: Cranberry bog (a bog which flows into the

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Namekagon River just below Pacwawong Dam, Sawer County, Wisconsin), Yellow River, Clam River (Burnett County, Wisconsin), Kettle River, Snake River (Pine County, Minnesota), Sunrise River (Chisago County, Minnesota), and Apple River (St. Croix County, Wisconsin). It is interesting to note that *Dolania* has not been previously reported from Wisconsin, although many streams have been intensively surveyed by William L. Hilsenhoff and co-workers (for example Hilsenhoff 1977).

Other mayflies collected with the *Dolania* specimens include *Baetis* spp. (Baetidae); *Isonychia* sp. (Oligoneuriidae); *Leucrocuta hebe* (McDunnough), *Stenacron interpunctatum* (Say), *Stenonema* spp., *Rhithrogena pellucida* Daggy, *Epeorus vitreus* (Walker) (Heptageniidae); *Choroterpes basalis* (Banks)?, *Leptophlebia cupida* (Say), *Paraleptophlebia* sp. (Leptophlebiidae); *Potamanthus* sp. (Potamanthidae); *Ephemera simulans* Walker, *Hexagenia limbata* (Serville) (Ephemeridae); *Ephoron leukon* Williamson (Polymitarcyidae); *Serratella* spp., *Ephemerella* spp., *Eurylophella* spp., *Attenella attenuata* (McDunnough) (Ephemerellidae); *Tricorythodes* sp. (Tricorythidae); *Caenis* spp., *Brachycercus* sp. (Caenidae), *Baetisca obesa* (Say) and *B. lacustris* McDunnough (Baetiscidae).

All of Minnesota and much of Wisconsin were covered with glacier during the last glacial stage, the Wisconsinan (Flint 1971), indicating post-glacial migration by the present day Ephemeroptera. This last glacial stage began retreating about 12-15 x 10^3 B.P. Aquatic dispersal by nymphs opposed to aerial dispersal by adults appears to be the likely mechanism in *Dolania*. The duration of the adult stage is less than two hours (Peters and Peters 1977). Flannagan and Flannagan (1984) outline post-glacial waterways from glacial Lake Agassiz (centered in Manitoba) and present likely migration routes. *Dolania* probably would be included in the South Agassiz group, inhabitants of the Gulf of Mexico watershed. Migration northward likely occurred through the Mississippi-Missouri River system when Lake Agassiz drained southwards. Contemporary watershed barriers probably prevented recent northward migration of *Dolania* and other mayflies from the southeastern Coastal Plain, indicating that *Dolania* has probably been present in the St. Croix River system before recent times.

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A NEW METHOD FOR COLLECTING ADULT PHRYGANEID CADDISFLIES (TRICHOPTERA: PHRYGANEIDAE)[1]

David E. Bowles[2, 3], Karl Stephan[4], Michael L. Mathis[5]

ABSTRACT: A fermented molasses trap was used to collect several specimens of the caddisfly genus *Ptilostomis* (Trichoptera: Phryganeidae). Molasses bait traps are inexpensive, relatively maintenance free, and can be used as an effective collecting technique. Molasses and other sugar-based materials are suggested to be a possible source of nutrition for these caddisflies.

Representatives of the trichopteran family Phryganeidae are large, attractive caddisflies often characterized by having distinctly patterned wings. Ten genera and 27 species of phryganeids are represented in North America (Wiggins 1984, Wiggins and Larson 1989). Depending on geographical location phryganeids can be common and adults may be obtained through a variety of techniques including fluorescent and UV-light traps, Malaise and flight-intercept traps, sweeping, and laboratory rearings of immature stages. Recently, one of the authors (KS) collected several specimens of the phryganeid genus *Ptilostomis* from an eastern Oklahoma woodland (Latimer County; near Red Oak) using a fermented molasses trap.

A mixture of molasses and water (3:1 ratio) was placed into a 355 ml plastic cup, approximately one-half full, and positioned approximately 2 m above ground level. The trap was being used to collect saprophagous Coleoptera that are attracted to the fermenting molasses.

During June 1989, several specimens of *Ptilostomis postica* (Walker) and two individuals of *P. ocellifera* (Walker) were collected with the molasses trap. Although specimens were removed from the trap daily, the numbers collected on a particular day were not recorded. The molasses

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[3] This paper reports the results of research completed while a graduate student in the Department of Entomology, University of Arkansas, Fayetteville, AR 72701. Opinions and assertions contained herein are those of the authors and are not to be regarded as official or as reflecting the views of the United States Air Force.

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trap was situated on a heavily forested hillside approximately 200 m from the nearest permanent water sources including a spring, small stream, and farm pond. All three sources of water could potentially serve as the larval habitat (Bowles and Mathis 1989). The molasses bait apparently attracted the caddisflies during nocturnal periods, and the specimens were found during daylight hours drowned in the fermented mixture. No specimens were collected alive; no additional caddisfly species were collected from the trap.

The total number of specimens collected for each species was similar for both the molasses bait and UV-light trap samples that were taken nightly during the same time period. The molasses bait yielded five female and seven male specimens of *P. postica* and two female specimens of *P. ocellifera*. UV-light trap collections yielded five females and six males of *P. postica* and one female of *P. ocellifera*. Males of the latter species have been collected previously from the same area. Voucher specimens of *P. ocellifera* and *P. postica* are deposited in the University of Arkansas Insect Collection.

The reason why the phryganeids were attracted to the molasses bait is not known. However, some species of Trichoptera have been reported to feed as adults, particularly on sweet materials such a flower nectar (Crichton 1957), sugar baits, honeydew, honey, and fruit preserves (Malicky 1989). The phryganeids probably were attempting to obtain nourishment when they became trapped in the molasses mixture. Crichton (1957) provided a detailed discussion of the structure and imbibing function of phryganeid mouthparts and compared them with those of representatives of 12 other trichopteran families. The protrusible haustellum used in imbibing fluids was found to be most developed in the Phryganeidae and Limnephilidae (Crichton 1957).

The molasses bait trap provides a relatively maintenance free and inexpensive means for collecting phryganeid caddisflies. Molasses bait traps could prove advantageous in situations where the collector has time constraints such as simultaneously collecting from several localities. A series of several bait traps placed in a given area could be used as an effective collecting tool. Possibly, other sugar based materials also might be effective attractants. Additional testing will be necessary to evaluate the usefulness of molasses bait traps for collecting other caddisfly species.

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SUCKING LICE (ANOPLURA) FROM PAKISTAN MAMMALS, WITH NOTES ON ZOOGEOGRAPHY[1]

L.A. Durden[2], R. Traub[2], K.C. Emerson[3]

ABSTRACT: Anoplura collected from wild rodents, insectivores and canids in Pakistan are documented. Twenty-two species of lice were recovered as follows: *Hoplopleura* (8), *Linognathoides* (1), *Neohaematopinus* (1), *Polyplax* (12). At least 14 of these species are recorded from Pakistan for the first time and some significant range extensions are established. Some of the records pertain to species previously known only from the type series or from other limited collections. Zoogeographically, Pakistan's anopluran fauna has strong Palearctic affinities although elements of this fauna show clear Oriental, Ethiopian or cosmopolitan associations.

Except for records of widespread species or descriptions of new taxa, the sucking lice (Anoplura) of Pakistan are poorly known. This is surprising because contributions documenting the anopluran fauna of adjacent regions in Afghanistan (Smetana and Daniel, 1970), India (numerous papers), Iran (Kim and Emerson, 1971), southern USSR (numerous papers) and the People's Republic of China (numerous papers) are available. Mishra (1981) produced a monograph of the hoplopleurid sucking lice of the Indian subcontinent and included the Pakistan fauna only from the Indus valley eastwards to the Indian border; however, that work principally addressed the Indian fauna and no specific records for Pakistan are given.

This paper provides records of sucking lice from wild land mammals (mainly rodents) obtained in Pakistan from 1962-1979. Most specimens were collected by field teams of the Department of Microbiology, University of Maryland School of Medicine, Baltimore under the direction of Robert Traub. Additional material was collected by Robert G. Tuck, then with the Division of Mammals, National Museum of Natural History (NMNH), Washington, D.C. Collection data for the 22 species of sucking lice recovered during these surveys includes hosts, collection localities, altitude (if available) and dates, followed by remarks. Louse synonymies listed are not new but are important to this study. Host mammal names follow Honacki *et al.* (1982) and Anoplura classification follows Kim and Ludwig (1978). Louse and host mammal material documented here is deposited in the collections of the NMNH, Washington, D.C.

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Family Hoplopleuridae Ferris

1) ***Hoplopleura affinis*** (Burmeister, 1838)

Specimens examined: (44 collections (39♂,253♀) ex *Apodemus* sp. (Rodentia, Muridae)) HAZARA DIST.: Kaghan valley: Soch, Naran, 2430 m and 2615 m, IX,X.1962, VII.1964, VII.1965 - 29 colls.; Shogran, 2385 m and 2770 m, VIII.1963, VIII.1964 - 3 colls.; Burawai, 3080 m, IX.1963 - 5 colls.; Battakundi, 2740 m, VIII.1963 - 1 coll.; 6.4 km E. of Lalazar, 2430 m, X.1962 - 1 coll.; GILGIT AGENCY: Naltar, 2985 m, VIII.1964 - 4 colls.; Gupis, Kohighizar, 2360 m, VIII.1964 - 1 coll.

Hoplopleura affinis is a common ectoparasite of Eurasian field mice of the genus *Apodemus*. There is some confusion regarding the status of *Apodemus* in Pakistan (Roberts, 1977); *A. sylvaticus* (Linn.) definitely occurs in that country but *A. flavicollis* (Melchior) may also be present. Hosts for the above-mentioned collections were listed as *Apodemus* sp., *A. flavicollis* or *A. sylvaticus*. To avoid erroneous records, a conservative approach is taken here and all hosts are listed as *Apodemus* sp. *Hoplopleura affinis* has previously been recorded from both *A. flavicollis* and *A. sylvaticus*.

2) ***Hoplopleura alticola*** Mishra and Bhat, 1972.

Specimens examined: (1 collection (2♀) ex *Alticola roylei* Gray (Rodentia, Arvicolidae)) HAZARA DIST.: Kaghan valley, 4155 m, VIII.1963.

Until now, this louse was known only from the type series taken from the vole, *A. roylei*, in montane regions in the Indian states of Uttar Pradesh and Himachal Pradesh (Mishra and Bhat, 1972; Mishra, 1981).

3) ***Hoplopleura captiosa*** Johnson, 1960 (synonym: *musculi* Wegner, 1961).

Specimens examined: (8 collections (6♂,17♀) ex *Mus musculus* Linn. (Rodentia, Muridae)) HAZARA DIST.: Murree Hills, Dunga Gali, 2495 m, IX.1962 - 3 colls.; Balakot, IX.1962 - 2 colls.; LAHORE DIST.: Near Ravi River bridge, 215 m, IX.1963 - 1 coll.; Changa Manga Forest, II.1965 - 1 coll.; PARACHINAR AGENCY: Parachinar, 1540 m, III.1964 - 1 coll. (5 collections (5♂,14♀) ex *Mus* sp. (Rodentia, Muridae)) CHITRAL DIST.: Chitral, 1490 m, VIII.1964 - 3 colls.; HAZARA DIST.: Kaghan valley, Shogran, 2385 m, VIII.1964 - 1 coll.; MALAKAND AGENCY: Amandarra, 845 m, VIII.1964 - 1 coll.

Hoplopleura captiosa is principally parasitic on the house mouse, *M. musculus* and probably occurs in most areas of the world where this largely peridomestic mammal is found. It would therefore be expected to occur throughout most of Pakistan, particularly in association with human settlements.

4) ***Hoplopleura maniculata*** (Neumann, 1909) (synonym: *mitsuii* Kaneko, 1963).

Specimens examined: (6 collections (33♂,37♀,4 nymphs) ex *Funambulus pennanti* Wroughton (Rodentia, Sciuridae)) LAHORE DIST.: Near Ravi River bridge, 215 m, IX.1963 - 2 colls.; Model Town, XI.1962 - 1 coll.; unspecified locality, XI.1962 - 1 coll.; RAWALPINDI DIST.: Ayub Natl. Park, XI.1962 - 1 coll.; SIND PROV.: Karachi, University campus, VII.1976 - 1 coll.

This louse was originally described from palm squirrels, *Funambulus palmarum* (Linn.), collected in India. It appears to be a widespread parasite of squirrels of the genus *Funambulus* (*F. palmarum, F. pennanti, F. tristriatus* (Waterhouse)) in India and Sri Lanka (Pratt and Stojanovich, 1961; Kaneko, 1963; Mishra *et al.*, 1974; Mishra, 1981). However, the specimens recorded here appear to be the first noted for Pakistan.

5) ***Hoplopleura merionidis*** Ferris, 1921.
Specimens examined: (1 collection (3♂,1♀) ex *Meriones libycus* Lichtenstein (Rodentia, Cricetidae)) KALAT DIST.: unspecified locality. 2320 m, X.1963.

Hoplopleura merionidis has not previously been reported from Pakistan although it is known from neighboring regions in Iran (Kim and Emerson, 1971), the People's Republic of China (Ferris, 1921) and the USSR (Sosnina, 1982). The type series from Shaanxi (as Shensi) Province, China, was recovered from the gerbil, *Meriones meridianus* (Pallas), while the Iran material was collected from both *M. libycus* and *M. crassus* Sundevall, and the USSR specimens were from both *M. libycus* (as *M. erythrourus*) and *M. meridianus*.

6) ***Hoplopleura pacifica*** Ewing, 1924.
Specimens examined: (8 collections (2♂,9♀,17 nymphs) ex *Rattus norvegicus* (Berkenhout) (Rodentia, Muridae)) SIND PROV.: Karachi: town area, I.1977 - 3 colls.; Empress market, I.1977 - 3 colls.; East wharf, I.1977 - 2 colls. (2 collections (1♂,2♀) ex *Rattus rattus* (Linn.) (Rodentia, Muridae)) GILGIT AGENCY: Kohighizar, 2360 m, IX.1963. (2 collections (2♂,11♀) ex *Rattus* sp. (Rodentia, Muridae)) HAZARA DIST.: Kaghan valley, Shogran, 2385 m, VIII.1964 - 1 coll.; RAWALPINDI DIST.: Ayub Natl. Park, XII.1962 - 1 coll.

Hoplopleura pacifica has an almost global distribution along with that of its domestic *Rattus* hosts.

7) ***Hoplopleura pavlovskyi*** Sosnina, 1951.
Specimens examined: (1 collection (2♀) ex *Rattus turkestanicus* (Satunin) (Rodentia, Muridae)) GILGIT AGENCY: Gilgit, Chinar Bagh, 1490 m, VIII.1964.

This species is similar to *H. pacifica* but whereas the dorsal apical angle of the paratergal plate of abdominal segment seven is extended in *H. pacifica*, no such lobe is present in *H. pavlovskyi*. Although *H. pavlovskyi* is well documented from numerous collections in Turkestan, USSR (Sosnina, 1951, 1967, 1982), this species does not appear to have been reported from other regions. The host rat, *R. turkestanicus*, ranges from southern Turkestan, northeastern Iran and Afghanistan to northern India and southwest China (Roberts, 1977; Honacki *et al.*, 1982).

8) ***Hoplopleura ramgarh*** Mishra, Bhat and Kulkarni, 1972.
Specimen examined: (1 collection (1♀) ex *Mus saxicola* Elliot (Rodentia, Murdiae) SIND PROV.: Rani Kot, I.1977.

This louse was previously documented only from several states in India as an ectoparasite of the mice, *M. saxicola* and *M. platythrix* Bennett

(Mishra *et al.*, 1972, 1974; Mishra, 1980, 1981; Saxena, 1987). Mishra (1980) pointed out that although mice belonging to the *M. platythrix* complex are morphologically similar, their sucking lice are quite different and could be utilized to aid studies of host systematics.

Family Polyplacidae Fahrenholz

9) ***Linognathoides palaearctus*** (Olsoufjev, 1938.)

Specimens examined: (2 collections (2♂,1♀, 7 nymphs) ex *Marmota caudata* (Geoffroy) (Rodentia, Sciuridae)) HAZARA DIST.: Kaghan valley: Saif Ul Maluke, 3200 m, X.1962 - 1 coll.; Besal, 3260 m, IX.1963 - 1 coll.)

This louse is a specific parasite of *M. caudata* (the long-tailed marmot) and was originally described from Turkestan, USSR. It has also been reported from Afghanistan (Smetana and Daniel, 1970), Jammu and Kashmir state, India (Mishra *et al.*, 1974; Mishra, 1981), Pakistan (Kim and Adler, 1982) and several provinces in the People's Republic of China (Chin, 1985).

10) ***Neohaematopinus echinatus*** (Neumann, 1909.)

Specimens examined: (11 collections (53♂,60♀, 9 nymphs) ex *Funambulus pennanti* Wroughton (Rodentia, Sciuridae)) LAHORE DIST.: Jahangir's tomb, IX.1962 - 2 colls.; Near Ravi River bridge, 215 m, IX.1963 - 1 coll.; Model Town, XI.1962 - 1 coll.; Luliani, X.1963 - 1 coll.; unspecified localities, XI.1962 - 2 colls; BAHAWALPUR DIST.: Uch-Sharif, XII. 1963 - 2 colls; SIND PROV.: Rani Kot, I,VI.1977 - 2 colls.

Neohaematopinus echinatus has previously been reported only from India where it is a widely distributed parasite of the squirrels, *Funambulus pennanti*, *F. palmarum* and *F. tristriatus* (Pratt and Stojanovich, 1961; Kaneko, 1963; Mishra *et al.*, 1974; Mishra, 1981; Kim and Adler, 1982). *Funambulus pennanti* is widely distributed in Pakistan but is the only squirrel of this genus occurring in that country (Roberts, 1977).

11) ***Polyplax asiatica*** Ferris, 1923 (synonym: *turkestanica* Blagoveshtchensky, 1950).

Specimens examined: (17 collections (18♂,38♀, 9 nymphs) ex *Nesokia indica* (Gray and Hardwicke) (Rodentia, Muridae)) LAHORE DIST.: Near Ravi River bridge, 215 m, IX.1962, IX.1963, I.IV.1964 - 6 colls.; Lahore, IX.1962 - 4 colls.; 6.4 km NW of Luliani, I.1964 - 1 coll.; DERA ISMAIL KHAN DIST.: unspecified localities, XII.1963, I.1964 -2 colls.; RAWALPINDI DIST.: Ayub Natl. Park, XII.1962, I.1964 - 2 colls.; SIALKOT DIST.: Charwa, IX.1962 - 2 colls. (1 collection (2♀) ex *Nesokia* sp. (Rodentia, Muridae)) KOHAT DIST.: Kohat, 310 m, VIII.1964. (1 collection (2♀) ex *Apodemus* sp. (Rodentia, Muridae)) HAZARA DIST.: Battakundi, 2740 m, VIII.1963. (1 collection (1♀) ex *Suncus* sp. (Insectivora, Soricidae) LAHORE DIST.: Near Ravi River bridge, 215 m, IX.1962.

This louse is a well documented ectoparasite of the burrowing rat, *N. indica* and has been reported from Taiwan westwards across central and southern Asia to North Africa. *Polyplax asiatica* has also been collected frequently from *Bandicota* spp., another fossorial murid genus, and occasionally from other commensal rodents and shrews. Except for collections from *Nesokia* and *Bandicota*, these records are considered to represent accidental infestations. The type series of *P. asiatica* designated by Ferris (1923) includes specimens recovered from *N. indica* (as *N. hardwickei*) in Quetta, Balunchistan Province, Pakistan.

12) ***Polyplax brachyrrhyncha*** Cummings, 1915.

Specimens examined: (2 collections (34♂,68♀) ex *Acomys cahirinus* (Desmarest) (Rodentia, Muridae)) SIND PROV.: Karachi, Khadeji Falls, XI.1976.

Polyplax brachyrrhyncha was originally described from *A. cahirinus* from Asyut, Egypt and is a common ectoparasite of this spiny mouse in that country (Johnson, 1960). It has also been recorded previously from various species of *Acomys* (principally *A. cahirinus*) from Iran (Kim and Emerson, 1971) and from North and East Africa but the present records are the first ones from Pakistan.

13) ***Polyplax calomysci*** Kim and Emerson, 1971.

Specimens examined: (5 collections (5♂,6♀) ex *Calomyscus bailwardi* Thomas (Rodentia, Cricetidae)) BALUCHISTAN PROV.: Quetta, Ziarat, 2315 m, X,XI.1963 - 3 colls.; Sibi, IX.1975 - 1 coll.; Kalat, 2135 m. IX.1975 - 1 coll.

This species was previously documented only by the type series from *C. bailwardi* from Iran (Kim and Emerson, 1971). The rodent host is confined to mountain steppe regions of Turkmenistan (USSR), Iran, Afghanistan and Pakistan (Roberts, 1977).

14) ***Polyplax chinensis*** Ferris, 1923.

Specimens examined: (5 collections (5♂,4♀) ex *Meriones crassus* Sundevall (Rodentia, Cricetidae)) BALUCHISTAN PROV.: 48 km SSW of Surab, IV,VII.1965.

Polyplax chinensis was originally described from the gerbil, *Meriones meridianus*, from Shaanxi (as Shensi) Province, People's Republic of China (Ferris, 1923) but has also been reported from the southeastern USSR (Sosnina, 1982). The present collections are the first ones documented from Pakistan.

15) ***Polyplax hurrianicus*** Mishra 1981.

Specimens examined: (5 collections (1♂,34♀, 28 nymphs) ex *Meriones hurrianae* Jerdon (Rodentia, Cricetidae)) SIND PROV.: Rani Kot, X,XI,1976, I.1977 - 3 colls.; Karachi, Malir Cantonment, X.1976, I.1977 - 2 colls. (1 collection (2♀) ex *Gerbillus nanus* Blanford (Rodentia, Cricetidae)) SIND PROV.: Rani Kot, VII.1976.

Until now, *P. hurrianicus* was known only from the type series from the gerbil, *M. hurrianae,* in Gujarat State, India (Mishra, 1981).

16) ***Polyplax kaiseri*** Johnson, 1960.

Specimens examined: (1 collection (2♀) ex *Gerbillus nanus* Blanford (Rodentia, Cricetidae)) DERA ISMAIL KHAN DIST.: unspecified locality, I.1964. (12 collections (18♂,31♀) ex *Gerbillus* sp. (Rodentia, Cricetidae)) BALUCHISTAN PROV.: 18 km SE of Kharan, II.1965 - 7 colls.; LASBELA DIST.: 8 km S of Bela, III.1965 - 5 colls.

Polyplax kaiseri is well-known from various gerbils of the genus *Ger-*

billus in North and East Africa, although Ledger (1980) has questioned records of this louse in sub-Saharan Africa. Kim and Emerson (1971) reported *P. kaiseri* from both *G. nanus* and *G. cheesmani* Thomas in Iran but the records given here represent the most easterly ones to date for this louse and the first ones for Pakistan. It is expected that *P. kaiseri* also parasitizes gerbils between the North Africa and Iran/Pakistan extremes.

17) **Polyplax kondana** Mishra, 1981.

Specimens examined: (3 collections (2♂,5♀, 1 nymph) ex *Millardia meltada* (Gray) (Rodentia, Muridae)) SIND PROV.: Badin, I.1977 - 2 colls.; Thatta, VIII.1975 - 1 coll.

This louse was previously documented only by the type series recovered from *Millardia kondana* Mishra and Dhanda in Maharashtra State, India (Mishra, 1981).

18) ***Polyplax paradoxa*** Johnson, 1960.

Specimens examined: (1 collection (2♀) ex *Meriones persicus* (Blanford) (Rodentia, Cricetidae)) BALUCHISTAN PROV.: unspecified locality, I.1963.

Polyplax paradoxa parasitizes various gerbils belonging to the genus *Meriones* in North and East Africa (Ledger (1980) questioned some of these records) and the Near East. Although *P. paradoxa* has not previously been reported from Pakistan, it has been recorded from *M. persicus* and *M. tristrami* Thomas in Iran by Kim and Emerson (1971) and Kaneko (1972), respectively.

19) ***Polyplax reclinata*** Nitzsch, 1864 (synonyms: *deltoides* Fahrenholz, 1938; *shimizui* Kaneko, 1957).

Specimens examined: (11 collections (44♂,68♀, 2 nymphs) ex *Suncus murinus* (Linn.) (Insectivora, Soricidae)) GUJRAT DIST.: Mangowal, VI.1965 - 1 coll.; HAZARA DIST.: Balakot, IX.1962 - 2 colls.; LAHORE DIST.: Near Ravi River bridge, 215 m, VI.1965 - 2 colls.; Model Town, XI.1962 - 1 coll.; SIALKOT DIST.: Charwa, 275 m, X.1962 - 1 coll.; SIND PROV.: Karachi, town area, XII.1975, II,III,IV.1976 - 4 colls. (1 collection (1♀) ex *Suncus* sp. (Insectivora, Soricidae)) LAHORE DIST.: Lahore, VII.1964.

This species is widespread in Eurasia and Africa (including Madagascar) as a parasite of numerous species of shrews (Soricidae).

20) ***Polyplax serrata*** (Burmeister, 1839) (synonyms: *affinis* Fahrenholz, 1938; *serrata paxi* Eichler, 1952).

Specimens examined: (1 collection (2♀) ex *Cricetulus migratorius* (Pallas) (Rodentia, Cricetidae)) GILGIT AGENCY: Kohighizar, Phandar, 3050 m, IX.1963.

This louse is a well-known cosmopolitan ectoparasite of the house mouse, *Mus musculus* Linn., although it is sometimes collected from other murid rodents (particularly *Apodemus* spp.). The present Pakistan record from a migratory hamster is considered atypical.

21) **Polyplax spinulosa** (Burmeister, 1839) (synonyms: *denticulatus* Nitzsch, 1864; *campylopteri* Zavaleta, 1945).

Specimens examined: (3 collections (6♂,31♀) ex *Rattus rattus* (Linn.) (Rodentia, Muridae)) LAHORE DIST.: Luliani, I.1964 - 2 colls.; Ravi road, IX.1963 - 1 coll. (1 collection (1 nymph) ex *Rattus norvegicus* (Berkenhout) (Rodentia, Muridae)) BALUCHISTAN PROV.: Kalat, IV.1976. (5 collections (12♂,18♀, 2 nymphs) ex *Rattus* sp. (Rodentia, Muridae)) LAHORE DIST.: 6.2 km NW of Luliani, XII.1963, I.1964 - 4 colls.; RAWALPINDI DIST.: Ayub Natl. Park, XII.1962 - 1 coll. (1 collection (1♂) ex *Apodemus* sp. (Rodentia, Muridae)) HAZARA DIST.: Kaghan valley, Burawai, 3050 m, IX.1963.

Polyplax spinulosa is a cosmopolitan ectoparasite of domestic *Rattus* and is probably widely distributed in Pakistan.

22) **Polyplax stephensi** (Christophers and Newstead, 1906.)

Specimens examined: (62 collections (229♂,453♀, 63 nymphs) ex *Tatera indica* (Hardwicke) (Rodentia, Cricetidae)) RAWALPINDI DIST.: Ayub Natl. Park, X,XII.1962, III.1963, I.1964 - 15 colls.; on Murree-Rawalpindi road, I.1964 - 1 coll.; DERA ISMAIL KHAN DIST.: unspecified localities, XI,XII.1963, I.1964 - 6 colls.; LAHORE DIST.: Near Ravi River bridge, 215 m, IX.1963 - 4 colls.; Luliani, IX.1963, I.1964 - 3 colls.; 6.2 km NW of Luliani, IX.1963 - 1 coll.; Sodhana, 17.6 km NW of Luliani, X.1963 - 1 coll.; Lahore, Jahangir's tomb, IX.1962 - 1 coll.; Model Town, XII.1963 - 1 coll.; Balloki, XII,.1962 - 1 coll.; Bari Doab canal, 16 km W of highway, VI.1964 - 1 coll.; Changa Manga Forest, V.1965 - 1 coll.; unspecified localities, VII.1965 -2 colls.; SIALKOT DIST.: Charwa, 275 m, X.1962 - 3 colls.; Marala, III.1965 - 1 coll.; BAHAWALPUR DIST.: Uch-Sharif, Abbraria canal, XII.1963, I.1964 - 3 colls.; Islam Headworks, VIII.1963 - 1 coll.; unspecified localities, I.1964 - 3 colls.; MULTAN DIST.: Mian Channun, XII.1963, XII.1970 - 3 colls.; SIND PROV.: Karachi: TPX Godowns, II.1975, I.1976 - 2 colls.; port area, I.1977 - 1 coll.; GUJRAT DIST.: Mangowal, VI.1965 -2 colls.; HAZARA DIST.: Mansehra, VII.1965 - 2 colls.; LASBELA DIST.: 8 km S of Bela, III.1965 - 1 coll.; MUZAFFARGARH DIST.: Taunsa barrage, III.1964 - 1 coll.; ZORALAI DIST.: Zoralai, XI.1963 - 1 coll. (4 collections (7♂,4♀, 14 nymphs) ex *Millardia meltada* (Rodentia, Muridae)) SIND PROV.: Gharo, VIII.1976 - 2 colls.; Mahro Bula Khan, VIII.1976 - 1 coll.; Rani Kot, VIII.1976 - 1 coll. (1 collection (1♂) ex *Nesokia indica* (Rodentia, Muridae)) LAHORE DIST.: Luliani, IX.1963. (1 collection (1♂,2♀, 6 nymphs) ex *Gerbillus nanus* (Rodentia, Cricetidae)) SIND PROV.: Rani Kot, VII.1976. (1 collection (2♀,1 nymph) ex *Canis aureus* Linn. (Carnivora, Canidae)) SIND PROV.: Karachi, Hawkes Bay, VIII.1963. (1 collection (2♀) ex *Vulpes bengalensis* (Shaw) (Carnivora, Canidae)) SIND PROV.: Thatta, IV.1976.

Clearly, *P. stephensi* is principally parasitic on the gerbil, *T. indica*. Records from other hosts cited here are presumed to represent accidental associations although the carnivore infestations could have been acquired as a consequence of recent predation on gerbils. There are numerous records of *P. stephensi* from India, and Kim and Emerson (1971) reported this species from Iran. Curiously, *P. stephensi* does not appear to have been documented previously from Pakistan although it is possible that some pre-1948 records given as 'India' actually refer to localities now within Pakistan's borders.

DISCUSSION

Twenty-two species of sucking lice, at least 14 of them new for the country, are reported here from wild land mammals of Pakistan. The large number of new records for Pakistan can be attributed to the scant literature on the Anoplura of the region. Six additional species of sucking lice have been reported from wild land mammals in Pakistan but were not recorded during the present survey. Three of these species were described from the palm squirrel, *Funambulus pennanti: Hoplopleura funambuli* Bilquees, *H. karachiensis* Khanum, and *Neohaematopinus qadrii* Khan and Khanum; the first two were from Karachi in Sind Province (Bilquees, 1976; Khanum, 1983) and the last was from Thatta District also in Sind Province (Khan and Khanum, 1980). Two more polyplacids, *Polyplax sindensis* Shafi, Samad and Rehana, from the shrew, *Suncus murinus*, and *P. humae* Khan and Khan, from the murid rodent, *Cremnomys blanfordi* (Thomas) have been described from the Karachi area (Shafi *et al.*, 1984; Khan and Khan, 1985). Lastly, the linognathid louse, *Linognathus vulpis* Werneck, was described from the fox, *Vulpes rüppelli* (Schinz), near Karachi (Werneck, 1952); *L. vulpis* has also been collected from *Vulpes vulpes* Linn. in Iran (Kim and Emerson, 1971). Detailed ectoparasite collections are not available for many of Pakistan's native mammalian species and it is estimated that about 10 additional species of sucking lice actually parasitize this fauna.

The zoogeographical affinities of Pakistan's anopluran fauna are worthy of brief consideration here. While most of Pakistan is situated within the Palearctic Region, the extreme southeastern section of the country is usually considered to be within the boundaries of the Oriental Region (Roberts, 1977). Traub *et al.* (1983) point out that topography and other factors such as climate, often have a profound effect on zoogeography; this is especially true for Pakistan's diverse terrain which they categorize into an 'Arid Southwestern Sector', and two 'Montane Central Asian Sectors' of the Palearctic and an 'Inter-Indian Sector' of the Oriental Region.

Predictably, most Anoplura occurring in Pakistan have largely Palearctic or Oriental distributions. Three species (*Hoplopleura affinis, H. merionidis, Linognathoides palaearctus*) have wide, more or less exclusively Palearctic distribution patterns. Nine (*Hoplopleura alticola, H. chinensis, H. funambuli, H. karachiensis, H. pavlovskyi, Linognathus vulpis, Neohaematopinus qadrii, Polyplax calomysci, P. sindensis*) have more limited geographical and/or altitudinal Palearctic distributions. Three species of Pakistan gerbil lice (*Polyplax brachyrrhyncha, P. kaiseri, P. paradoxa*) are principally Palearctic and are widespread across the Near and Middle East and North Africa but also extend to varying degrees into the

Ethiopian Region. Six species are considered here to represent the Oriental fauna: *Hoplopleura maniculata, H. ramgarh, Neohaematopinus echinatus, Polyplax humae, P. hurrianicus, P. kondana*. At least two species (*Polyplax asiatica, P. stephensi*) are widespread in both Palearctic and Oriental Regions. The remaining five species of Anoplura are cosmopolitan or nearly so; *Polyplax reclinata* occurs throughout much of the Palearctic, Oriental and Ethiopian Regions; *Hoplopleura captiosa, H. pacificia, Polyplax serrata* and *P. spinulosa* are distributed throughout much of the world.

Many of the louse distributions outlined above clearly mirror those of their hosts. This is true for the Palearctic *H. alticola/A. roylei, P. calomysci/C. bailwardi* (both of these associations are at high altitude), *H. affinis/Apodemus* sp., *L. palaearctus/M. caudata* associations, the Palearctic-North African *P. brachyrrhyncha/Acomys* sp. association, and the Oriental-Palearctic *H. maniculata/Funambulus* sp., *H. ramgarh/Mus* sp., *N. echinatus/Funambulus* sp., *P. asiatica/Nesokia* sp. and *Bandicota* sp., *P. hurrianicus/M. hurrianae, P. kondana/Millardia* sp. and *P. stephensi/T. indica* associations. The very widespread distributions of *P. reclinata* on numerous species of shrews and of the four cosmopolitan lice mainly on peridomestic murid rodents are likewise understandable. However, certain species of lice occupy ranges smaller in size than those of their hosts, possibly reflecting climatic or topographic factors. For example, *P. kaiseri* and *P. paradoxa* parasitize gerbils (*Gerbillus* and *Meriones*, respectively) from North Africa to Pakistan but have not been recorded further east despite the availability of seemingly suitable gerbil hosts. The opposite trend is apparent for *H. merionidis* and *P. chinensis* both of which parasitize *Meriones* spp. in the southeastern Palearctic but do not extend to congeneric North African gerbils. To some extent, *P. kaiseri* and *P. paradoxa* replace *H. merionidis* and *P. chinensis* as parasites of *Meriones* spp. gerbils in the southwestern Palearctic. Similarly, although *Rattus turkestanicus* is widely distributed in the south-central Palearctic Region (Honacki *et al.*, 1982), its characteristic hoplopleurid louse, *H. pavlovskyi*, has been reported only from the USSR and (now) Pakistan. The six Pakistan louse species that were not collected during this survey appear to have restricted Palearctic distributions but they are known principally from their respective type series and further collecting may reveal their presence elsewhere. Only *L. vulpis* is represented by more than the type collection and is known from outside of Pakistan. One of these, *P. humae*, is known only from *Cremnomys blanfordi* from the Karachi area; this murid host is known from India and Sri Lanka (neither Roberts (1977) nor Honacki *et al.* (1982) list it for Pakistan) and *P. humae* is here assumed to have Oriental affinities.

It is instructive to consider the number of anopluran species (associated with wild land mammals) shared by Pakistan and its neighboring countries/regions. Extensive literature searches have revealed that the following numbers of species are shared as part of the 28 species reported here for Pakistan: India (15 shared species), Iran (14), southwestern USSR (10), People's Republic of China (10), North Africa (9), Afghanistan (6). Thus, the geographically adjacent Indian (Oriental) and Iranian (Palearctic) faunas appear to be most similar to the Pakistan fauna. It must be pointed out, however, that not all of the faunas have received equal study. Overall, while the Pakistan anopluran fauna has significant Oriental and minor Ethiopian and cosmopolitan elements, this fauna principally has Palearctic affinities.

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A CHECKLIST OF THE CADDISFLIES (TRICHOPTERA) FROM WEST VIRGINIA[1]

Donald C. Tarter[2]

ABSTRACT: County distributional records and dates of adult capture are provided for 176 species, representing 15 families and 60 genera, collected in West Virginia. Hydropsychidae ranked first in number of species (39), followed by Limnephilidae (30), Leptoceridae (27), Hydroptilidae (16), Rhyacophilidae (14), and Polycentropodidae (13); the other nine families accounted for 37 species. Of the species reported, 42 are new state records. The largest number of species (62) was collected in Pocahontas County.

This paper represents the first checklist of caddisflies for West Virginia. Ross (1944) listed 13 species for the state. Over the last two decades, several publications, including Applin and Tarter (1977), Hill *et. al.* (1977, 1978), Hill and Tarter (1978), Tarter and Hill (1979, 1982), Nugen and Tarter (1983), Tarter and Donahoe (1989), and Glover and Tarter (1989), have contributed additional records. The collection dates and records, based on adults unless otherwise mentioned, listed in this paper are a compilation of literature records, West Virginia Department of Agriculture (WVDA) and West Virginia University (WVU) specimens, unpublished records from the National Museum of Natural History (NMNH) and Army Corps of Engineers, Huntington District (USCE), and individual collecting efforts by (Ralph Kirchner-(RFK) and Donald Tarter, West Virginia Benthological Survey, Marshall University (WVBS/MU). The purpose of this checklist is to provide a baseline for additional work on the West Virginia caddisfly fauna.

One hundred and seventy-six species of caddisflies, representing 15 families and 60 genera, were recorded for West Virginia; 42 species are new state records (*). I followed the classification of Wiggins (1977). The following families in descending order contained caddisfly species: Hydropsychidae (39), Limnephilidae (30), Leptoceridae (27), Hydroptilidae (16), Rhyacophilidae (14), and Polycentropodidae (13) (Fig. 1). Nine additional families accounted for 37 species. Species records are listed for counties (Fig. 2). In descending order, the following counties contained the greater number of caddisfly species: Pocahontas (62), Randolph (54), Summers (45), Pendleton (47), Monroe (42), Kanawha (31), Jefferson (30), Braxton (28), Wayne (26), Hardy (22), Tucker (23), Hampshire (21), and Putnam (23). The remaining 36 counties contained at least one caddisfly record (Fig. 2). Numbers in parentheses at the end of each citation, corresponding with those in Figure 2, indicate the county records for the species.

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Philopotamidae

Chimarra aterrima Hagan; Ross (1944), USCE, NMNH. August; (8,30).
C. augusta Morse; Lago and Harris (1987), no date; (8, 27, 28, 45).
* *C. obscura* (Walker); USCE. June; (27, 44).
C. socia Hagen; USCE, NMNH, WVBS/MU, MVU. May to August; (5, 8, 27, 44).
* *Dolophilodes distinctus* (Walker); MVBS/MU. July, August; (7, 8, 10, 27, 47).
Wormaldia moesta (Banks); Ross (1944, as *Dolophilus*, no county record), NMNH. May to July; (9, 27, 29).

Psychomyiidae

* *Lype diversa* (Banks); USCE, NMNH, WVBS/MU. July; (15, 29).
Psychomyia flavida Hagen; Ross (1944), USCE, NMNH, WVBS/MU. May to October; (4, 8, 44, 45).

Polycentropodidae

* *Cyrnellus fraternus* (Banks); USCE, WVBS/MU. September; (40, 41, 44, 51).
* *Neureclipsis crepuscularis* (Walker); USCE, WVBS/MU, MVU. June to September; (40, 44, 51, 55).
Nyctiophylax affinis (Banks); Tarter and Hill (1979). July: (27).
N. celta Denning; Morse (1972); no county record.
N. moestus Banks; Morse (1972) and Tarter and Hill (1979). June; (27).
Phylocentropus lucidus (Hagen); Tarter and Hill (1979), Stout and Stout (1989), WVU. May, June; (10, 15, 27).
* *P. placidus* (Banks); USCE, WVBS/MU. August; (30, 51).
* *Polycentropus cinereus* Hagen; USCE, NMNH, WVBS/MU. May to August; (7, 8, 30, 44, 51).
P. clinei (Milne); Tarter and Hill (1979), NMNH. June, July; (9, 27).
* *P. colei* Ross; NMNH, WVBS/MU. June; (9).
* *P. confusus* Hagen; NMNH, WVBS/MU. August; (8).
P. maculatus Banks; Tarter and Hill (1979), NMNH. June to August; (8, 9, 27).
P. pentus Ross; Tarter and Hill (1979), NMNH. June; (9, 27).

Hydropsychidae

* *Cheumatopsyche campyla* Ross; Phillips (1982), USCE, WVBS/MU, WVDA, MVU. April to September; (1, 2, 4, 7, 10, 17, 30, 40, 42-45, 55).
* *C. ela* Denning; Phillips (1982); WVBS/MU. June, July; (2, 7, 27, 44).
C. gracilis (Banks); Gordon (1974), Phillips (1982), NMNH. June, August; (7, 8).
* *C. gyra* Ross; Phillips (1982), NMNH. July; (15).
* *C. halima* Denning; Phillips (1982), WVBS/MU, MVU. June, July; (10, 27).
C. harwoodi Denning; Gordon (1974), Phillips (1982), WVDA, MVU. May to August; (6, 27, 30, 45).
* *C. helma* Ross; Phillips (1982), WVBS/MU, WVU. June to August; (2, 27, 30).
* *C. minuscula* (Banks); Phillips (1982), WVBS/MU, WVDA. June to August; (2, 7, 27, 29, 42, 45, 47).
C. oxa Ross; Ross (1944), Phillips (1982), WVDA. May to June; (1, 45).

* *C. pasella* Ross; Phillips (1982), WVBS/MU. June, July; (29, 49).

* *C. pettiti* (Banks); Phillips (1982), WVBS/MU. April to October; (15, 17, 25, 30, 32, 41, 42, 45, 47, 50, 51, 55).

* *C. sordida* (Hagen); Phillips (1982), WVBS/MU, WVDA, WVU. June to August; (2, 5, 15, 27, 44).

* *C. wrighti* Ross; Phillips (1982), WVBS/MU. August; (8).

Diplectrona modesta Banks: Ross, (1944), Tarter and Hill (1979), Phillips (1982), WVDA, WVU, RFK. May to September; (7-9, 11, 15, 17, 26-28, 38, 39, 41-43, 45, 47, 48, 51, 52, 55).

* *Homoplectra monticola* (Flint); Phillips (1982), WVBS/MU. May; (27).

* *Hydropsyche alhedra* Ross; Phillips (1982); WVBS/MU, WVDA. July, August; (8, 27, 46, 47).

* *H. betteni* Ross; Phillips (1982), USCE, WVBS/MU, WVDA. June to September; (1, 15, 17, 23, 29, 38, 39, 42, 45, 47, 51, 55).

H. bronta Ross; Phillips (1982), Nugen and Tartar (1983) (larva); May to September; (7, 15, 23, 27, 29, 30, 41, 45, 47, 48, 52).

H. brunneipennis Flint and Butler; Flint and Butler (1983). June; (27).

* *H. cheilonis* Ross; Phillips (1982); WVBS/MU, WVDA. May to October; (1, 7, 8, 42, 45).

H. dicantha Ross; Phillips (1982), Nugen and Tarter (1983) (larva), WVDA. June to September; (1, 2, 9-11, 15, 29, 30, 40, 49, 53, 55).

H. hageni Banks; Phillips (1982), Nugen and Tarter (1983) (larva), WVDA. June to September; (1-5, 42-44, 45).

H. hoffmani Ross; Phillips (1982), Nugen and Tarter (1983) (lrva), WVDA. May to August; (1, 44).

H. leonardi Ross; Phillips (1982), Nugen and Tarter (1983) (larva), MVDA. June to August; (1, 44).

H. macleodi Flint; Nugen and Tarter (1983) (larva); (7-9, 13, 27).

H. morosa Hagen; Ross (1944), Phillips (1982), Nugen and Tarter (1983), WVDA. June to September. (1-6, 8, 15, 27, 30, 42, 44, 45, 52, 55).

H. opthalmica Flint; Flint (1965), Phillips (1982). May, August; (1, 7).

H. orris Ross; Phillips (1982), USCE, WVDA. June to September; (4, 9, 15, 17, 30, 39-42, 44, 45, 50).

H. phalerata Hagen; Phillips (1982), Nugen and Tarter (1983), WVDA, WVU. May to September; (1, 5, 7, 27, 44).

H. scalaris Hagen; Phillips (1982), Nugen and Tarter (1983), WVDA, WVU. May to September; (1, 5, 7, 27, 44).

H. simulans Ross; Phillips (1982), Nugen and Tarter (1983) (larva), USCE, WVDA. June to October; (39, 41, 42, 51, 55).

H. slossonae Banks; Phillips (1982), Nugen and Tarter (1983) (larva). July to September; (7, 8, 15, 27, 43, 46, 47, 54, 55).

H. sparna Ross; Ross (1944), Hill and Tarter (1978), Phillips (1982), Nugen and Tarter (1983) (larva). May to September; (2, 3, 7, 9, 27-30, 38, 42, 45, 47, 48, 51, 55).

H. ventura Ross; Phillips (1982), Nugen and Tarter (1983) (larva), May to August; (7, 11, 27-30, 44, 45).

* *H. venularis* Banks; Phillips (1982), USCE, WVBS/MU. no date; (26, 37).

H. walkeri (Betten and Mosely); Phillips (1982), Nugen and Tarter (1983) (larva), WVDA. June to September (4, 6, 15, 26, 27, 29, 43-45).

Macrostemum zebratum (Hagen); Ross (1944, as *Macronemum*), Phillips (1982) WVBS/MU, WVDA. June to October; (1, 15, 27, 30, 42-44).

* *Parapsyche apicalis* (Banks); Phillips (1982), WVBS/MU. June to September; (15, 27, 44).

* *Potamyia flava* (Hagen); Phillips (1982), USCE, WVBS/MU, MVDA. June to September; (1, 17, 23, 38-42, 50, 51).

Rhyacophilidae

* *Rhyacophila banksi* Ross; RFK, WVBS/MU. no date; (27).
R. carolina Banks; Applin and Tarter (1977, larva), Tarter and Hill (1979). June, July; (7, 9, 26, 27, 42, 43).
* *R. carpenteri* Milne; WVBS/MU (larva); (15, 27).
R. fuscula (Walker); Ross (1944), Applin and Tarter (1977, larva). Hill and Tarter (1978). June, August, September; (8, 9, 15, 25-29, 43-46).
R. glaberrima Ulmer; Applin and Tarter (1977, larva); (15).
R. invaria (Walker); Applin and Tarter (1977, larva); (15, 27).
R. ledra Ross; Applin and Tarter (1977, larva); (51).
R. loibifera Betten; Applin and Tarter (1977, larva); (39).
R. melita Ross; Applin and Tarter (1977, larva); (15).
R. minora Banks; Roback (1975), Applin and Tarter (1977, larva). May; (7-9, 15).
R. nigrita Banks; Applin and Tarter (1977, larva); (6, 8, 15, 26, 27).
R. torva Hagen; Roback (1975), Applin and Tartar (1977, larva); (9, 43).
R. vibox Milne; Applin and Tarter (1977, larva); (15, 50-52).
R. vuphipes Milne; Applin and Tarter (1977, larva); (4).

Glossosomatidae

* *Agapetus minutus* Sibley; WVBS/MU, MVU. July; (10).
* *Glossosoma nigrior* Banks; WVBS/MU, MVU. July; (10).
* *Protoptila maculata* (Hagen); WVBS/MU. August; (8).
P. palina Ross; Ross (1944, no county record), USCE, WVBS/MU. July-August; (4, 44).

Hydroptilidae

* *Dibusa angata* Ross; USCE. June-July; (29-51).
Hydroptila ajax Ross; Tarter and Donahoe (1988). September; (42).
H. armata Ross; Tarter and Donahoe (1988). August; (4).
H. delineata Morton; Tarter and Donahoe (1988). August; (4).
H. grandiosa Ross; Tarter and Donahoe (1988), USCE. June, July, September; (2, 55).
H. hamata Morton; Tarter and Donahoe (1988), USCE. September; (30, 42, 44).
H. perdita Morton; Tarter and Donahoe (1988). August; (4).
* *Leucotrichia pictipes* (Banks); USCE. June, July; (27, 44).
Neotrichia vibrans Ross; Tarter and Donahoe (1988). September; (51).
Ochrotrichia dardeni Harris; Tarter and Donahoe (1988). August; (4).
O. denningi Blickle and Morse; Blickle (1979) (no county record).
O. graysoni Parker and Voshell; Tarter and Donahoe (1988), USCE; September; (42, 44).
O. tarsalis (Hagen); Tarter and Donahoe (1988). September; (42).
Oxyethira pallida (Banks); Tarter and Donahoe (1988). August; (4).
* *Palaeagapetus celsus* (Ross); RFK, NMNH., June, July; (27).
Stactobiella delira (Ross); Smith (1969), Tarter and Donahoe (1988). September; (6).

Phryganeidae

Agrypnia vestita (Walker); Hill et al. (1978), Tarter and Hill (1979). April to October; (1, 10, 15, 17, 26-28, 41, 42, 44, 45, 47).

* *Banksiola crotchi* Banks; WVBS/MU, MVDA. July; (23).

B. dossuaria (Say); Hill et al. (1978), Stout and Stout (1989), RFK, USNM, WVU. May to July; (9-11, 15, 27, 45, 53).

Oligostomis pardalis (Walker); Stout and Stout (1989). June; (15).

Phryganea sayi Milne; Hill et al. (1978), WVDA. July to October; (1, 15, 17, 23, 25, 41, 42, 45-47, 51).

Ptilostomis ocellifera (Walker); Hill et al. (1978), Tarter and Hill (1979), Stout and Stout (1989). June to September; (2, 4, 5, 7, 10, 15, 47).

P. postica (Walker); Hill et al. (1978), WVDA. August; (2).

P. semifasciata (Say); Hill et al. (1978), Tarter and Hill (1979), USNM, WVDA. May to September; (4, 8, 9, 15, 17, 27, 44).

Brachycentridae

Brachycentrus appalachia Flint; Flint (1984). May; (15).

B. lateralis (Say); Flint (1984). May; (4).

B. nigrosoma (Banks); Flint (1984). May; (4).

* *B. numerosus* (Says); WVBS/MU. April; (8, 15).

B. solomoni Flint; Flint (1984). April; (8).

* *Micrasema scotti* Ross; WVBS/MU, NMNH. May; (8).

Limnephilidae

Frenesia difficilis (Walker); Tarter and Hill (1980), Stout and Stout (1989), WVU. May, September, November; (11, 15).

* *Goera calcarata* Banks; WVBS/MU, NMNH. August; (8).

Goerita betteni Ross; Ross (1962, no county record), Tarter and Hill (1980). June, July; (27).

Hydatophylax argus (Harris); Hill and Tarter (1978), Tarter and Hill (1980), WVDA, WVU. June, July; (1, 15, 27, 29, 43, 45).

Ironoquia kaskaskia (Walker); Hill and Tarter (1978), Tarter and Hill (1980), WVDA. September; (15, 51).

I. punctatissima (Walker); Hill and Tarter (1978), Tarter and Hill (1980), NMNH, WVDA. June, July, September, October; (6, 9, 15, 17, 23, 26, 41, 42, 45, 47, 51).

Leptophylax gracilis Banks; Hill and Tarter (1978), WVDA. June to September; (45).

Limnephilis indivisus Walker; Hill and Tarter (1978), Tarter and Hill (1980), WVDA, WVU. June, September; (1, 15, 30, 45).

L. moestus Banks; Hill and Tarter (1978), Tarter and Hill (1980), Stout and Stout (1989), NMNH, WVU. May to August; (9, 10, 15, 27).

L. ornatus Banks; Tarter and Hill (1980), WVDA. June, July; (41, 45).

L. rhombicus (Linnaeus); Tarter and Hill (1980), WVBS/MU. May; (1).

L. submonilifer Walker; Hill and Tarter (1978), Tarter and Hill (1980), WVDA, WVU. June, August, October; (10, 11, 15, 41, 49).

Nemotaulis hostilis (Hagen); Hill and Tarter (1978), Tarter and Hill (1980), Stout and Stout (1989), WVDA, WVU. August; (9, 15, 27).

Neophylax anigua Ross; Tarter and Hill (1980), WVDA. September; (15).

N. concinnus McLachlan; Hill and Tarter (1978), WVDA, MVU. September, October; (10, 15, 41, 47).

N. consimilis Betten; Hill and Tarter (1978), Tarter and Hill (1980), WVDA, WVU. September, October; (15, 30, 45, 49).

N. stolus Ross; Hill and Tarter (1978), NMNH. October; (8).
N. wigginsi Sykora and Weaver; Tarter and Hill (1980), WVDA. September; (15).
Platycentropus radiatus (Say); Hill and Tarter (1978), Tarter and Hill (1980), WVDA, WVU. May to October; (5, 7011, 27, 44, 45, 47).
Pseudostenophylax sparsus (Banks); Hill and Tarter (1978), Tarter and Hill (1980), RFK, NMNH, WVDA, WVU. May to July; (1, 6, 7, 9-11, 17, 27, 34, 41).
P. uniformis (Betten); Hill and Tarter (1978), Tarter and Hill (1980), RFK, NMNH, WVU. May to July; (8, 9, 11, 27, 43, 44).
Pycnopsyche circularis (Provancher); Hill and Tarter (1978), WVDA. September; (41-45).
P. divergens (Walker); Hill et al. (1977), Hill and Tarter (1978), Tarter and Hill (1979, 1980), WVBS/MU. July to August; (26, 27).
P. gentilis McLachlan; Hill and Tarter (1978), Tarter and Hill (1980), WVDA, WVU, September, October; (4, 8, 10, 15, 18, 29, 45, 47, 49, 51).
P. guttifer (Walker); Hill and Tarter (1978), NMNH. October; (8).
P. indiana (Ross); Hill and Tarter (1978), NMNH. October; (8).
P. lepida (Hagen); Ross (1944), Betten (1950), Hill and Tarter (1978), Tarter and Hill (1979), WVDA, WVU. June to October; (15, 23, 26, 27, 41, 45, 47, 49, 51).
P. luculenta (Betten); Hill and Tarter (1978), Tarter and Hill (1979, 1980), WVDA, WVU. July to October; (8, 10, 15, 26-28, 30, 45, 47).
P. scabripennis (Rambur); Ross (1944), Hill and Tarter (1978), Tarter and Hill (1979, 1980), WVDA, WVU. June to October; (3, 8, 10, 11, 15, 16, 27, 29, 30, 41, 42, 45-47, 49, 51).
P. subfasciata (Say); Hill and Tarter (1978), Tarter and Hill (1980), WVDA. August to October; (1, 15, 45, 49).

Lepidostomatidae

Lepidostoma griseum (Banks); Tarter and Hill (1979), WVBS/MU. August; (27).
* *L. pictile* (Banks); Weaver (1988), WVBS/MU. May; (8, 9).
L. sackeni (Banks); Tarter and Hill (1979), MVBS/MU. August; (27).
* *L. stylifer* Flint and Wiggins; WVBS/MU, NMNH. May; (8).
L. togatum (Hagen); Weaver (1988). April; (8).
L. vernale (Banks); Weaver (1988). April; (1).
* *Theliopsyche melas* Edwards; WVBS/MU. June; (8).

Odontoceridae

Psilotreta labida Ross; Parker and Wiggins (1987). June; (8).
P. rossi Wallace; Parker and Wiggins (1987), NMNH. July; (27).

Molannidae

Molanna blenda Sibley; Tarter and Hill (1979), WVBS/MU. August; (27).

Helicopsychidae

Helicopsyche borealis (Hagen); Ross (1944) (no date or county record), USCE, NMNH, WVBS/MU. June, July; (4, 8, 27, 44).

Leptoceridae

Ceraclea cancellata (Betten); Glover and Tarter (1989), USCE, WVDA. June to August; (1, 6, 8, 21, 22, 27, 30, 39, 40-42, 44, 45, 47, 51).
C. diluta (Hagen); Glover and Tarter (1989). July; (27).
C. flava (Banks); Glover and Tarter (1989), USCE. June, July; (29, 40, 41).
C. maculata (Banks); Glover and Tarter (1989), USCE, WVDA, WVU. June to September; (1, 11, 22, 30, 39, 40-42, 44, 45, 51).
C. neffi (Resh); Glover and Tarter (1989), WVDA, WVU. June to August; (8, 27, 30, 44).
C. ophioderus (Ross); Glover and Tarter (1989). June, August; (44).
C. slossonae (Banks); Glover and Tarter (1989), WVBS/MU. No date; (4).
C. tarsipunctata (Vorhies); Glover and Tarter (1989), USCE, WVDA. June, July; (1, 30, 42, 44, 51).
C. transversa (Hagen); Glover and Tarter (1989), USCE, WVDA. June to September; (27, 29, 30, 40, 42, 44, 45).
C. wetzeli (Ross); Glover and Tarter (1989), NMNH. May; (8).
Leptocerus americanus (Banks); Glover and Tarter (1989). July; (32).
Mystacides sepulchralis (Walker); Yamamoto and Wiggins (1964), Glover and Tarter (1989). July, August; (2, 4, 30).
Nectopsyche candida (Hagen); Glover and Tarter (1989), USCE. July; (40).
N. exquisita (Walker); Glover and Tarter (1989), USCE, WVDA, WVU. June to August; (1, 8, 30, 40, 42, 44, 45, 50).
N. pavida (Hagen); Glover and Tarter (1989), USCE, WVDA. July, August; (1, 10, 30, 40, 51).
Oecetis avara (Banks); Ross (1944), Glover and Tarter (1989), USCE, NMNH, WVDA. May to September; (1, 6-8, 29, 30, 42, 44, 45).
O. cinerascens (Hagen); Glover and Tarter (1989), WVDA. July to October; (1, 15, 40, 51).

(text continued on page 244)

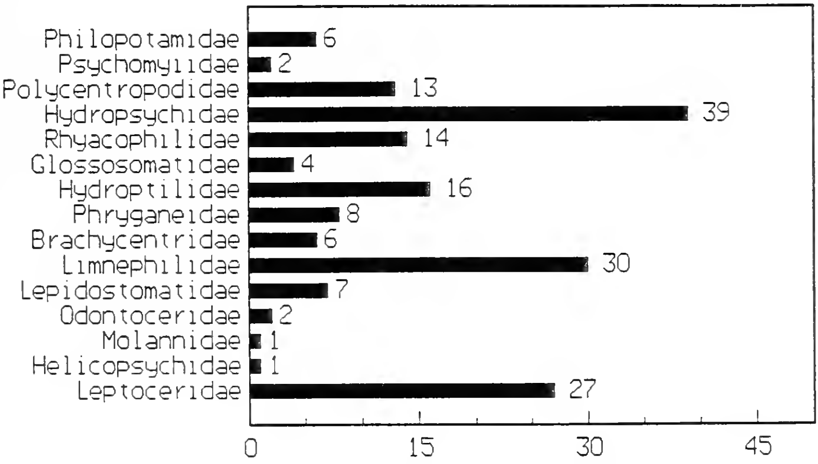

Figure 1. West Virginia caddisfly families with number of species.

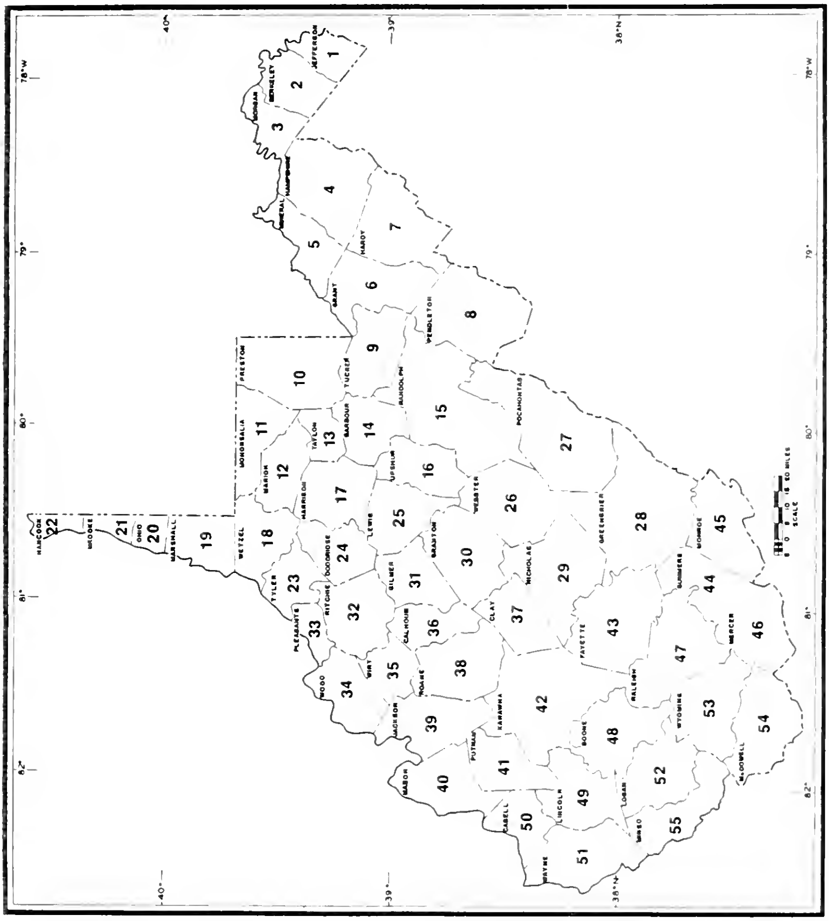

Figure 2. West Virginia map showing sampling stations of caddisflies by counties.

O. inconspicua (Walker); Glover and Tarter (1989), USCE, WVDA, WVU. June to September; (1, 4, 6-8, 10, 11, 13, 15, 17, 23, 27, 29, 30, 31, 40-42, 44, 45, 47, 48, 50, 54).
O. nocturna Ross; Glover and Tarter (1989), USCE, WVBS/MU. June, July, September; (6, 8, 27, 40, 41, 42, 44, 51).
O. persimilis (Banks); Glover and Tarter (1989), WVDA. June to August; (27, 30, 39, 44, 50).
Setodes incerta (Walker); Glover and Tarter (1989), WVDA. June to August; (44).
Triaenodes flavescens Banks; Glover and Tarter (1989). July, August; (17, 44, 45).
T. ignitus (Walker); Glover and Tarter (1989). April, June; (50, 51).
T. injustus (Hagen); Glover and Tarter (1989), WVDA. May to August; (15, 41, 42, 44).
T. marginatus Sibley; Glover and Tarter (1989), WVDA. July, August; (44).
T. pernus Ross; Glover and Tarter (1989), WVBS/MU. June; (44).
T. tardus Milne; Glover and Tarter (1989), WVDA. September; (41).

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I am grateful to the following persons and institutions for the loan of specimens and/or records: Linda Butler (WVU), Charles Coffman (WVDA), Oliver S. Flint, Jr., (NMNH), Jan Hacker (WVDA), Brian Haganbuch (WVDA), Ralph F. Kirchner (USCE), and the West Virginia Benthological Survey/Marshall University. Special thanks to Oliver S. Flint, Jr., and Robert W. Kelley for identifications, and to Lu Ann South for typing the manuscript. Oliver S. Flint, Jr. and Ralph F. Kirchner made suggestions and comments on the manuscript.

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COLLECTIONS OF DROSOPHILIDAE (DIPTERA) IN KENYA, WITH DESCRIPTION OF A NEW SPECIES OF *DETTOPSOMYIA*[1]

H. Takada[2], R.C. Woodruff[3], J.N. Thompson, Jr.[4]

ABSTRACT: Drosophilids (Diptera) were collected by sweeping in 52 localities in Kenya from May to August, 1988. Natural population samples of *Drosophila melanogaster* were collected from 16 sites to screen for variation in mutation rates and other genetic factors. A total of 37 other species of drosophilid flies were also captured. A new species in the genus *Dettopsomyia* is described, and three new records are reported.

Natural populations of *Drosophila melanogaster* carry transposable DNA elements that increase mutation rates and cause other genetic changes (Woodruff *et al*., 1983). Populations differ in the number of active elements in each individual. Since the species is thought to have originated in Africa, collections in Kenya were made by two of us (R. Woodruff, all sites; and J. Thompson, sites 22-31; see Figure 1) to survey transposable DNA levels (Woodruff *et al*., 1989). A total of 34 locations were sampled. In doing this, 35 other species of the subfamily Drosophilinae and 2 species of the subfamily Steganinae were identified among 1,211 alcohol specimens (deposited at Sapporo University, Sapporo, Japan) and 36 live strains (maintained at Bowling Green State University, Bowling Green, Ohio).

Information on species distributions, collection locations and methods are given below. All collection locations are cross-referenced to the map of Kenya (Figure 1). Information on drosophilid species is summarized in Wheeler (1981, 1986), and the Afrotropical drosophilid fauna is discussed in Tsacas *et al*. (1981). A new species, *Dettopsomyia woodruffi*, is described, and new distribution records are provided for three species of the subgenus *Drosophila*: *Drosophila mercatorum*, *D. fulvimacula*, and *D. virilis*.

Genus *Zaprionus* Coquillett

1. ***Zaprionus tuberculatus*** Malloch, 1932. Stylops. 1(1): 11.
   Specimens examined: 144 males and 131 females.
   Locations: 1, 4-7, 11, 14, 16, 20, 26, 28, 29, 31, 34
   Collection methods: sweeping and trapping on banana, mango, and other fruit, rotting tomatoes and fungus.

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2. ***Zaprionus indianus*** Gupta, 1970. Proc. Ind. Nat. Sci. Acad. 36: 63.
Specimens examined: 109 males and 108 females.
Locations: 1, 4, 6-8, 10, 13, 14, 16, 18-20, 26-31, 34
Collection methods: sweeping and trapping on banana, mango, and other fruit, rotting tomatoes and fungus.

3. ***Zaprionus ghesquierei*** Collart, 1937. Bull Mus. Roy. Hist. Nat. Belg. 13(9): 8
Specimens examined: four males and three females.
Distribution: Afrotropical Region
Locations: 20, 31
Collection methods: sweeping on rotting fruits

4. ***Zaprionus inermis*** Collart, 1937. Bull. Mus. Roy. Hist. Nat. Belg. 13(9): 11
Specimens examined: two males and one female.
Distribution: Central Africa
Location: 28
Collection methods: sweeping on rotting tomatoes

Genus *Drosophila* Fallen
Subgenus *Sophophora* Sturtevant
melanogaster species group Sturtevant
melanogaster species subgroup Hsu

5. ***Drosophila melanogaster*** Meigen, 1830. Syst. Beschr. Bek. Eur. Zweifl. Ins. 6: 85
Specimens examined: 113 males and 23 females
Distribution: cosmopolitan
Locations: 1, 3, 4, 6, 7, 11, 14-16, 18, 22, 23, 25, 27, 28, 31, 32, 34
Collection methods: sweeping and trapping on banana, mango, and other fruit, rotting tomatoes and fungus.

6. ***Drosophila simulans*** Sturtevant, 1919. Psyche 26: 153
Specimens examined: 200 males and 66 females
Distribution: cosmopolitan
Locations: 1, 4, 5, 7-11, 13, 14, 16, 18-20, 24-29, 32
Collection methods: sweeping and trapping on banana, mango, and other fruit, rotting tomatoes and fungus.

7. ***Drosophila yakuba*** Burla, 1954. Rev. Suisse Zool. 58: 161
Specimens examined: 15 males and two females
Distribution: Afrotropical Region
Locations: 4-7, 11, 31
Collection methods: sweeping on bananas and other rotting fruit

montium species subgroup Hsu

8. ***Drosophila nikananu*** Burla, 1954. Rev. Suisse Zool. 58: 160
Specimens examined: two males and three females
Distribution: Central Africa
Locations: 30
Collection methods: sweeping on rotting banana

9. ***Drosophila seguyi*** Smart, 1945. Proc. Roy. Ent. Soc. Lond. (B), 14: 56
Specimens examined: living culture
Distribution: widespread in Africa

Locations: 11, 34
Collection methods: sweeping on rotting fruit

10. ***Drosophila vulcana*** Graber, 1957. Zool. Jahrb. Abt. Syst. 85: 309
Specimens examined: ten males
Distribution: widespread in southern Africa
Locations: 1, 2, 4, 16, 20, 21
Collection methods: sweeping and trapping on banana, other rotting fruit, fig tree, and fungus

11. ***Drosophila burlai*** Tsacas & Lachaise, 1974. Ann. Univ. Abidjan. ser. E (Ecologie) 7: 200
Specimens examined: one male and living cultures
Distribution: Central Africa
Locations: 1, 23
Collection methods: sweeping fungus and rotting banana

dentissima species subgroup Bock and Wheeler

12. ***Drosophila anisoctena*** Tsacas, 1980. Ann. Soc. Ent. Fr. (N.S.) 16: 527
Specimens examined: one male and living stocks
Distribution: Kenya and Zaire
Location: 30
Collection methods: sweeping rotting banana

13. ***Drosophila bahunde*** Tsacas, 1980. Ann. Soc. Ent. Fr. (N.S.) 16: 529
Specimens examined: five males and a living culture
Distribution: Kenya and Zaire
Location: 1
Collection methods: sweeping on fungus

ananassae species subgroup Hsu

14. ***Drosophila ananassae*** Doleschall, 1858. Natuurk. Tijds. Nederl. Indie 17: 128
Specimens examined: 32 males and eight females
Distribution: Circumtropical region
Locations: 1, 3, 4, 10, 11, 13, 14, 26, 31
Collection methods: sweeping on rotting fruits and on fresh fruits, including mango, banana, and pineapple

15. ***Drosophila malerkotliana*** Parshad & Paika, 1964. Res. Bull. (N.S.) Panjab Univ. 15: 225
Specimens examined: five males and three females
Distribution: widespread in Oriental African regions, Brazil
Locations: 4, 11, 16
Collection methods: sweeping on rotting fruit and trapping on banana

16. ***Drosophila fima*** Burla, 1954. Rev. Suisse Zool. 61: 165
Specimens examined: one male
Distribution: Central Africa
Location: 21
Collection methods: sweeping on fig tree

17. ***Drosophila dimitra*** Tsacas & Lachaise, 1981. Ann. Soc. Ent. Fr. (N.S.) 17(3): 410
Specimens examined: one male
Distribution: Kenya, Cameroun, Burundi, Zaire
Location: 21
Collection methods: sweeping under fig tree

Subgenus *Scaptodrosophila* Duda

18. ***Drosophila latifasciaeformis*** Duda, 1940. Ann. Hist-nat. Mus. Nat. Hung. 33: 2
Specimens examined: 103 males and 30 females
Distribution: widespread in Africa, U.S.A., Mexico, West Indies, South America
Locations: 1, 4-7, 11, 13, 19, 20, 23, 25, 27-29, 34
Collection methods: sweeping on rotting fruit and on mango, banana, avacodo, and tomato

19. ***Drosophila dibi*** Burla, 1954. Rev. Suisse Zool. 61: 126
Specimens examined: four males and one female
Distribution: Kenya, Ivory Coast
Locations: 5, 10
Collection methods: sweeping on banana and other fruit and trapping on banana

20. ***Drosophila*** species 1.
Specimens examined: one male and one female
Locations: 2, 8
Collection methods: sweeping on banana and other fruit and trapping on banana

Subgenus *Drosophila* Fallen

21. ***Drosophila mercatorum*** Patterson & Wheeler, 1942. Univ. Texas Publ. 4213: 93
Specimens examined: 12 males and three females
Distribution: Kenya (New Record), U.S.A., South America, Europe
Location: 26
Collection methods: sweeping on rotting citrus

22. ***Drosophila repleta*** Woollaston, 1858. Ann. Mag. Nat. Hist. Ser. 3, 1: 117
Specimens examined: eight males and two females
Distribution: cosmopolitan
Locations: 1, 14, 22, 23, 31
Collection methods: sweeping fruits, including banana, mango, pineapple, and strawberry jam

23. ***Drosophila hydei*** Sturtevant, 1921. Carnegie Inst. Publ. 301: 101
Specimens examined: 14 males and 13 females
Distribution: cosmopolitan
Locations: 1, 19, 20, 25, 32
Collection methods: sweeping fungus and rotting fruit

24. ***Drosophila fulvimacula*** Patterson & Mainland, 1944. Univ. Texas publ. 4445: 42
Specimens examined: live cultures
Distribution: Kenya (New Record; First Old World Record), Mexico to Brazil
Locations: 7, 25
Collection methods: sweeping rotting fruit

25. ***Drosophila nasuta*** Lamb, 1914. Trans. Linn. Soc. Lond. Ser. 2 (Zool.), 16: 346
Specimens examined: one female
Distribution: Central Africa, Seychelles, Madagascar, Mauritius
Location: 1
Collection methods: sweeping on fungus

26. ***Drosophila virilis*** Sturtevant, 1916. Ann. Ent. Soc. Am. 9: 330
Specimens examined: live cultures
Distribution: Kenya (New Record), widespread in southern Nearctic, Neotropical, and northern Oriental regions
Location: 16
Collection methods: trapping on banana

27. ***Drosophila immigrans*** Sturtevant, 1921. Carnegie Inst. Publ. 301: 83
Specimens examined: five males and three females
Distribution: cosmopolitan
Locations: 1, 19, 25
Collection methods: sweeping on rotting fruit and on fungus and on fruit, including banana and pineapple

28. ***Drosophila nutrita*** Duda, 1935. Stylops 4: 25
Specimens examined: one male
Distribution: Kenya (New Record), Abidjan, Ivory Coast, Cameroon, Zimbabwe
Location: 19
Collection methods: sweeping on rotting fruit

29. ***Drosophila adamsi*** Wheeler, 1959. Univ. Texas Publ. 5914: 183
Specimens examined: two males
Distribution: widespread in Africa
Location: 2
Collection methods: sweeping on fungus

30. ***Drosophila funebris*** (Fabricius), 1787. Mantissa Insectorum 2: 345
Specimens examined: one male
Distribution: cosmopolitan
Location: 32
Collection methods: sweeping on rotting banana

31. ***Drosophila pruinosa*** Duda, 1940. Ann. Hist-nat. Mus. Nat. Hung. 33: 41
Specimens examined: six males and two females
Distribution: Central Africa
Locations: 23, 30
Collection methods: sweeping on rotting banana

Subgenus *Dorsilopa* Sturtevant

32. ***Drosophila busckii*** Coquillet, 1901. Ent. News 12: 18
Specimens examined: two males and one female
Distribution: cosmopolitan
Locations: 7, 23
Collection methods: sweeping on rotting fruit

Genus *Lissocephala* Malloch

33. ***Lissocephala*** species 1.
Specimen examined: one female
Location: 8
Collection methods: sweeping on rotting fruit

Genus *Chymomyza* Czerny

34. ***Chymomyza*** species 1.
Specimens examined: two males
Location: 4
Collection methods: sweeping on rotting fruit

Genus *Scaptomyza* Hardy

35. ***Scaptomyza*** species 1.
Specimen examined: one male

Location: 33
Collection methods: sweeping on a lily

Genus *Dettopsomyia* Lamb

36. ***Dettopsomyia woodruffi*** Takada, n.sp.
Type area: Kiboko region, Kenya
Locations: 4, 5
Collection methods: collected by R.C. Woodruff by sweeping on banana and rotting fruit

Diagnosis: Eye much oblique to body axis; ocellars inserted just outside triangle made by ocelli; anterior reclinate orbital about 1/3 as long as proclinate; cheek about 1/3 as broad as greatest diameter of eye; costal lappet large; costal-index 1.0; R2 + 3 strongly curved to costa apically; R4 + 5 and M parallel; acrostichal bristle absent; tibia ringed; wing not spotted; acrostichal hairs in four rows; C3-fringe more than 1/2.

Description: Male and female (Figure 2). Body about 1.5mm; wings about 1.5mm in alcohol specimens. Eye much oblique to body axis. Arista with four upper and two lower branches plus terminal fork. Oscellar triangle dark brown. Ocellars inserted just outside triangle. Anterior reclinate about 1/3 as long as proclinate, situated slightly before proclinate. Vibrissa strong; other orals fine. Cheeks about 1/3 as broad as greatest diameter of eye, yellowish brown. Frons flat, yellowish brown, orbits yellowish brown; a pair of dark brownish stripes between ocelli and orbits. Palpi dark brown with two stout apical setae.

Mesonotum dark brown, with two pairs of greyish longitudinal stripes. Acrositichal hairs in four rows; dorsocentrals in two pairs; anterior scutellars divergent; posterior scutellars convergent, upright. Halteres yellowish brown. Sterno-index about 0.5.

Abdomen dark brown, slightly shining. Legs yellowish brown; all tibiae with two dark brownish rings.

Wings hyaline, distal costal incision deep, lappet black and large. R2 + 3 strongly curved to costa; R4 + 5 and M parallel; C-1 bristles two, long. Costal-index about 1.0; 4V-index about 3.0; 4C-index about 2.3; 5x-index about 2.3; C3-fringe on basal 3/4.

Periphallic and phallic organs are shown (Fig. 2d, e) and the female egg-guide (Fig. 2g) is compared to egg-guides of some other Kenyan drosophilids (Fig. 3).

Type material: Holotype male, Kiboko by sweeping in a garden of bananas and other fruit, R.C. Woodruff, May 17, 1988. Paratypes: one male and one female from same locality, and one female from Makindo by sweeping rotting fruit, R.C. Woodruff, May 17, 1988. The type-series of the new species is deposited in the Biological Laboratory, Sapporo University, Japan.

Subfamily Steganinae
Genus *Leucophenga* Mik
Subgenus *Leucophenga* Mik

37. ***Leucophenga apicifera*** (Adams), 1905. Kansas Univ. Sci. Bull. 3: 185
Specimen examined: one female
Distribution: Central to south Africa
Location: 22
Collection methods: sweeping on banana and pineapple

38. ***Leucophenga disjuncta*** Bachli, 1971. Exploration Parc. Nat. de l' Upemba. Fasc. 71: 32
Specimen examined: one male
Distribution: Central Africa
Location: 21
Collection methods: sweeping on fig tree

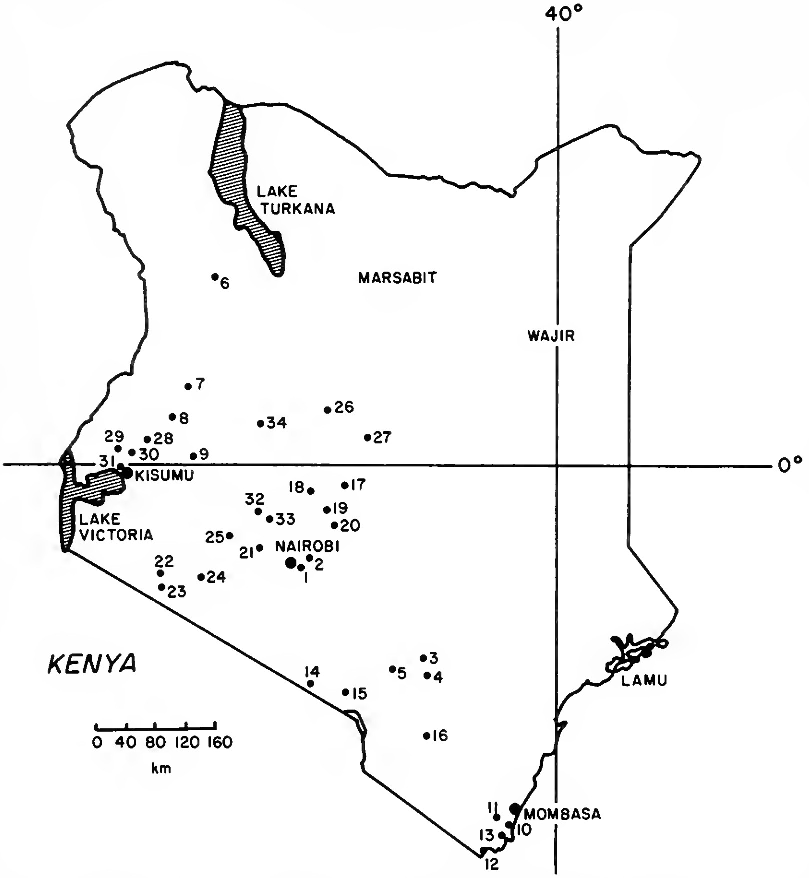

Fig. 1. Collection locations: 1, Nairobi; 2, Nairobi National Park; 3, Hunter's Lodge, highway A109 near Kiboko; 4, Makindu, on A109 west of B7 junction; 5, National Range Research Station Headquarters, Kiboko; 6, Lokichar, on Al west of Lake Turkana; 7, Makutano, on A1 north of Kitale; 8, Kitale; 9, Eldoret; 10, Jadini Beach Hotel, on Diani Beach south of Mombassa; 11, Kwale, southwest of Mombassa; 12, Shimoni, on coast just north of Tanzanian border; 13, Ukunda, on highway A14 south of Mombassa; 14, Namanga, on A104 on Tanzanian border; 15, Amboseli Serena Lodge, Amboseli National Park; 16, Ngulia Lodge, West Tsavo National Park; 17, Mt. Kenya; 18, Naro Moru River Lodge, on A2 west of Mt. Kenya; 19, Karatina, on A2 southwest of Mt. Kenya; 20, Sagana, on A2 southwest of Mt. Kenya; 21, Mayer's Farm, on B3 between Narok and Nairobi; 22, Mara River Camp, Masai Mara National Reserve; 23, Little Governor's Camp, Masai Mara National Reserve; 24, Narok; 25, Naivasha; 26, Isiolo; 27, Meru; 28, Kakunga, on A1 between Kitale and Kisumu; 29, Kakamega, on A1 north of Kisumu; 30, Kakamega National Forest; 31, Kisumu; 32, North Kinagop, near Naivasha on edge of Aberdare Range; 33, Mt. Aberdares, southeast edge of Aberdare Range; 34, Island Camp, Lake Baringo.

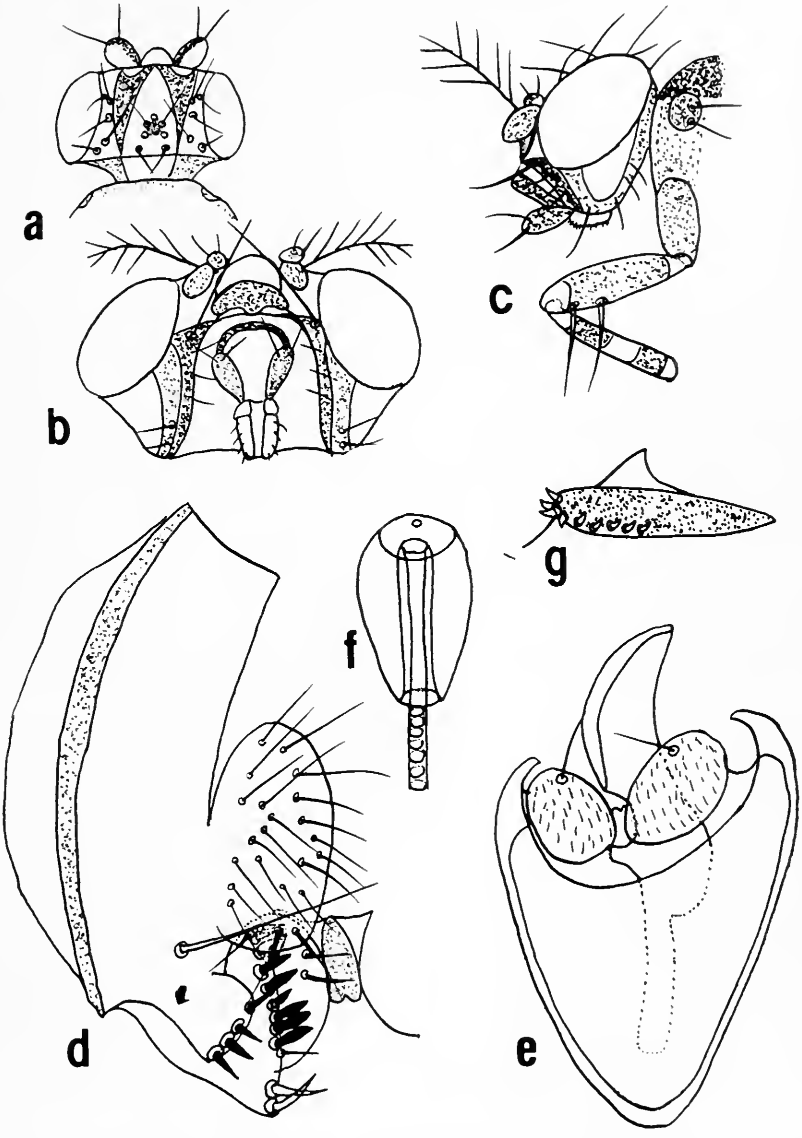

Fig. 2. *Dettopsomyia woodruffi* Takada, n.sp. (a) dorsal view of head, (b) vental or anterior view of head, (c) lateral view of head and first leg, (d) periphallic organs, (e) ventrolateral aspect of phallic organs, (f) spermatheca, (g) egg-guide of female.

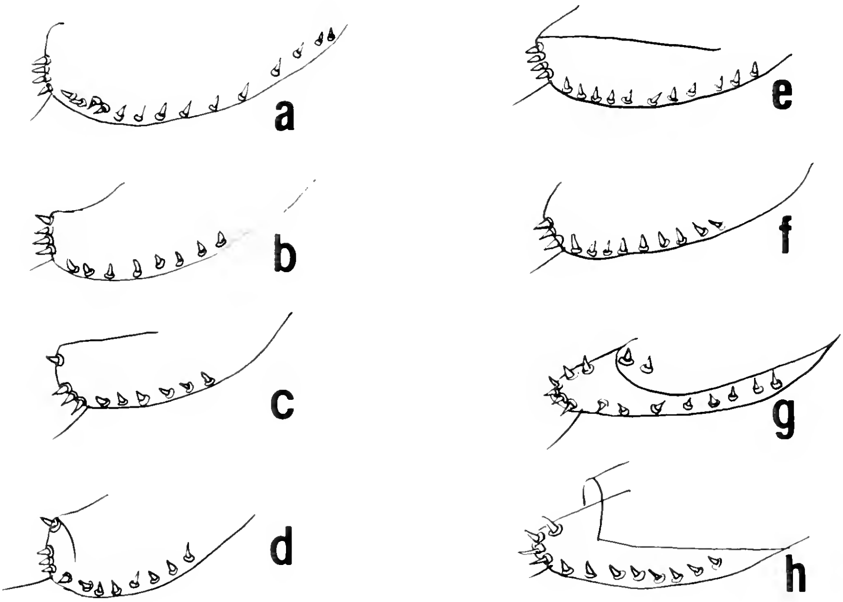

Fig. 3. Egg-guides of females of some Kenyan Drosophilidae. (a) *Drosophila melanogaster* (b) *D. yakuba*, (c) D. nikananu, (d) *D. malerkotliana*, (e) *D. simulans*, (f) *D. seguyi*, (g) *Zaprionus tuberculatus*, (h) *Drosophila* (*Scaptodrosophila*) *latifasciaeformis*

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ERRATUM OF OMISSION

The fine review of Holldobler and Wilson: THE ANTS that appeared in Vol. 101, No. 3, May & June, 1990, of ENT. NEWS, on page 157 was authored by Mark A. Deyrup, Associate Research Biologist, Archbold Biological Station, P.O. Box 2057, Lake Placid, FL 33852. My sincere apology to Mark Deyrup, to both authors, and to all readers of that review for that editorial omission.

- H.P.B.

BOOKS RECEIVED AND BRIEFLY NOTED

INSECT NEUROCHEMISTRY AND NEUROPHYSIOLOGY. A.B. Borkovec and E.P. Masler, eds. 1989. Humana Press Inc., PO Box 2148, Crescent Manor, Clifton, NJ 07015. 480 pp. $79.50.

This book provides a wide-ranging survey of research in every key area of insect neuroscience. It is divided into three principal sections: Neuroanatomy, Neurochemistry, and Neurophysiology and includes a collection of original research papers covering a broad spectrum of topics.

INSECT DEFENSES: ADAPTIVE MECHANISMS AND STRATEGIES OF PREY AND PREDATORS. D.L. Evans and J.O. Schmidt, eds. 1990. State University of New York Press, State Univ. Plaza, Albany, NY 12246. 481 pp. $73.50 cloth, $24.95 paper.

Fifteen chapters divided into four major parts: (1) Evolution of Major Defensive Ensembles, (2) Predatory Strategies and Tactics, (3) Predation Prevention: Avoidance and Escape Behaviors, and (4) Predation Prevention: Chemical and Behavioral Counterattack.

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(Continued on inside of back cover)

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DRINKING AS A PRE-OVIPOSITION BEHAVIOR OF WILD *CULEX PIPIENS* (DIPTERA: CULICIDAE)[1]

R.G. Weber, Chris Tipping[2]

ABSTRACT: In the field, *C. pipiens* females land on open water where they stand on their pro- and mesothoracic legs. Females do not hold onto anything prior to, or during, oviposition, nor do they cross their hind legs for oviposition as reported previously. Lowering of the metathoracic legs and paralleling them on the surface behind the abdomen for oviposition occurs only after a female drinks from the ovisite. Drinking from the water upon which they will oviposit is a regular behavior (97.3%). Most individuals (91.9%) drink more than once, drink for more than ten seconds total (81.1%), and spend an average of five seconds or more per drink (67.7%). Total time spent drinking averages 65.7 seconds. Because drinking occurs before oviposition is begun, contact chemoreceptors on the mouthparts could be involved in the final stages of ovisite acceptance. Time spent in drinking exceeds that necessary for mere tasting, and drinking may also serve to distend the abdomen and assist in movement of eggs through the oviduct.

The literature of mosquito oviposition behavior begins with Réaumur's illustrated account of egg-laying by a species of mosquito which he did not identify (Réaumur 1738). The mosquitoes whose egg raft construction he observed and described are believed to have belonged to the species *Culex pipiens* L. (Howard, *et al.* 1912, Mattingly 1970). Since Réaumur's report, oviposition behavior of this species and its subspecies has been examined from several perspectives[3]. These include behavior at oviposition sites (ovisites) prior to landing on the water (de Meillon and Sebastian 1965, Kennedy 1942, Mattingly 1965), behavior after landing (Hudson 1956, Ikeshoji 1966a), egg raft construction (Beament and Corbet 1981, Wallis 1954), and diel distribution of oviposition activity (de Meillon, *et al.* 1967, Lowe, *et al.* 1973, MacDonald, *et al.* 1981, Oda 1967, Oda and Kuhlow 1979, Subra 1971, Suleman and Shirin 1981). No one has reported the entire sequence of behaviors exhibited by female *Culex* spp. from time of landing on the water to initiation of oviposition.

Physiological aspects of the female mosquito's evaluation of ovisite chemistry also have been examined. Much of this research has dealt with effects of various chemicals, or bacteria, on ovisite selection (e.g. Gjullin and Johnsen 1965, Ikeshoji 1965, Kaul, *et al.* 1977, Murphey and Burbutis

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[1] Received June 12, 1990. Accepted July 7, 1990.

[2] Delaware Agricultural Experiment Station, Department of Entomology and Applied Ecology, College of Agricultural Sciences, University of Delaware, Newark, DE 19717.

[3] *Culex pipiens pipiens* Linnaeus, *C. p. fatigans* Wiedemann, *C. p. molestus* Forskal, *C. p. quinquefasciatus* Say, and *C. p. pallens* Coquillett. For representative discussions of these taxa and possible synonymies, see Barr (1960), Mattingly, *et al.* (1951) and Rozeboom (1951).

1967, Rockett 1987). Because chemicals influence ovisite selection, there has been interest in determining which anatomical parts contain sensors that transduce this information. Several mosquito species, including *C. pipiens*, periodically appear to touch the substrate with their mouthparts prior to ovipositing. Thus sensors associated with the mouthparts could be involved in ovisite selection. This behavior, referred to as "drinking", has been reported for several species (Detinova 1936, Hudson 1956, Ikeshoji 1966b, Pappas and Pappas 1982), but it has been considered doubtful that drinking is a regular part of ovisite selection behavior (Hudson 1956, Ikeshoji 1966b, Kalandadze and Sagatelova 1939, Kennedy 1942). Only *Culiseta inornata* (Williston) is currently known always to contact the water surface with its proboscis, and apparently drink, prior to oviposition (Pappas and Pappas 1982).

We report here the postural changes and behaviors observed as unmanipulated, wild *Culex pipiens* females which had just landed made their final acceptance of an ovisite and began construction of their egg raft. We further report that drinking from the water upon which they will oviposit is a regular behavior for females of this species and is precursory to oviposition.

MATERIALS AND METHODS

Females of several *Culex* species, including *C. pipiens* L., oviposit at night. There is a major peak of oviposition shortly after sunset and a smaller peak before sunrise (de Meillon, *et al.* 1967, MacDonald, *et al.* 1981, Oda 1967, Subra 1971), though this may vary with latitude and season (Oda and Kuhlow 1979) or experimental design (Suleman and Shirin 1981). We made our observations during the post-sunset activity period at containers of wheat straw infusion (Weber and Weber 1985), which is very attractive to gravid, wild *Culex* spp. mosquitoes. We conducted this research during the summer of 1988, on the University of Delaware Research Farm in Newark, Delaware.

Our nightly procedure was to scan our containers until a mosquito was observed hovering above the surface in the way characteristic of gravid *Culex* spp. females (de Meillon and Sebastian 1965, Kennedy 1942, Reiter 1983). We collected data only for females which we saw as they landed, and which we then observed continuously up to placement of about the tenth egg in their raft. A continuous spoken record of date, starting time, and behavior from time of beginning observation to collection of the individual was recorded on a tape recorder. When approximately 10 eggs had been placed in the raft, we collected the individual with a mouth-operated aspirator, placed it in a labelled vial, and froze it for later identification. For identification we used the key in Darsie and Ward (1981). Data from tapes were played back later and transcribed to printed forms. During playback and transcription, a stop watch was used to determine times spent in the various phases of ovisite acceptance.

After landing on the water, and before beginning to oviposit, *Culex* spp. females are easily disturbed by a variety of things, especially by white (full visible spectrum) light. However, after egg raft construction is underway (15-20 eggs laid), females can be observed, even using white light, with much less danger of interrupting their behavior[4] (Mattingly 1970). Because our interest was in behavior during the easily-disturbed period from landing to initiation of a raft, we made all observations using flashlights covered with red, translucent plastic (Sandholm and Price 1962, Wallis 1954). Red light is less disturbing than white to mosquitoes that have not yet begun to oviposit[5].

We made our observations at an eye-to-mosquito distance of 15.3 cm-20.3 cm(6"-8"), and a light-to-mosquito distance of 30.5 cm-35.5 cm (12"-14"). By holding the flashlight approximately parallel to the surface and 90° to one side of the eye-mosquito axis, we could readily observe changes in leg or proboscis attitudes, and see clearly the dimpling caused whenever the proboscis made contact with the water.

Early in the study it became apparent that proboscis contact with the water was a characteristic behavior. To more closely examine this behavior we caged eight wild, gravid females (obtained at ovisites) individually over oversite water colored with a flourescing, red dye[6]. These individuals were observed at frequent intervals and were collected after they had begun rafts.

RESULTS AND DISCUSSION

We observed 37 ovipositing, wild *C. pipiens* L. females. All were collected and identified. Both *C. pipiens* L. and *C. quinquefasciatus* Say separate out at the same location in the key we used for identification (Darsie and Ward 1981). We consider the individuals whose behavior we report here to belong to *C. pipiens* rather than *C. quinquefasciatus* because *C. pipiens* is the more northerly species, occurring north of 39° N (Barr 1957). This

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[4] Beament and Corbet (1981) were able to transport individual ovipositing *C. pipiens* females, picked up in clear plastic dishes of water, from an outdoor container into their laboratory for examination under a microscope.

[5] Adult insects of a variety of species cannot perceive wavelengths above ca. 600-650 nm ("red") (Burkhardt 1964) and larvae of *C.pipiens* are not attracted to red light (Weber 1989).

[6] "Intracid Rhodamine WT Liquid", (product #4517100). Manufactued by Crompton & Knowles Corporation, P.O. 341, Reading, PA 19603.

study was conducted at 39° 41' N (U.S.G.P.O. 1984). Further, all 90 male *Culex* sp. from Newark, Delaware, examined by Barr (1957) during his study of *C. pipiens* and *C. quinquefasciatus* distribution were found to be *C. pipiens*.

All individuals we observed landed on open water, where they stood and eventually oviposited. One individual walked ca 5 mm from where it landed before beginning to oviposit; the others oviposited where they landed. In contrast with Réaumur's (1738) report, no females held onto anything during oviposition, although particles of straw and other vegetable detritus were usually present on the water.

Females landed and stood on their pro- and mesothoracic legs. The metathoracic legs were held up, with their tarsi curving upward above the abdomen, as has been reported for *Culex molestus* by Hudson (1956). During this time the abdomen was parallel to the surface. Usually the proboscis was directed approximately 45 degrees downward, but in 15 instances (40.5%) was more nearly horizontal. Some time after landing (which we were unable to measure accurately), the proboscis was lowered to put its tip in contact with the surface. When contact was made, the meniscus was plainly visible, which allowed us to readily determine duration of contact, or "drinking". After drinking one or more times of variable duration, females lowered their metathoracic legs to the surface and brought them close together behind the tip of the abdomen. Metatarsi were brought approximately parallel; we saw no instances of crossed hind tarsi as described and illustrated by Reaumur (1738). Soon after lowering the legs and bringing the tarsi back, the tip of the abdomen was lowered nearly to the surface, between the tarsi. Shortly after this, the first egg appeared and was placed, on its end, on the water between the hind tarsi. Data we present about drinking, below, was collected prior to appearance of the first egg.

All but one of the 37 *C. pipiens* females we observed (97.3%) drank from the ovisite before they began to oviposit. Females drank at least once before beginning to lay eggs, and one drank 11 times (mean = 4.4 times). The one individual which did not drink landed on the surface and began to lay almost immediately. Because this happened at 108 minutes post-sunset, we believe that this individual may have gone through the pre-oviposition drinking phase earlier, had been disturbed, and merely resumed ovipositing when it relanded. Seventeen other individuals landed at post-sunset times of 116 to 163 minutes, but these drank from 2 to 10 times before beginning to oviposit.

Of the 37 mosquitoes, 91.9% drank more than once (Fig. 1), 81.1% spent more than ten seconds drinking (Fig. 2), and 67.6% spent an average of five seconds or more per drink (Fig. 3). Total time individuals spent

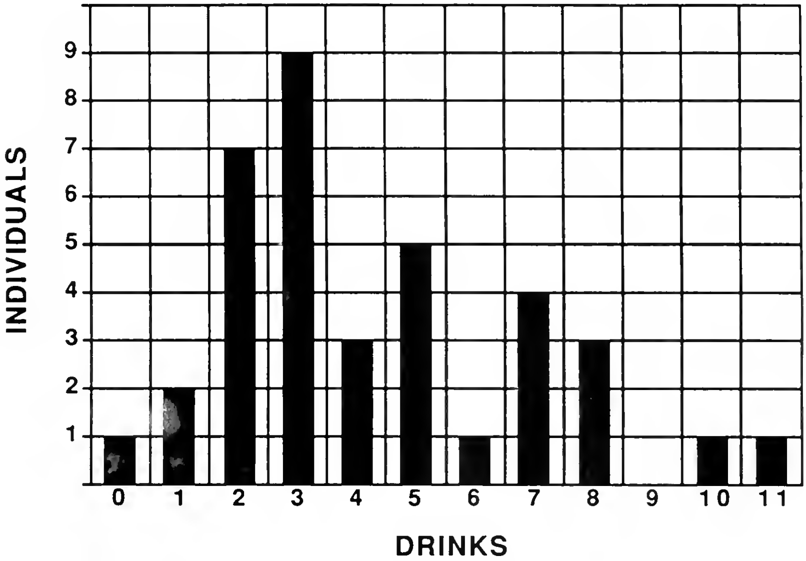

Figure 1. Number of times gravid, wild *Culex pipiens L.* females drank before they began to oviposit.

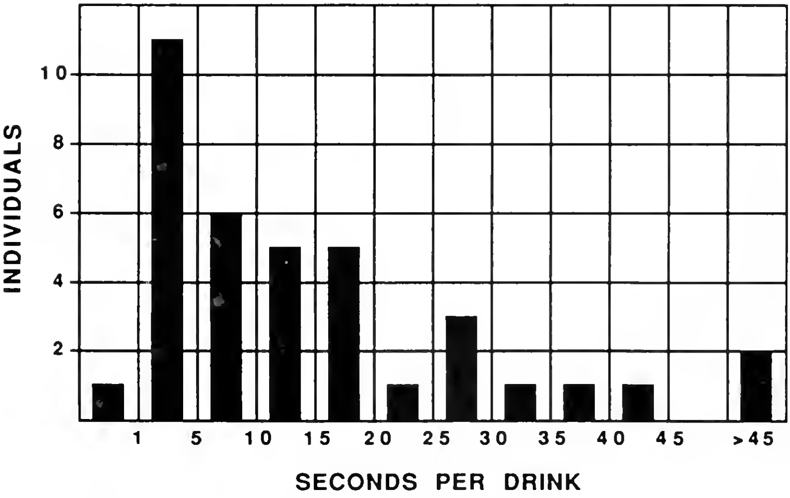

Figure 2. Total seconds spent in drinking by gravid, wild *Culex pipiens L.* females before they began to oviposit.

drinking ranged from 3 to 343 seconds (ave. = 65.7 seconds), but only 21.6% of our sample spent more than 80 seconds drinking (Fig. 2). Average time/drink ranged from 1.3 to 76.0 seconds (Fig. 3). Only 13.5% of the sample had an average time/drink greater than 30 seconds. Drinking from the ovisite prior to oviposition thus appears to be a normal, possibly necessary, component of *C. pipiens* preoviposition behavior, at least for the population in our study area.

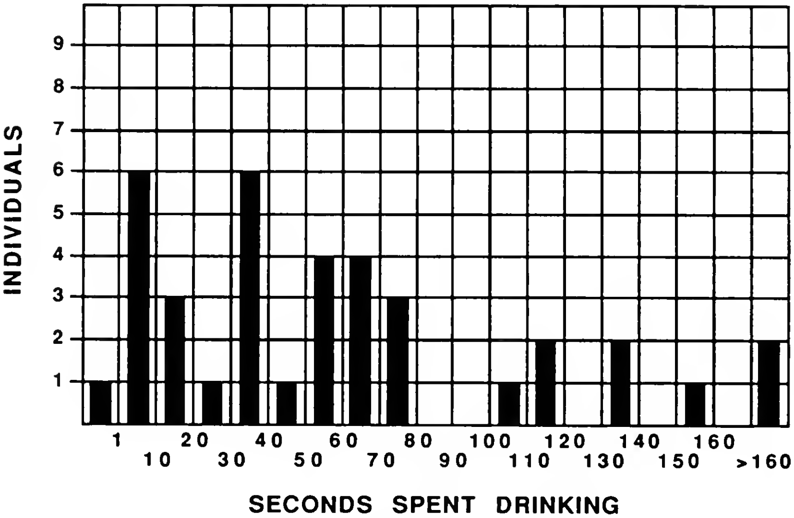

Figure 3. Average time per drink, in seconds of gravid, wild *Culex pipiens L.* females.

All eight *C. pipiens* females caged over red water and collected after they began to oviposit (but before raft completion), had red liquid in their abdomens which fluoresced under UV illumination. The quantity of red liquid in each individual varied, but each contained enough that fluorescence was plainly visible through the intact ventral abdomen. Dissections showed the liquid to be within the gut tract, but we did not attempt to determine whether it was in the ventral diverticulum or the ventriculus (Snodgrass 1959).

We have not yet examined the role of mouthpart chemoreception in ovisite acceptance. Because drinking occurs before oviposition is begun, the possibiliy exists that labral, labellar, or cibarial contact chemoreceptors (McIver 1982) could be involved in the final stages of ovisite acceptance. Hudson (1956) doubted that drinking is a necessary preoviposition behavior of *Culex molestus*. However, Ikeshoji (1966a) found "when the proboscis was extirpated and taking up the water was prevented there was hardly any oviposition" by *Culex fatigans.* Even if mouthpart chemosensors are involved in final ovisite acceptance, the drinking we observed could have additional importance to the gravid mosquito. Most individuals drank more than once, drank for appreciable time, and females on dyed water imbibed considerable amounts of ovisite water, which suggests that if drinking is used to test ovisite suitability, this is not its only function. Following their study of *Culiseta inornata* oviposition behavior, Pappas and Pappas (1982) suggested that "drinking before egg laying may build up pressure in the abdomen and help release eggs." Considering the constancy and duration of drinking we observed, this also may be true for *C. pipiens.*

ACKNOWLEDGMENTS

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BOOK REVIEW

THE BIOLOGY OF SCORPIONS. Gary A. Polis, ed. 1990. Stanford University Press. $85.00

This long-awaited book greets the reader with an eerie photograph on its dust jacket of a scorpion brightly fluorescing under ultraviolet light. Fluorescence of the cuticle is but one of many fascinating and sometimes enigmatic featues of this group of animals. Scorpions are all viviparous; their young are nourished to a greater or lesser extent in the uterus of the mother, and are born alive. They then climb aboard their parent's back for a further period of protection, and in a few species even older young may share the parental burrow. In one species this has developed into a rudimentary society, a dozen or more scorpions of both sexes sharing a common home deep within a termite mound. Scorpions may be found in habitats ranging from the wrack of the shore to elevations of 16,000 ft. or more, but are most diverse in deserts. Accordingly, they are capable of better water conservation than any other arthropod that has been examined. Sensory hairs on the legs can detect Rayleigh and compressional waves in sand, so that scorpions can locate even burrowing prey with great accuracy.

Deservedly called living fossils, scorpions assumed their present body form at least 450 million years ago, and probably even earlier. Predominantly a marine group through much of their history, the single surviving clade of scorpions is now entirely terrestrial; textbook statements to the contrary, scorpions were latecomers (Late Devonian?) to land. Scorpion fossils are rare but often include unprecedented detail because an unusual layer in scorpion cuticle, the hyaline exocuticle, survives fossilization and persists, evidently little changed, for tens of millions of years.

Only about 20 species of the more than 1500 known ones are dangerous to man, but those few take a toll: they cause more human deaths each year than any other non-parasite. Given all these reasons to be interested in scorpions, it is remarkable that a book like this one has not appeared sooner.

Gary Polis edited the book, wrote the introduction, and also wrote or contributed to five of the 11 chapters. Other contributors include Cloudsley-Thompson (mythology), Hadley (environmental physiology), Hjelle (anatomy), McCormick (prey, predators, parasites), Root (neurobiology), Simard and Watt (venoms), Sissom (systematics and phylogeny), and Warburg (biorhythms). The clarity of the writing is uniformly good and organization of each chapter is tight, overcoming some of the major problems often experienced with multiauthor books. Illustrations, with a few exceptions, are clearly and cleanly executed,

(Continued on page 272)

DISTRIBUTION OF PONDEROSA PINE *(PINUS PONDEROSA)* FEEDING SAWFLIES (HYMENOPTERA: DIPRIONIDAE) IN THE UNITED STATES AND CANADA[1]

Clarence S. Dunbar, Michael R. Wagner[2]

ABSTRACT: Six species of diprionid sawflies are known to feed on ponderosa pine, *Pinus ponderosa*, in western United States. Collection records were compiled from 29 insect collections throughout the United States and Canada. Based on these records, distributions of the species on ponderosa pine are reported.

Six species of diprionid sawflies (Diprionidae), five in the genus *Neodiprion*, feed on ponderosa pine, *Pinus ponderosa* Dougl. ex Laws., the most widely distributed pine in North America (Fowells 1965). Diprionid sawflies are major economic pests of natural and plantation forests in the eastern United States (Wilson 1977.) As forest management intensifies in the West, sawflies are increasingly important economic pests (Dahlsten 1961, 1966). This research was undertaken to determine the distribution of diprionids feeding on ponderosa pine. Records have never been compiled for these insects. Keys for identification of North American genera are provided by Ross (1955) and Smith (1974).

METHODS

Twenty-nine federal and state research stations, museums and universities provided 97 collection records for sawflies found feeding on ponderosa pine. These localities were plotted on a map with the distribution of ponderosa pine (Fig. 1). The distribution of ponderosa pine was taken from Fowells, 1965. The distribution of each species of sawfly was then determined by considering both the collection records and the distribution of its host (Fig. 2)

RESULTS

Locality data for each species are as follows:

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Zadiprion townsendi (Cockerell)

ARIZONA: Flagstaff, 28 Jun 1916; Santa Rita Mts., Jul 1924; North Rim, Grand Canyon, 7 Dec 1964; Mt. Lemmon, Sta. Catalina Mts., 3 Aug 1967. COLORADO: Jefferson Co., Evergreen, 26 Aug 1937; Teller Co., Woodland Park, 2 Jun 1938; Boulder Co., Boulder, 2 Mar 1963; Chambers Lake, Roosevelt N.F., 9200 ft., 2 Aug 1968; Larimer Co., Rist Canyon, Mar 1979; El Paso Co., Black Forest. NEBRASKA: Dawes Co., Crawford 12-28 Jul 1910; Dawes Co., Pine Ridge, Jul 1910; Sioux Co., War Bonnet Canyon; Sioux Co., Hat Creek; Lancaster Co., Lincoln 1 May 1914. NEW MEXICO: Bernalillo Co., Rio Arriba Co., Vallecitos, 30 June 1924; Socorro Co., Magdalena, 13 Jan 1961; Tijeras, 19 Dec 1969; Bernalillo Co., Sandia Park, 19 Dec 1969; San Jaun Co., 8.7 mi. N. Navajo, 30 Jun 1972. SOUTH DAKOTA: Custer Co., Custer State Park, nr Custer, 1911. UTAH: San Juan Co., Blanding, Chippean Ridge 2 Nov 1972.

Neodiprion autumnalis (Smith)

ARIZONA: Yavapai Co., Camp Verde, 18 May 1981; Coconino Co., Flagstaff, 26 May 1981; Apache Co., Springerville, 13 Aug 1981. CALIFORNIA: Butte Co., Jarbae Pass, 12 May 1949; Shasta Co., Mt. Shasta, 14 Aug 1957; Humbolt Co., Orleans, 8 May 1961; Trinity Co., Ruth, Oct 1976. COLORADO: Teller Co., Woodland Park, 5 Oct 1914; El Paso Co., Husted 12 Oct 1914. IDAHO: Kootenai Co., Coeur d'Alene, 18 Sep 1922; Idaho Co., Grangeville, 19 Jun 1971. MONTANA: Sanders Co., Camas 28 Aug 1913; Lake Co., Bitterroot N.F., Ravalli, 11 Oct 1959; Phillips Co., Landusky, 24 Sept 1959. NEBRASKA: Cherry Co., Valentine, 23 Jul 1971; Dawes Co., Nebraska N.F., Chadron, 20 Jun 1973. NEW MEXICO: Cibola Co., Grants, Jun 1957. OREGON: Allison R.S., reared 1943; Klamath Co., Diamond Lake, 25 Sep 1963. SOUTH DAKOTA: Custer Co., Pringle, Sep 1935; Harding Co., Camp Crook, 1 Sep 1971; Perkins Co., Lemmon, 6 Jun 1972; Todd Co., Olsenville, 23 Jun 1972; Todd Co., Rosebud, 14 Jun 1973. WASHINGTON: Spokane Co., Spokane, 26 Sept 1960.

Neodiprion fulviceps (Cresson)

ARIZONA: Coconio Co., Flagstaff nr I-40, 21 Jul 1982. NEVADA.

Neodiprion gillettei (Rohwer)

ARIZONA: Yavapai Co., Prescott, 11 Jun 1928; Yavapai Co., Oak Creek Canyon, 7 Oct 1951; Chiricahua Mts., 21 Aug 1961; Sitgreaves N.F., Chevelon Rd., 7 Jul 1969; Oak Creek, vicinity of Sedona, 1 Oct 1970; Kaibab N.F., 22 Sep 1974; Apache Co., Springerville 27 May 1987. COLORADO: Grand Co., Granby, 9 Nov 1961; Larimer Co., Rist Canyon 21 Jul 1986.

Neodiprion mundus (Rohwer)

UNITED STATES. IDAHO: Valley Co., Cascade, 9 Jul 1961; Idaho Co., White Bird, 21 Oct 1961. OREGON: Corvallis, 13 May 1951; Benton Co., Corvallis 3 Jun 1944.
CANADA. Kelowna, B.C.

Neodiprion ventralis (Ross)

ARIZONA: Coconino Co., Flagstaff, 30 Jun 1982. COLORADO: Phillips Co., Holyoke; Jefferson Co., Plainview, Oct 1935. NEBRASKA: Lancaster Co., Lincoln, Oct 1977.

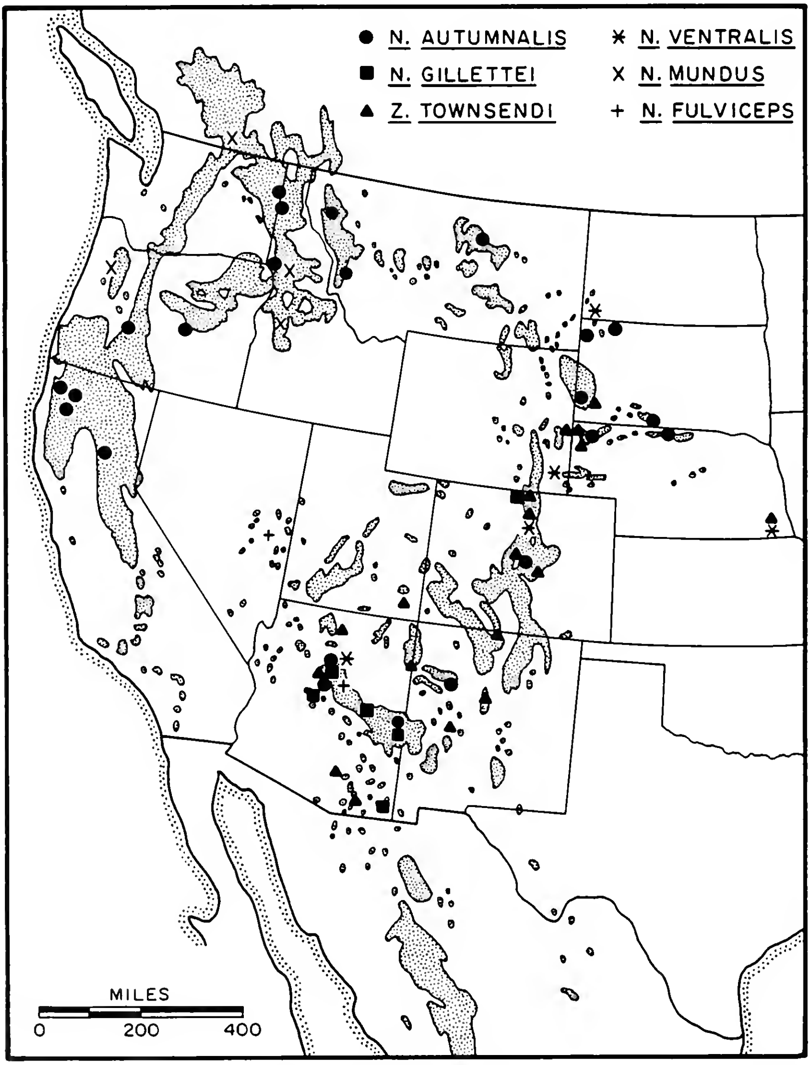

Figure 1. Distribution of ponderosa pine feeding sawflies from collection records. The distribution of ponderosa pine is indicated by stippled areas.

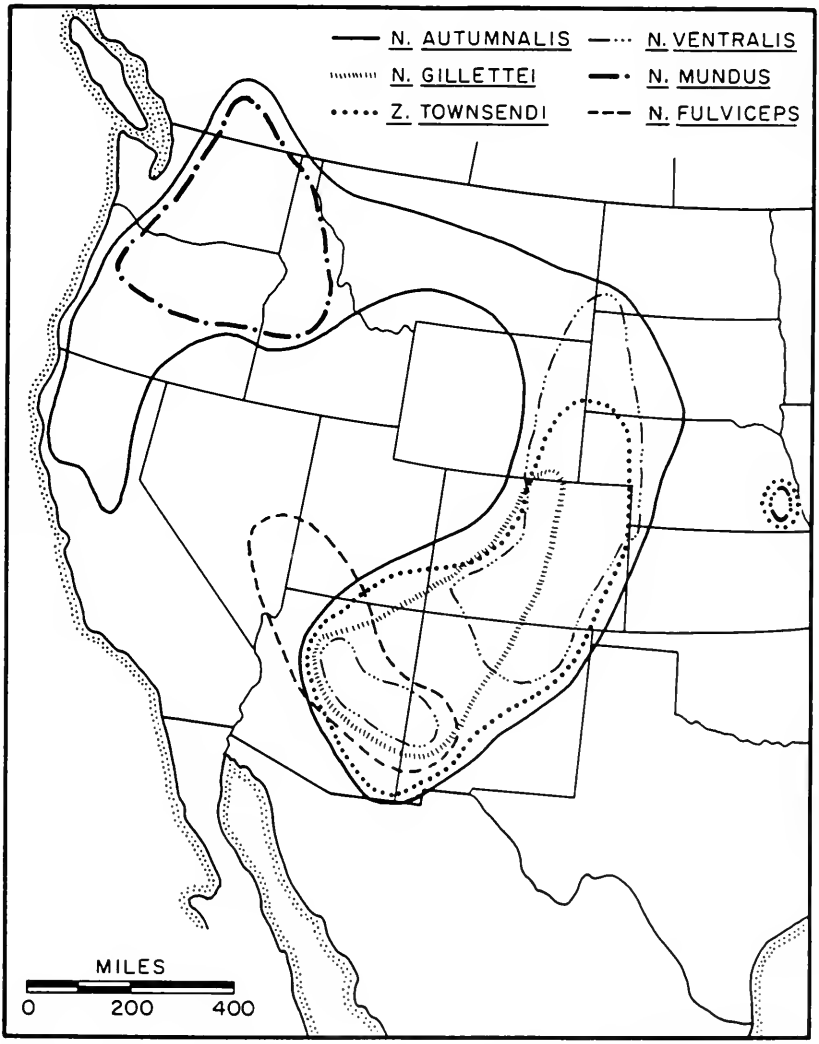

Figure 2. Hypothesised distribution of ponderosa pine feeding sawflies extrapolated from collection records and host distribution.

NORTH DAKOTA: Slope Co., Burning Coal Vein Area, 18 Jul 1973; Slope Co., 6 Jun 1974. WYOMING: Platte Co., Glendo, 25 Oct 1961.

TAXONOMIC NOTES

The *Neodiprion fulviceps* complex was defined by Ross (1955). The complex was then separated into two species, *N. autumnalis* and *N. fulviceps* (Smith and Wagner 1986). *N. autumnalis* overwinters as eggs, whereas *N. fulviceps* overwinters as cocoons (Wagner *et. al.* 1986).

Many of the specimens previously identified as *Neodiprion fulviceps* complex, are actually *N. autumnalis* (Smith and Wagner 1986). Sawflies that were incorrectly identified as *Neodiprion edwardsii* and *Neodiprion demoides* by B.D. Burks, have been identified as *N. autumnalis* (Smith, personal communication). The following records are from specimens identified as *N. fulviceps,* but need to be reexamined for correct identity. Many may be *N. autumnalis* especially those collected late in the season, if the dates refer to adult emergence or collection records.

Neodiprion fulviceps (complex)

UNITED STATES. ARIZONA: Santa Rita Mts., 26 Sept 1925. CALIFORNIA: Siskiyou Co., Dorris, 20 Jun 1912; Mendocino Co., Ft. Bragg, 8 May 1936; Mendocino Co., Pygmy Forest, 4 mi. East Mendocino City, 21 May 1938; Plumas Co., West of Milford, 6000 ft., 8 Jul 1942; Mendocino Co., Mendocino, 1 Oct 1957. COLORADO: Jefferson Co., Plainview, 1 Jul 1937; Larimer C ., Ft. Collins, Jul 1964 as larvae, adults Sep 1964. MONTANA: Rosebud Co., Forsyth, 22; Jul 1922; Rosebud Co., Lee, 24 Jul 1922 (as larvae), adults emerged Sep 13-22 1922; Phillips Co., Little Rockies, Zortman, Sep 1960; Ravalli Co., Stevensville, 15 Jun 1973. NEBRASKA: Thomas Co., Halsey, 8 Oct 1936. NEVADA: Clark Co., Charleston Mts., Kyle Canyon, 7500 ft. OREGON: Benton Co., Peoria, 21 Apr 1940. UTAH: Garfield Co., Panguitch, Utah State University Farm, 17 Jul 1970; Millard Co., Kanosh, East Side of Clear Creek, 5 Aug 1970; Cache Co., Cove Fort, Clear Creek, 15 Oct 1970.
CANADA. Cascade, B.C.; Falkland, B.C.; Fountain Creek, B.C.; Kelowna, B.C.; Okanagan Mission, B.C.; Osoyoss, B.C.; Pritchard, B.C.; Rock Creek, B.C.; Winfield, B.C.

DISCUSSION

Neodiprion autumnalis is the most widely distributed species reaching from the Southwest, north through the east side of the Rockies, across Montana to the Northwest and south to northern California. *Zadiprion townsendi* is found in the Southwest and as far north as the southwest corner of South Dakota. *N. gillettei* is located in the Southwest and as far north as northern Colorado. *N. ventralis* has been collected in northern Arizona, northern Colorado, southeastern Wyoming, and the southwest corner of North Dakota. *N. fulviceps* occurs in the Southwest and *N. mundus* in the Northwest (Fig. 2).

Five of the six species of sawflies that feed on ponderosa pine occur near Flagstaff, Arizona. We have observed some interesting features of the food resource allocation for four of these sympatric species. *N. gilletti* prefers small trees less than three feet tall or branches of older trees that touch the ground. *N. autumnalis* and *N. ventralis* generally occur on medium pole sized trees, while *N. fulviceps* typically feeds on older more mature trees. This type of stratification along with differing life cycles allows these sympatric sawflies to feed on the same species of pine without competing.

VOUCHER SPECIMENS

Depositories for voucher specimens are as follows: National Museum of Natural History, Washington, DC; Arizona State University, Tempe; Biosystematics Research Centre, Ottawa, Ontario; Bureau of Plant Industry, Lincoln, NE; California Academy of Sciences, San Francisco; California Department of Food and Agriculture, Sacramento; Colorado State University, Ft. Collins; Forest Service, Albuquerque, NM; Forest Service, Berkeley, CA; Forest Service, Ft. Collins, CO; Forest Service, Missoula, MT; Forest Service, Ogden, UT; Forest Service, Portland, OR; Forest Service, Washington, DC; Forestry and Range Sciences Laboratory, LaGrande, OR; Forestry Sciences Laboratory, Lincoln, NE; Montana State University , Bozeman, MT; Natural History Survey, Champaign,IL; Oregon Department of Agriculture, Salem; Oregon State University, Corvallis; Pacific Forestry Centre, Victoria, BC; University of Arizona;, Tucson; University of California, Berkeley; University of Nebraska, Lincoln; University of Wyoming, Larmie.

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We are grateful to the following people who contributed collection records: John Anhold, Donald L. Dahlsten, Clarence J. DeMars, Jr., Jerald E. Dewey, James A. DiGiulio, Mary Ellen Dix, Henri Goulet, James Hatfield, Mark Harrell, Frank F. Hasbrouck, Leland M. Humble, M. Ivie, Stephen V. Johnson, B.C. Kondratieff, Robert J. Lavigne, Garland N. Mason, Douglas L. Parker, Wojciech J. Pulawski, John M. Schmid, Edward L. Smith, David R. Smith, Torolf R. Torgersen, Marius S. Wasbauer, Floyd Werner, and Richard L. Westcott. We would also like to thank, C.D. Johnson and Jon Nealson for reviewing the manuscript.

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Wilson, L.F. 1977. A guide to insect injury of conifers in the Lake States. U.S. For. Serv., Agric. Handbook 501. 218 pp.

(Continued from page 265)

but the photographs survive being printed on matt-textured, cream-colored paper only because the originals were undoubtedly very sharp.

The nearly 500 pages of text can probably be said to sum up all that is currently known of scorpion biology, but may not be entirely up to date; the references and wording in some chapters suggest strongly that they were completed several years ago, perhaps as early as 1983. On the other hand, the bibliography contains numbers of references from 1987, and a handful from 1988.

As a systematist, I was particularly interested in the chapter on systematics and phylogeny, and found it a gem. It includes keys to all the known genera of scorpions, and diagnoses and other notes for each family. The section on fossil history relies almost entirely (and understandably) on the posthumous monograph of Kjellsevig-Waering, which now is seen as containing some serious errors and misinterpretations (for example, the "gills" of the Devonian *Tiphoscorpio* are in reality parts of an extinct myriapod, and the "carapace" of the same animal has no features of a scorpion). The life history and ecology chapters likewise are excellent, and the one on venoms morbidly fascinating.

The subject of fluorescence arises again in a chapter on field and laboratory methods, where it is remarked that 500 to 1000 scorpions can easily be captured in a single night using UV light. Sisson, Polis, and Watt warn, however, that while scorpions fluoresce, rattlesnakes do not. The scorpionologist must exercise caution!

In summary, this is truly a landmark book: the first real synthesis of the biology of a group of important and exciting organisms. It now becomes the standard reference on scorpions, and will remain so for many years.

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NEOTYPE DESIGNATION FOR *LEBIA MORIO* DUFTSCHMID, FIXING THE NAME AS A JUNIOR SYNONYM OF *DROMIUS AGILIS* (F.) (COLEOPTERA: CARABIDAE)[1]

James K. Liebherr[2]

ABSTRACT: A neotype is designated for *Lebia morio* Duftschmid, *nomen dubium*, which fixes it as a junior subjective synonym of *Dromius agilis* (F.) (NEW SYNONYMY), and removes it from synonymy with *Sericoda bogemannii* (Gyllenhal).

In 1812 Caspar Duftschmid published volume 2 of his *Fauna Austriae*, in which he described *Lebia morio* (Table 1). In 1868, Gemminger and Harold synonymized *Lebia morio* under "*Platynus Bogemanni*" (Gyllenhal, 1813), which had been described as "*Harpalus Bogemannii*". Csiki (1931) retained *morio* Duftschmid as a junior synonym of the younger *bogemannii* Gyllenhal, but placed a "?" before the entry, presumably indicating his uncertainty regarding the prior action of Gemminger and Harold. I have recently completed a revision of the genus *Sericoda* Kirby (Liebherr, in press), which contains *bogemannii* as a member species. In the present note I designate a neotype for *L. morio*, fixing it as a junior subjective synonym of *Dromius agilis* (F.) (NEW SYNONYMY). This action removes *morio* from the synonymy of the younger *bogemannii*, preserving the stability of that name.

That Gemminger and Harold did not see any specimens of *L. morio* prior to their 1868 publication is supported by Gusenleitner's (1984) explanation of the fate of the Duftschmid collection, which I summarize below. Duftschmid's collection was purchased by Josef Knörlein, and in 1861, the Knörlein collection was purchased by the Oberösterreichisches Landesmuseum, Linz. Subsequent examination of the collection by Landesmuseum curators established that Knörlein had removed the original labels from the Duftschmid material, and uniformly substituted his own labels. Some time after 1933, the specimens in the Duftschmid-Knörlein collection were incorporated into the main collection of the museum, removing any positional information of the Knörlein labeled specimens. These actions eliminate the possibility of positively identifying which specimens Duftschmid used as the basis for his *Fauna Austriae*, effectively rendering Duftschmid's species *nomina dubia*. Specimens held at the Oö. Landesmuseum derived from the Duftschmid-Knörlein collection are identifiable by the label — "Alte Sammlung."

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Duftschmid placed *morio* in his "Fünfte Familie" of his interpretation of *Lebia* (Table 1). Duftschmid's generic concept was considerably broader than that of currently recognized genera. Duftschmid's "Familie", which in his usage was a rank lower than genus, roughly corresponds to a present-day genus. Only his "Familie" 4 is heterogeneous phylogenetically (Table 1). These species also exhibit the smallest body size of any species Duftschmid included in *Lebia*. All species in "Familie" 5 are currently placed in the genus *Dromius*, with Duftschmid's "*agilis* F." and "*velox* F."(*sic* = Olivier) currently considered conspecific (Csiki, 1932).

Duftschmid's concept of *velox* differs from that of *agilis* chiefly by the former being black, and *agilis* being rufous. Duftschmid's *morio* may be diagnosed from *velox* only by having the thorax subtly transversely rugulose, versus transversely rugulose. It seems likely that Duftschmid's *morio* was described from a dark specimen of what would currently be considered the variably colored *Dromius agilis*.

The male neotype selected and designated here to represent *Lebia morio* Duftschmid bears the labels: Austria (typescript label) / alte Samml. (typescript label) / agilis F., Aust. (handwritten label) / agilis Fab., det. M. Priesner / NEOTYPE, Lebia morio Duftschmid, J.K. Liebherr 1990 (red label). It is deposited in the Oö. Landesmuseum, Linz. This designation establishes *Lebia morio* Duftschmid, 1812 as a junior subjective synonym of *Dromius agilis* (Fabricius, 1787) (NEW SYNONYMY), and removes *L. morio* from synonymy with *Sericoda bogemannii* (Gyllenhal), thus ensuring the nomenclatural stability of this well-known Holarctic species.

Table 1. Listing of species, with "Familie" rank designations, included by Duftschmid (1812) in *Lebia*. The doubtful status of *Lebia morio* Duftschmid (Csiki, 1931) is clarified by the neotype designation herein. Other current senior synonyms, combinations, and authors are based on Csiki (1928, 1932), supplemented by Freude *et al.* (1976) and Cameron (1988).

"Familie" species epithet and author[1]		current status
1	*fasciolata* F.	*Polystichus connexus* (Geoffroy)
2	*axillaris* F.	*Cymindis axillaris* (F.)
2	*humeralis* F.	*Cymindis humeralis* (Geoffroy)
2	*homagrica* Duftschmid	*Cymindis axillaris* (F.)
2	*lunaris* Dahl	*Cymindis angularis* Gyllenhal
2	*miliaris* F.	*Cymindis variolosa* F.
3	*crux-minor* L.	*Lebia cruxminor* L.
3	*cyanocephala* L.	*Lebia cyanocephala* L.
3	*chlorocephala* Hoffman	*Lebia chlorocephala* (Hoffman)
3	*haemorrhoidalis* F.	*Lebia marginata* (Geoffroy)
3	*turcica* F.	*Lebia scapularis* (Geoffroy)

	"Familie" species epithet and author[1]	current status
4	*quadrillum* Creutzer	*Lionychus quadrillum* (Duftschmid)
4	*quadriguttata* Paykull	*Bembidion quadrimaculatum* (L.)
4	*truncatella* L.	*Syntomus truncatellus* (L.)
4	*punctatella* Megerle	*Syntomus foveatus* (Geoffroy)
4	*glabrata* Megerle	*Microlestes minutulus* (Goeze)
4	*obscuro-guttata* Andersch	*Syntomus obscuroguttatus* (Duftschmid)
4	*plagiata* Megerle	*Microlestes plagiatus* (Duftschmid)
5	*quadrimaculata* L.	*Dromius quadrimaculatus* (L.)
5	*agilis* F.	*Dromius agilis* (F.)
5	*velox* F.	*Dromius agilis* (F.)
5	*morio* Duftschmid	?
5	*quadrinotata* Panzer	*Dromius quadrinotatus* (Panzer)
5	*fascitata* F.	*Dromius sigma* (Rossi)
6	*atricapilla* L.	*Demetrias atricapillus* (L.)
6	*elongatula* Zenker	*Demetrias atricapillus* (L.)
6	*punctato-striata* Duftschmid	*Dromius linearis* (Olivier)

[1] Authorship listed is that attributed by Duftschmid (1812) even though incorrect in som cases.

ACKNOWLEDGMENTS

I thank Mag. Fritz Gusenleitner, Abtlg. Botanik und Evertebrates, Oö.Landesmuseum, Linz, for gracious access to information and specimens. I thank J.D. Oswald and E.R. Hoebeke for advice about nomenclatural matters, and for critical reviews of the manuscript.

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REARING AND DEVELOPMENT OF *PHYLLOCOPTES FRUCTIPHILUS* (ACARI:ERIOPHYIDAE)[1,2]

Abdullah Kassar, James W. Amrine Jr.[3]

ABSTRACT: A mass rearing program for *Phyllocoptes fructiphilus*, the eriophyid vector of rose rosette disease, was developed. The mites inhabit shoot tips and leaf petiole bases of several varieties of roses. A rearing arena, allowing observation of individual mites, was designed. Developmental periods for life stages, and wintering form and sites are reported.

Rose rosette disease (RRD) is a disease of many wild and domestic roses, especially *Rosa multiflora* Thunb. It was orginally described and reported from western states and Canada (Thomas and Scott 1953) and more recently from midwestern states (Allington *et al.* 1968, Crowe 1982, Gergerich and Kim 1983, Hindal and Amrine 1987, 1989). It also is known from Ohio in 1988 and West Virginia in 1989 (Amrine, unpublished).

Rose rosette disease is transmitted by the eriophyid mite, *Phyllocoptes fructiphilus* Keifer (Allington *et al.* 1968, Amrine *et al.* 1988, Gergerich and Kim 1983). Little is known about the mite's biology, but its life history is thought to be similar to that of other eriophyids (Allington *et al.* 1968). It lives and breeds in protected areas between leaf petiole bases and lateral buds, within small developing leaflets and particularly on the tips of rapidly growing shoots. Many eriophyids that overwinter as adults are known to develop deuterogynous females. However, none have been reported for this species. Conventional methods of rearing individual eriophyid mites (Rice and Strong 1962, Tashiro 1967, Slykhuis 1969) proved unsatisfactory for *P. fructiphilus*, since the mite could not feed and breed satisfactorily. Also, rearing large colonies in the greenhouse was not possible because spider mites generally invade and must be controlled.

This paper describes a reliable method for rearing large colonies of *P. fructiphilus* and a chamber for observation of individual mites. Life history data are also reported.

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MATERIALS AND METHODS

Large colonies of mites were maintained year-round on potted *R. multiflora* plants in illuminated rearing stands. Each rearing stand was constructed of wood 5x10 cm (2″x4″'s) with dimensions of 1.2x0.8x2.3 m to accommodate two shelves, one at the bottom and one at the center (Figure 1). Lighting for each shelf consisted of five pairs of 1.2m fluorescent tubes (40 W each), three pairs at the top (1.1m above each shelf) and one on each side, and six incandescent lights (100 W each) in two rows of three each at the top between the fluorescent tubes. Each shelf had a separate switch and timer for each type of light.

Large *R. multiflora* were dug, pruned to the crown, potted in sterilized soil medium, placed on the stands, and maintained at 16L:8D under fluorescent lights. Incandescent lights were used for 4 hrs in mid-photoperiod to stimulate mid-day higher temperatures (33°C) and light intensity. Temperature ranged from 27°C to 33°C and relative humidity averaged 45%. The plants were artificially infested with noninfected *P. fructiphilus* obtained from *R. multiflora* in Morgantown, WV, and with RRD-infected mites from *R. multiflora* in Madison, IN. Noninfected and RRD-infected colonies were kept in separate rooms and mites were regularly identified to insure species purity. Special precautions were taken to assure exclusion of spider mites: trimming plants to two or three canes 15-20 cm long; spraying these basal canes with spraymount to trap any attached mites; and restricting entry, especially if person(s) had visited the greenhouse.

To rear and observe individual mites, a 12x12 mm plastic coverslip (0.17-0.25 mm thick) was cut into four, 6x6 mm sections, and a 3 mm diameter hole was punched into the center of each section. The 6x6 mm section was cemented to a young host plant leaflet using Elmers Glue-All (Figure 2). An egg or female *P. fructiphilus* was placed in the arena, and a circular, 12 mm diameter glass coverslip (0.13-0.17 mm thick), treated with Spritz anti-fog spray, placed on top. Each leaf with arenas and damp facial tissue around the leaf base was then placed on damp filter paper in a petri dish and maintained at 16L:8D under fluorescent lights. Test leaves were maintained at room temperature (23±1°C).

To determine the duration of each life stage, younger leaves from healthy multiflora rose were prepared with 5-10 arenas, depending on leaf size (Figure 3). For each trial of three replicates, 20 adult mites (live mites can not be sexed, but males made up only 10-30% of population (Amrine, unpublished)) were placed singly in separate arenas. Adults were removed after egg depositon. Eggs were checked at 6-hr intervals, and emerging larvae were transferred to separate arenas (one per arena) on fresh leaves. The number of stages and time required for each

Figure 1. An illuminated rearing stand.

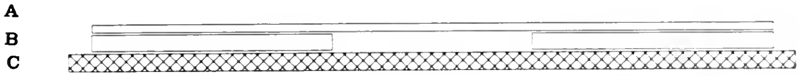

Figure 2. Cross section of a rearing arena (12X). A, coverslip treated with anti-fog; B, plastic coverslip with 3 mm diameter hole in center; C, host plant leaflet.

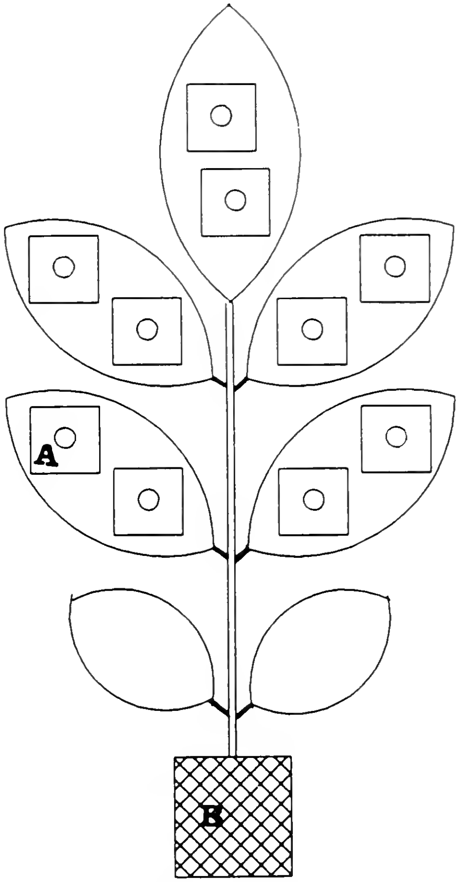

Figure 3. The arrangement of individual arenas on a host leaf. A, arena; B, damp tissue.

developmental period were recorded.

To determine wintering stages and sites, plant material was collected in December 1988 at Madison IN from plants known to have been infested with *P. fructiphilus* and returned to the lab and kept in 5°C refrigerator to be examined thoroughly for over-wintering mites.

RESULTS AND DISCUSSION:

Mite Rearing. The rearing stands produced good growth of multiflora rose plants and supported large colonies of *P. fructiphilus* which lasted for about 3-4 months under these conditions. The rearing arena was successful in caging all stages of mites, for observation. However, most adult *P. fructiphilus* moved about and climbed the arena wall and onto the coverslip. Adults apparently fed little and survival was low; this is reflected in the scarcity of adult data in Table 1. The low acceptance of arena habitus by adult mites probably reflects their preference for rapidly growing shoot tips.

Life Cycle. *Pl fructiphilus* has a typical eriophyid mite life cycle which consists of egg, protonymph, deutonymph and adult. Development times for each stage are presented in Table 1. Newly laid eggs were transparent and became milky white as they aged. Single eggs were deposited randomly within the feeding arena. The egg stage averaged 4.3 days.

Newly emerged protonymphs were transparent and also became white with age. Protonymphs were active and fed for about 2.4 days before transforming into the stationary, swollen and shiny "phararte" form. Deutonymphs resemble adults in size and shape. As they mature, the color changes from white to yellowish white. They actively move and feed for about 2.5 days before the mities become quiescent, swollen and shiny, pharate forms.

The yellowish white adults are active and start feeding almost immediately after emerging. Females start laying eggs within 12-24 hrs. after emergence. In our study, females laid an average of 1 egg/day for the first few days and then no eggs for the remainder of the adult stage, a period which varied from 10 to 50% fo their life span producing an average of 0.64 eggs/day (Table 2).

Hibernation Sites. Examination of whole branches in December revealed an orange form of the mite which had been noticed in field populations during the 1987 and 1988 seasons. This form is thought to represent either a facultative change in color and shape as a response to adverse conditions, or it may be a deutogyne. Aside from the orange color and more trapezoidal shape, there were no obvious anatomical differences from typical *P. fructiphilus* to support a deutogyne desig-

Table 1. Life stage intervals for *Phyllocoptes fructiphilus*

Stage	N	Mean Duration (days)	Range
egg	37	4.31±0.16	1.29-6.04
Protonymph	31	3.29±0.13	2.17-4.33
Deutonymph	32	3.29±0.18	1.83-4.63
adult	7	14.14±0.96	6.00-26.00

Table 2. Egg production of *Phyllocoptes fructiphilus* K.

Mite No.	Sex	Days Observed	Total Eggs Laid	Eggs/Day
1	F	6	5	0.83
2	M	26	0	0.00
3	F	16	4	0.25
4	F	7	6	0.86
5	F	16	10	0.63
6	F	14	11	0.79
7	F	14	7	0.50
Mean		14.14	7.17	0.64
Variance		6.64	2.79	0.24
Standard Error		0.97	0.63	0.19

nation (Amrine, unpublished). *P. fructiphilus* wintered in groups or singly in various sheltered places but mostly under bud scales of small lateral buds and occasionally under the loose bark of the previous year's growth.

SUMMARY

A method of rearing *P. fructiphilus* using artificial lighting and transplanted multiflora rose plants proved successful in reducing spider mite infestations and eliminating the need to control spider mites.

A special arena was designed utilizing plastic slide coverslips glued to rose leaflets which allowed study of the life stages from egg to the adult. The average duration of life stages was: egg 4.31 days, first nymph 3.29 days, second nymph 3.29 days and adult 14.14 days.

ACKNOWLEDGMENTS

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OBSERVATIONS PERTINENT TO THE ROLE OF SEXUAL SELECTION IN THE STONEFLY *PTERONARCELLA BADIA* (PLECOPTERA: PTERONARCYIDAE)[1]

David D. Zeigler[2]

ABSTRACT: Virgin males of *Pteronarcella badia* delivered semen volumes of just over one percent of their body weight. Mated females oviposited the great majority of their eggs shortly after mating and thereafter remained unreceptive to male drumming calls and tactile contacts. Implications of these findings are discussed in relation to sexual selection theory.

Much work and even more theorizing has appeared over the past two decades in the area of sexual selection. Perhaps not surprising, much of this work has involved insects (Thornhill and Alcock 1983, Alexander and Borgia 1979, Kaneshiro 1983, Carson 1978, West-Eberhard 1984, and many others). Some workers imply that sexual selection is, in varying forms and to varying degrees, essentially ubiquitous in sexually reproducing animals (West-Eberhard 1984, Thornhill and Gwynne 1986).

My work with the reproductive calling behavior of stoneflies (drumming) has led to the question of sexual selection's possible role in shaping adult behavior(s) in this interesting but inadequately studied group. This paper will deal with two aspects of reproduction which bear on the nature and degree of sexual selection pressures to be expected in stoneflies. The first question is that of semen volume transferred by males during mating. The second is the relative degree of polygyny/ployandry typical of stoneflies.

MATERIALS

Mature *Pteronarcella badia* (Hagen) nymphs were collected from the Conejos River, Conejos Co., CO in late June 1988 just before peak emergence of the adults. Nymphs were transported to the lab (Southwest Texas State University, San Marcos, TX) for rearing in chilled styrofoam ice chests. Adults were separated at emergence to insure virgin condition. Small triangular enclosures of sheet balsa wood (7.5 mm/side and 1.5 mm deep) with clear plastic lids were used to contain adults during observations. All virgin contacts, including matings, were between adults two to three days old. Pre- and post-mating weights of males were made using an American Scientific Products S/P 120 scale. Values reported below are means plus or minus sample standard deviations.

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RESULTS AND DISCUSSION

Semen Weight — Six intersexual pairings of virgin *P. badia* adults were made in order to estimate the amount of semen transferred in a first mating situation. Males were weighed just before and after mating. Prior to mating, males weighted .0431 ± .0042 gr. while postmating weight was .0426 ± .0041 gr. This amounts to only a 1.12 ± .022 percent loss in body weight. In numerous other insect groups, the male transfers large semen volumes or spermatophores (from 20 to 40 percent of the male's premating weight) which are apparently used by the females in part as a nutritional resource (reviewed by Thornhill and Alcock 1983, Gwynne 1983, Thornhill and Gwynne 1986). This nourishment may be essential for final development and formation of the female's eggs, and, when in the form of a spermatophore, may actually be eaten by the female (Gwynne 1983, Thornhill and Gwynne 1986). Movement of most spermatophore/semen nutrients into the female's eggs can require from less than 24 to over 70 hours (Gwynne 1983). Generally, females are the more choosy of the two sexes due to their larger relative investment in the offspring. In species where males deliver substantial nutrients with their semen, females might be expected to mate preferentially with males capable of donating large spermatophore/semen volumes. However, this expectation will be counterbalanced by an increase in male selectivity for "optimal" females due to the male's increased material investment in the offspring (Gwynne 1983, Thornhill and Gwynne 1986). Such "role reversal", typified by choosy males, seems unlikely in *P. badia* judging from the small weight of semen transferred, and from the short time period between mating and egg laying (see below).

Males of *P. badia* show no obvious signs of choosiness in mate selection. They typically attempt mounting virgin females, non-virgin females, and even other males. Also, in two out of eight separate interspecific pairings of *P. badia* males with *Isogenoides zionensis* Hanson females (a co-emerging species at the Conejos River), the males mounted the females and attempted copulation. Each of these two males remained mounted for over five minutes before dismounting. These observations suggest a lack of identification contact pheromones in *P. badia* as well as a lack of selectivity and discrimination by the *P. badia* males.

The six intraspecific matings were not timed, but all lasted approximately 30-45 minutes. After mating, females were gently transferred to styrofoam cups with screen lids. Each cup contained three cm of river water for oviposition. All six females laid eggs shortly after mating (395 ± 54 eggs). This egg data compared favorably with that from 16 other *P. badia* females (354 ± 74 eggs) which were mated in the course of other experiments. Seven of the latter were observed to lay second clutches of eggs (55.1 ± 23.4 eggs) 2-5 days after the initial batches were laid. Two of these seven females were remated by virgin males prior to their second laying, but the other five had no secondary male contacts. These data suggest that females require only one mating for the fertilization of most, if not all, of their eggs, most of which are laid in the first oviposition event. The six females mated in the semen weight experiments lived for 11.4 ± 0.9 days.

Mated Female Response to Male Calls — Five *P. badia* males were seen to resume calling within minutes after their first mating, and two similar observations were made after second matings. Males of *Taeniopteryx nivalis* (Fitch) have also been observed to resume calling just after mating (Stewart and Zeigler 1984). These observations indicate that male stoneflies are polygynous, though to what extent is still an unanswered question. Mated female stoneflies have not been observed to answer male calls (Rupprecht 1967, Stewart and Zeigler 1984), but this observation has often been based on a female's exposure to male calls only minutes or hours after mating. To test the hypothesis that females might again become responsive to male calls after egglaying and/or some refractory period, mated females (which laid eggs within 6 hours after mating) were exposed to male calls as follows. Five females were exposed to male calls (her chamber acoustically coupled to a chamber containing a signaling male) 24 hours after mating, six females were exposed to calls 48 hours after mating, and seven females were exposed to calls 96 hours after mating. In none of these 18 exposures was a mated female observed to answer male calls. Similar acoustically coupled chambers, with the male and female in two separate but coupled chambers, have been used in previous studies to record the drumming signals of virgin stonefly pairs and have a "proven" track record of providing efficient signal transfer between the sexes (Stewart and Zeigler 1984, Zeigler and Stewart 1985).

Observations of tactile contacts between other mated females and virgin males also indicate an unwilling or at least "disinterested attitude" on the part of the females. One mated female (56 hrs post-mating) ran from a virgin male on initial contact and would probably have escaped from him in nature. As both were contained in a common chamber, the male eventually mounted her and mated. This female continued to move about the chamber while the male was engaged (virgin females typically remain motionless during the mating process). Another female, minutes after mating but before egglaying, successfully rejected a second male's mounting attempts by raising her abdomen at about a 90 degree angle from her body axis and wagging it laterally during mounting attempts.

Similar rejection responses have been noted in other stoneflies (Rupprecht 1967, Zeigler and Stewart 1977, Stewart and Zeigler 1984).

In terms of sexual selection theory, a female who puts all her eggs in one basket (fertilizes all her eggs with sperm from one male) should profit by being choosy as to which male fertilizes her eggs (Thornhill and Gwynne 1986). This is especially so for insects such as stoneflies where the male contributes nothing to the female or offspring except sperm (Borgia 1981). But, if adults are short-lived and females typically encounter males infrequently, mating with the first male encountered may be the optimal strategy due to the costs of locating two or more males and making a comparison (Wittenberger 1983). Predation, bad weather, or other environmental hazards could also make waiting around for a second more "attractive" or fit male a suboptimal strategy (Borgia 1979, Wittenberger 1983). Alternately or concurrently, if males are typically of equal or near-equal fitness and meet some minimum threshold specifications (a proposition I am now addressing in an unfinished manuscript), the female would on average, be best served by mating with the first male encountered (Wittenberger 1983). Based on years of drumming studies, I can state qualitatively that as a group virgin stonefly females are not obviously coy or choosy in selecting a mate. Females typically answer the drumming call of, and mate with, the first male encountered (these statements derive largely from laboratory observations).

In nature, females may feed and so fuel the continued development of a second large egg batch, but several hours of observations along the Conejos River during peak emergence have not yielded evidence of adult feeding (Ed Dewalt, personal communication). The data on feeding in adult stoneflies as reviewed by Hitchcock (1974) and Hynes (1976) indicate that adults of the family Pteronarcyidae, which includes *Pteronarcella*, do not feed but do drink water (and may take in honeydew or nectar). Adults of both sexes were provided with water and were seen drinking during the course of observations. In some other families, adults do feed, and in some genera the females apparently require food in order to fuel initial egg development and maturation, which can take many days (Hynes 1976), but this is obviously not the pattern in *P. badia*. Two of the 16 *P. badia* females mentioned above were mated within two hours of emergence and went on to lay a typical clutch of eggs within five hours of mating.

In conclusion, it appears likely that females of *P. badia* rely on single matings to fertilize most, if not all, of their eggs. The possibilty exists that second matings may occur shortly after the initial mating but prior to egg laying, possibly with sperm displacement by the second male, but the non-responsiveness of mated females to male calls and observations of male rejections by recently mated females argue against this being a typical event.

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DEVELOPMENT OF THE BLACK WILLOW SCALE, *CHIONASPIS SALICISNIGRAE* (HOMOPTERA: DIASPIDIDAE), IN TENNESSEE[1]

Paris L. Lambdin[2]

ABSTRACT: Weekly collections of the black willow scale, *Chionaspis salicisnigrae*, on *Salix nigra* were made from 7 January 1984 to 31 December 1989 to determine the life history of the species. This species overwintered as eggs and had three generations per year in Tennessee. Each female deposited a mean of 152 (18-265) eggs beneath a waxy, tentlike covering. Adult males emerged in May, August and September. Behavioral aspects of each instar are discussed.

The black willow scale, *Chionaspis salicisnigrae* (Walsh), was originally described in 1868 from specimens collected on black willow, *Salix nigra* Marsh. Species of *Chionaspis* are predominatly mono- or oligophagous insects (Takagi 1969). The black willow scale has been collected from the bark and leaves of several ornamental trees in the United States that include: *Amelanchier canadensis* (L.), (Rosaceae); *Cornus pubescens* Nutt. and *C. asperifolia* Michx., (Cornaceae); *Fraxinus americana* L. (Oleaceae); *Populus canadensis* Moench., *P. candicans* Ait., *P. deltoides Marsh., P. grandidentata* Michx., *P. tremuloides Michx., Salix interior* Rowlee, *S. nigra* Marsh., and *Salix* sp. (Salicaceae), (Kosztarab 1963, Dekle 1976). Willow trees, planted to enhance the aesthetic beauty of residential areas, are often infested with this pest. Damage to the host is caused by sap extraction which results in loss of vigor, dieback, stunting and eventual death of the affected plant.

The black willow scale was reported to infest native willows in Indiana and occasionally became an economic problem (Diez and Morrison 1916). Langford (1926) concluded that this species had two generations in Colorado with eggs hatching in late April and July, respectively. Also, Houser (1918) and Kosztarab (1963) reported that the overwintering eggs hatched in mid-May in Ohio and that *C. salicisnigrae* may have two generations per year. Because little information is known concerning the biology of the black willow scale, my objective was to determine the life history of this species in Tennessee.

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MATERIALS AND METHODS

Chionaspis salicisnigrae on *S. nigra*, was studied under both field and laboratory conditions from 1984-89 at The University of Tennessee, Knoxville. Greenhouse populations were maintained on black willow cuttings (6 to 26 cm long) grown in an equal mixture of clay, sand and peat in plastic pots (10 cm in diam.). Field populations of *C. salicisnigrae* on 6 infested black willow trees and 12 potted saplings, located at the U.T. Plant Science Farm, were sampled weekly. Collections of scale insects from infested branches (2 to 4 cm long) were taken to the lab to be processed, stained, and mounted on slides to construct the life history of the species. In the greenhouse, fecundity was determined by counting the number of eggs deposited under the test of 100 females, and by placing the females in Hoyer's solution to count the remaining number of eggs visible through the derm. Number of generations per year and developmental rates were monitored by transferring a minimum of 100 (100-145) newly emerged crawlers to each of 12 uninfested host plants upon eclosion. The tests were replicated 4 successive years from 7 Jan. 1984 to 31 Dec. 1989.

RESULTS AND DISCUSSION

The black willow scale is a multivoltine species that overwintered as eggs under the parental tests. Females undergo three developmental stages, the mobile crawler stage followed by the sessile second and adult stages. Males have additional prepupal and pupal stages before development into the mobile adult stage. Waxy tests of the immature stages were enlarged by moving their abdomens side to side while secreting wax through the pygidial macroducts as described by Stoetzel (1976).

Populations in the greenhouse developed one to two weeks earlier than those in the field. Due to the mild winter and spring in 1989, overwintering eggs began to hatch about two weeks earlier than for previous years. Females deposited a mean of 152 (18-265) eggs over a 10-14 day period. Absolute fecundity was not obtained. At eclosion, the chorion split anteromedially and the crawler freed itself with leg movements. Eclosion of eggs within the population was staggered and may account for the overlapping of stages within a generation. The smooth chorion of each egg was covered with minute, waxy filaments that prevent the eggs in a cluster from adhering to one another. Eggs were 0.25 mm long, 0.10 mm wide, and reddish-purple. Overwintering eggs were present from mid-November to 1st week in May (Fig. 1). Eggs were deposited in June, August and in mid-November.

The mobile crawlers began emerging the 3rd week in April, 2nd week in June, and the 4th week in August. Color of the newly emerged crawler was similar to that of the egg. Several of the female crawlers settled under the old parental tests which eventually resulted in a heavy encrustation on the branches. Heaviest infestations on willow trees occurred on the trunk and branches in the lower 1/3 to 1/4 region of the tree or sapling. As competition for space increased on older branches, the distance crawlers settled from each other diminished resulting in complete encrustation of these branches. Those females that settled on new growth were often found near the twig nodes. Most males migrated to the leaves where they settled on the top surface near the veins. Those male crawlers remaining on the twigs and branches frequently settled adjacent to a cluster of females. Once settled on a suitable site, the crawlers began exuding fine, waxy filaments from the dermal microducts and macroducts that gave the specimens a fuzzy appearance. Second instars were found the 1st week in May, 2nd week in July, and 1st week in September. The snow-white tests of the second stage females were subcircular and slightly convex, while those of the males were distinguished by being more elongated with parallel sides and rounded posteriorly. Prepupal males were present from 2nd-to-4th week in May, the 2nd week in July to 1st week in August, and the 2nd-to-4th week in September. Prepupal males developed into pupal males after ca. one week. The immature male tests possessed a flexible posterior exit flap that allowed the adult male to emerge by backing out of the test.

The ephemeral adult males began emerging the 4th week in May, 1st week in August and the 2nd week in September. Upon emergence, males immediately began to seek out and fertilize adult females. Flight activity in males was rare. However, when they came in contact with the edge of a leaf or twig, they would often take to flight. Two adult males have been found among the field population that had no wings. Males were observed to walk over the surface of an infested branch constantly tapping the female tests with their antennae. When a suitable female was encountered, the male would raise the posterior of the abdomen bringing forward the genitalia between the legs and positioned it beneath the female test at the anal groove in search of the vulvar orifice. After mating, males often groomed themselves by rubbing the genitalia between the prothoracic legs before beginning a search for other females. Males observed died within 24-36 hours after emergence.

The adult females were present the 3rd week in May, 4th week in July and 3rd week in September. The lady beetle, *Rhyzobius lophanthae* (Blaisdell) (Coleoptera: Coccinellidae), was commonly found feeding on eggs deposited beneath the test of the female. Upon discovery of a

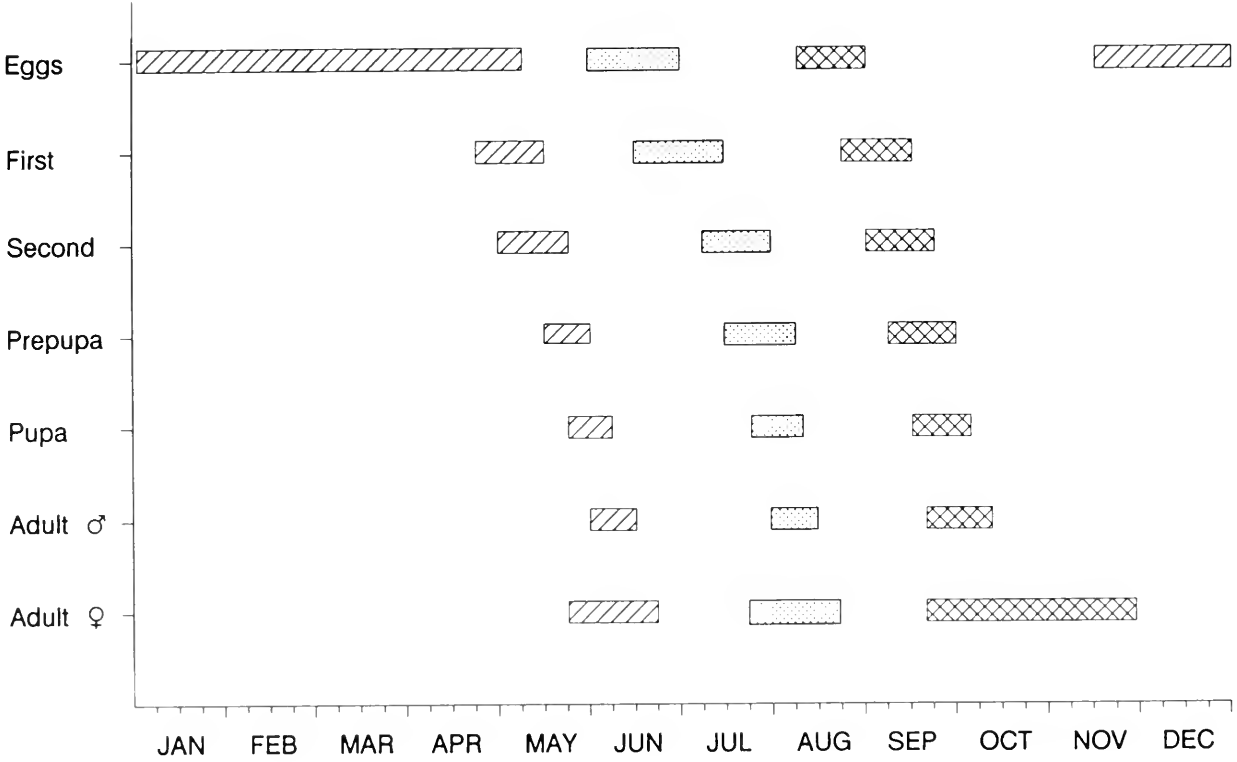

Figure 1. Development of the black willow scale in Tennessee.

gravid female, the lady beetle chewed an irregular hole in the dorso-posterior section of the scale test to feed on the eggs.

The black willow scale was found to have three generations per year in Tennessee which differs somewhat from the two generations reported by Hollinger (1923), Langford (1926) and Kosztarab (1963) for studies on more northern and western populations. The report of 33 (11 - 54) eggs per female by Langford (1926) appears quite low in comparison to some 152 (18-265) eggs per female found in this study. Additonal studies are needed to determine the influence of temperature on development and morphology of the various stages of the black willow scale.

ACKNOWLEDGMENTS

I wish to thank Dave Paulsen and Feng Pingzhang, Department of Entomology and Plant Pathology, University of Tennessee, Knoxville, TN, for their most valuable assistance in collecting and processing specimens for this study, and J. B. Chapin, Department of Entomology, Louisiana State University, Baton Rouge, LA, for her help in the identification of the ladybug found feeding on the black willow scale.

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THE LEAFHOPPER GENUS *BYTHONIA* (HOMOPTERA: CICADELLIDAE)[1, 2]

H. Derrick Blocker[3], M.D. Webb[4]

ABSTRACT: Available specimens of the genus *Bythonia* are examined, and the subfamily status of Bythoniinae is reviewed. A new species of *Bythonia* from Brazil is described, and the genus is assigned to the subfamily Iassinae.

The genus *Bythonia* Oman (1936) was described from a female specimen from Bolivia, *Nionia rugosa* Osborn. Linnavuori (1959) described the male of *rugosa* from a specimen from Peru and one new species, *kalypso,* from a single male specimen from Brazil. He described the subfamily Bythoniinae based on these three specimens. A third species is described here from a single male specimen collected in Brazil and deposited in the British Museum (Natural History).

Bythonia is here assigned to the subfamily Iassinae based on a review of this subfamily by Blocker (1979a), which agrees with the subfamily description of Kramer (1963). Some of the characters used by Linnavuori (1959) to establish a new subfamily are present in some of the more primitive genera of Iassinae, e.g., absence of a coronal suture, swollen clypeus (e.g., *Gargaropsis*), postfrontal suture present (e.g., *Gargaropsis*, *Baldriga*), and ocelli in anterior margin of head (several genera). *Bythonia* is probably most closely related to *Pachyopsis* and *Scaropsia* (see Blocker 1979b). A worldwide reclassification of the higher categories of Iassinae is needed.

Bythonia Oman

Bythonia Oman, 1936:358. Type species, *Nionia rugosa* Osborn, 1923:32 by monotypy.

Vertex short, slightly shorter medially than next to eye; face short and broad, ocellocular area with a distinct ledge above antennal pit; postfrontal suture extending past antenna, curving mesad of ocellus; ocellus remote from eye, approximately 3X its diameter; forewing with 3 anteapical cells; hindwing with second anteapical cell narrow. The original generic description (Oman 1936) and the subsequent description of Linnavuori (1959) should be consulted.

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[2] Contribution 90-508-J from the Kansas Agricultural Experiment Station.

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Bythonia rugosa (Osborn)

(Fig. 1)

Nionia rugosa Osborn, 1923:32.
Bythonia rugosa (Osborn), Oman 1936:358.

Length of male 7.0 mm, female 8.0 mm; head width of male 2.7 mm, female 3.0 mm; pronotal width of male 2.6 mm, female 2.9 mm; pronotal length of male 1.3 mm, female 1.4 mm; vertex length approx 0.2 mm, slightly longer next to eye in both sexes.

Female abdominal sternum VII (fig. 1) elongate, with a spine on anterior third of each lateral margin and caliper-like area at each caudolateral margin, caudal margin dentate. Description and illustration of male in Linnauuori (1959).

Holotype, female, Sta. Cruz de la Sierra, Bol. (J. Steinbach), Acc. 4549, in Carnegie Museum. The type and a male specimen from Peru (locality and collector unknown), in The American Museum of Natural History, have been studied.

Bythonia kalypso Linnavuori

Bythonia kalypso Linnavuori, 1959:15.

Length of male 9.0 mm. This specimen was described and illustrated by Linnavuori (1959) from a single specimen from Brazil. The holotype has not been studied. It is reportedly deposited in the Hungarian Natural History Museum but could not be located in that collection (Dr. Tamas Vasarhelyi, personal communication); neither is it present in the Linnavuori collection at the American Museum of Natural History (Dr. M.D. Schwartz, personal correspondence).

Bythonia consensa, new species

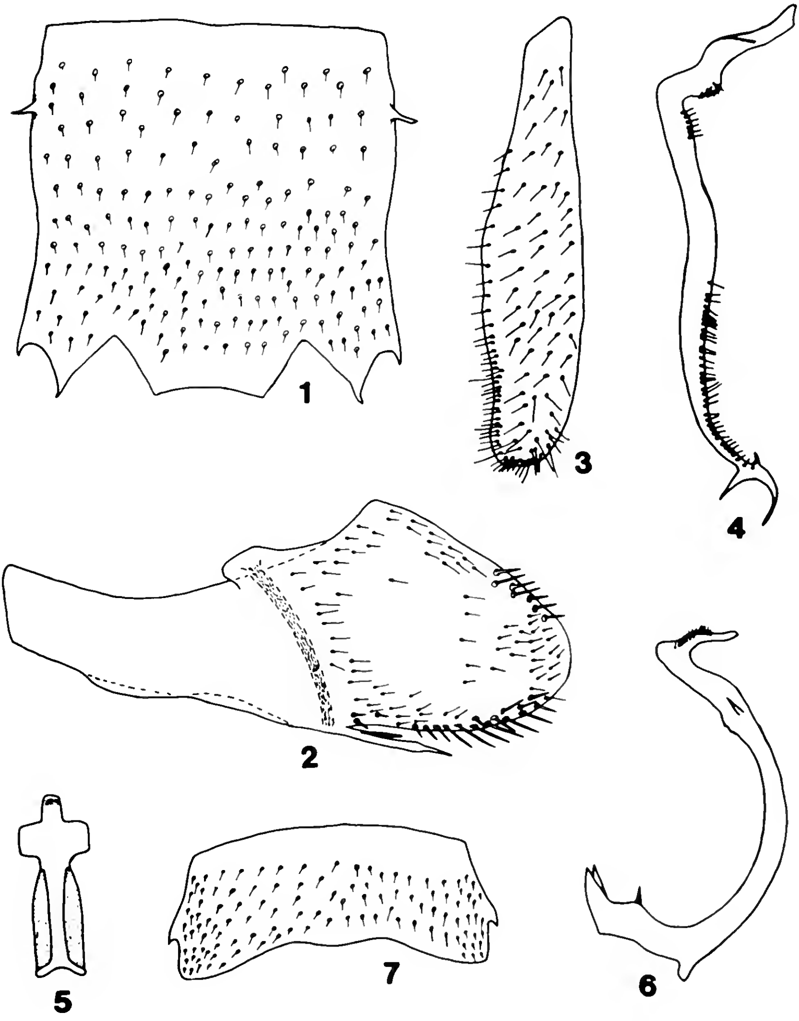
(Figs. 2-7)

Length of male 7.0 mm; head and pronotal width 2.5 mm; vertex width 0.2 mm next to eye, slightly shorter medially; pronotal length 1.2 mm; female unknown.

Color dark red with vertex fuscous, face with median fuscous band; pronotum and scutellum with a fuscous pattern, legs with fuscous markings; forewings uniformly dark red.

Ocellus 2½ X its diameter from eye, on anterior margin of vertex; face tumid; preapical tarsomere of hind leg reduced, without apical setal row. Abdominal sternum VIII (fig. 7) with conspicuous process on lateral margins.

Pygofer (fig. 2) elongate, with a heavily sclerotized diagonal internal ridge located at midlength; a bifurcate process at midlength on ventral margin which extends caudad; apical half heavily setose, especially along ventral margin. Plates (fig. 3) linear, elongate, with numerous microsetae. Style (fig. 4) elongate, apex caliper-like, with a retrorse spine



Figs. 1-7. *Bythonia rugosa*: 1, female sternum VII, ventral view. *Bythonia concensa*: 2, pygofer, lateral view; 3, plate, ventral view; 4, style, broad aspect; 5, connective, dorsal view; 6, aedeagus, lateral view; 7, sternum VIII, ventral view.

subapically, numerous microsetae on dorsolateral surface; connective (fig. 5) elongate, thickened anteriorly in lateral view, curving ventrad; aedeagus (fig. 6) with conspicuous apodeme, with a medial spine at midlength, bifurcate at midlength, arms broadly U-shaped; shaft elongate, widened at apical ¼, with a pair of lateral spines; apex recurved, with numerous microspines on caudal surface.

Holotype, male, Tijuco Preto, Esp. Santo [Brazil] deposited in the British Museum (Natural History). Described from this single specimen.

B. concensa is related to *rugosa* but can be distinguished by the shape of the apex of the aedeagal shaft and the shape of the style apex.

ACKNOWLEDGMENTS

The type of *Bythonia* was lent by the Carnegie Museum courtesy of Chen W. Young; the male specimen of *B. rugosa* was lent by the American Museum of Natural History courtesy of M.D. Schwartz. C.A. Viraktamath, during a visit, examined the types of *concensa* and *rugosa* and offered advice on subfamily placement.

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NEW RECORDS OF MAYFLIES (EPHEMEROPTERA) FROM MAINE

Steven K. Burian[2], Ronald G. Mack[3]

ABSTRACT: Five species of mayflies (Ephemeroptera) are reported from Maine for the first time: *Ameletus lineatus*, *Acerpenna macdunnoughi*, *Acentrella ampla*, *Centroptilum bellum*, and *Leucrocuta aphrodite*. The occurrence of the primarily southern species *Acentrella amplua* in central and coastal Maine represents the northernmost record for the species.

Maine is a large geographically diverse area for which the mayfly fauna is poorly understood. A current review of the historical records for Maine indicate that only about 100 species were reported (Burian 1990). This number represents only half the species expected to occur in the region based on continental distribution records (Edmunds *et al.* 1976).

To improve our knowledge of the diversity and distribution of mayflies in Maine an extensive survey was conducted from 1985-87. In addition to inland sampling (Burian 1990), the offshore islands of Mount Desert and Isle au Haut were intensively sampled (Mack 1988). These sampling programs produced several thousand new specimens for study. The purpose of this paper is to report the occurrence of five species (*Ameletus lineatus* Traver, *Acerpenna macdunnoughi* (Ide), *Acentrella ampla* (Traver), *Centroptilus bellum* (McDunnough), and *Leucrocuta aphrodite* (McDonnough)) for the first time from Maine.

Abbreviations for life stages, locations, and collectors used in species records are: nymph (N), adult (A), males (M), females (F), at (@), Mount Desert Island (MDI), Acadia National Park (ANP), S.K. Burian (SKB), K.E. Gibbs (KEG), and R.G. Mack (RGM). Distribution records are listed separately for nymphs and adults. Records are arranged by county, and habitat information for sites listed is provided by Mack (1988) for Mount Desert Island and Burian (1990) for inland areas. Specimens listed in this paper were deposited in the Aquatic Insect Collection of the Department of Entomology, University of Maine, Orono, Maine, U.S.A.

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Siphlonuridae

Ameletus lineatus Traver

(N) FRANKLIN: 3rd small brook crossing golf course road, Sugarloaf Ski Area 23-V-85 SKB; HANCOCK: Duck Brk. @ Rt. 233 MDI-ANP 2-V-87 RGM; Great Brk. 1 km south of outlet to Great Long Pond MDI-ANP 19-V-87 RGM; Stanley Brk. along Park Loop Rd. MDI-ANP 19-V-87 RGM.

(A) HANCOCK: Stanley Brk. along Park Loop Rd. MDI-ANP 19-V-87 (F) & 23-V-87 (F) RGM.

In addition to the records noted here for the Moosehead Plateau and costal Maine, early instar nymphs that are either *Ameletus ludens* or *A. lineatus* were collected from Washington County. Mature nymphs or adults are necessary to clarify these additional records.

Baetidae

Acerpenna macdunnoughi (Ide)

(N) FRANKLIN: Carrabassett R. east of rest area @ Rt. 16 22-V-86 SKB; Carrabasett R. @ confluence with West Branch Carrabassett R., Kingfield 20-VI-86 SKB; HANCOCK: Breakneck Brk. ANP boundary, Hulls Cove, MDI 31-III-86 SKB; Duck Brk. outlet of Eagle Lake @ Rt. 223 MDI-ANP 8-V-86 SKB; Duck Brk. @ Rt. 3 MDI-ANP 2-V-87 RGM; Lurvey Brk. @ Seal Cove Rd. MDI-ANP 13-VII-87 RGM; Great Brk. 100 m south of the mouth of brook MDI-ANP 19-V-87 RGM; Brook (unidentified) entering Aunt Betty Pond on east side of carriage path MDI-ANP 25-V-87 RGM; Stanley Brk. along Park Loop Rd. MDI-ANP 7 & 18-V-87 & 6-VI-87 RGM; PENOBSCOT: Sunkhaze Str. @ Studmill Rd. bridge, Costigan 9-VI-86, 3-VII-86, & 5-VIII-86 SKB; Baker Brk. upstream & downstream of culvert on County Rd., Milford 27-VI-86 SKB; Birch Str. upstream & downstream of bridge on County Rd., Milford 19-V-86, 4 & 5-VIII-86 SKB; PISCATAQUIS: Lazy Tom Str. @ spillway bridge on Spencer Bay Rd. 24-VI-86, 28-V-86, 25-VI-86, & 29-VII-86 SKB; Lily Bay Brk. above confluence with North and South Brooks 26-VIII-86 SKB; Tussel Brk. above inlet to Moosehead Lake 29-V-86; WALDO: Small stream @ intersection of Back Rd. & North Palermo Rd., Palermo 14-IV-86 SKB; WASHINGTON: Flood Brk. downstream of culvert @ Rt. 6 4-VI-86 & 12-VIII-86 SKB; Small brook @ rest area on East Musquash Lake, upstream of culvert 5-VI-86 SKB; Tomah Str. upstream & downstream of bridge @ Rt. 6 13-VIII-86 SKB.

(A) FRANKLIN: Small tributary (unnamed) to Carrabassett R. at base of Sugarloaf Mtn. 27-VI-86 (M) SKB; PENOBSCOT: Sunkhaze Str. @ Studmill Rd. bridge, Costigan 11-V-86 (F) SKB; PISCATAQUIS: Lazy Tom Str. @ spillway bridge on Spencer Bay Rd. 26-VIII-86 (F) SKB; Lagoon Brk. upstream & downstream of culverts on road to Big Lyford Pond 29-V-86 (M,F) SKB; Lily Bay Brk. confluence with Moosehead Lake 26-VIII-86 SKB.

This species is widely distributed across the state and is one of the most frequently encountered baetids in cool rocky streams.

Acentrella ampla (Traver)

(N) HANCOCK: Duck Brk. @ bridge off of New Eagle Lake Rd. MDI-ANP 11-V-86 KEG & 9-V-87 RGM; Stanley Brk. MDI-ANP 6-IX-87 RGM; PENOBSCOT: Souadabscook Str. @ Rt. 9 29-IV-86 KEG; WASHINGTON: Small brook @ rest area on East Musquash Lake @ Rt. 6 5-VI-86 SKB.

(A) HANCOCK: Duck Brk. @ bridge off of New Eagle Lake Rd. MDI-ANP 19-V-87 (M,F) RGM.

Primarily a southeastern species, *Acentrella ampla* is restricted to the coastal and central southern interior parts of Maine. The species was most abundant at Duck Brk. on Mount Desert Island where it occurred in dense *Fontinalis* mats in swift rock-bottom streams.

Centroptilum bellum McDunnough

(N) FRANKLIN: Reed Brk. above confluence with Carrabassett R. @ Rt. 16 west of Kingfield 21-VIII-86; HANCOCK: Breakneck Brk. @ ANP boundary Hulls Cove, MDI 10-VI-86 SKB; Breakneck Brk. @ Rt. 3 MDI-ANP 13-VI-87 RGM; PENOBSCOT: Sunkhaze Str. @ Studmill Rd. bridge, Costigan 9-VI-86, 3-VII-86, & 5-VIII-86 SKB; Birch Str. upstream & downstream of bridge on County Rd., Milford 9-VI-86 & 19-VI-86 SKB; Baker Brk. upstream & downstream of culvert on County Rd., Milford 4-VIII-86 SKB; SOMERSET: Carrabassett R. 2.4 km west of North Anson along Rt. 16 21-VI-86 & 13-VII-86 SKB; WASHINGTON: Tomash Str. upstream & downstream of bridge @ Rt. 6 1-VIII-86 SKB.

(A) FRANKLIN: Reed Brk. above confluence with Carrabassett R. @ Rt. 16 12-VIII-86 (M,F) SKB; WASHINGTON: Tomah Str. @ bridge on Rt. 6 1-VII-86 SKB.

This species is broadly distributed across the state and frequently occurs in cool rocky streams and rivers.

Heptageniidae

Leucrocuta aphrodite (McDunnough)

(N) LINCOLN: Sheepscot R. (mainstem) Rt. 126 North Whitefield 15-VIII-86 SKB.

(A) HANCOCK: Duck Brk. @ Rt. 3 MDI-ANP 11-VII-87 (M) RGM; PENOBSCOT: Sunkhaze Str. @ Studmill Rd. bridge 5-VIII-86 (M) SKB; Birch Str. @ confluence with Stillwater R. @ Rt. 116 bridge 12-VI-86 (M,F) SKB; Lights @ Mobil Gas Station @ Stillwater Ave. exit of I-95 7-VII-86 (M, F) SKB; Lights @ Maineway Store, Old Town 16-VII-86 (M,F) SKB; Lights behind Nutting Hall, University of Maine campus, Orono 11 & 30-VI-86 & 4-VIII-86 (M,F) SKB.

Broadly distributed across eastern Canada (Edmunds *et al.* 1976), *Leucrocuta aphrodite* is restricted in Maine to the central and southern interior areas. The species probably dispersed into Maine from the south and west (Burian 1990), and it is expected that additional collections made in the southwestern parts of the state will uncover other populations.

ACKNOWLEDGMENTS

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SEPARATION OF INSECT AND PLANT MATERIAL FROM SCREEN-SWEEP SAMPLES[1]

Gregory Zolnerowich, John M. Heraty, James B. Woolley[2]

ABSTRACT: An alcohol technique which separates plant debris from insect material in screen-sweep samples is described. Data show this method can be up to 100% efficient at separating Chalcidoidea (Insecta: Hymenoptera) from bulk plant material when 95% ethanol is used. This technique opens up new habitats for collecting, decreases time needed to sort a sample, and reduces storage space required to house samples.

Screen-sweeping, a technique pioneered by Lubomir Masner, (personal communication), is an effective method for collecting large numbers of small insects (e.g., see Noyes 1989), and the use of a screen-sweep net is the first step in reducing plant debris in a sample. Triangular net heads are used when collecting to maximize the surface area of the net in contact with the ground. A ¼ inch galvanized hardware cloth screen fitted over the net opening effectively prevents many leaves, stems, stones, and twigs from entering the net bag (L. Masner, pers. comm., Noyes 1982, 1988). Polyethylene matting used in place of hardware cloth results in fewer damaged specimens (L. Masner, pers. comm.) but is less durable under rugged collecting conditions. In the field, the net bag is periodically emptied into gallon size heavy duty plastic freezer bags. The sample in the bag is sprayed with a saturated salt solution (NaCl in H_2O) which drowns and preserves small insects. We are concerned primarily with collecting the superfamily Chalcidoidea (Hymenoptera), parasitic wasps which are usually 1-5 mm long. Of special interest are Encyrtidae, many of which are found in dense grasses at ground level. However, even with a screen, sweeping such habitats quickly results in a ball of plant material inside the net which can damage delicate specimens. In addition, processing and subsequent laboratory sorting of such samples can be time-consuming. We describe here an alcohol flotation technique which further separates plant debris from insect material in a screen-sweep sample. This technique opens up new habitats for collection, decreases time needed to sort a sample, and reduces storage space required to house samples.

APPARATUS

The individual parts needed are easily constructed of Rubbermaid®

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[1] Received June 4, 1990. Accepted July 13, 1990.

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Servin' Saver™plastic containers. The main units employed by this method are a fine mesh strainer, a separation chamber, and a transport/pouring container (Fig. 1).

Fine mesh strainer (Fig. 1, A). The strainer is comprised of two tall 1.4 liter containers with their bottoms removed. The internal dimensions of each container are 12 x 12 x 13 cm. A suitable fine mesh material is stretched across the bottom of one container, which is then pushed tightly into the second container to form a taut screen. A small section of panty hose makes an excellent straining material, as it is strong, has an intricate weave which prevents even tiny insects from passing through, and insects or plant material do not cling to it.

Separation chamber (Fig. 1, B). The separation chamber is formed by a 2.4 and 4.5 liter square container. The bottom is removed from the smaller container and its sides are shortened so that it fits inside the larger container. The internal dimensions of the smaller container are 21 x 21 x 7.5 cm. A screen bottom made of ¼ inch mesh galvanized hardware cloth is attached near the bottom of the smaller container. Silicone rubber aquarium sealer can be used to affix the hardware cloth screen 1 cm above the bottom rim. The internal dimensions of the 4.5 liter container are 24.5 x 24.5 x 11 cm.

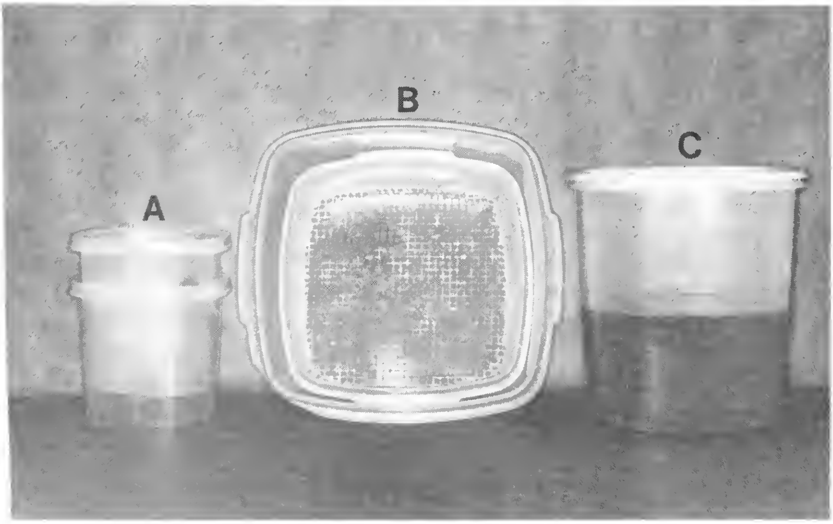

Figure 1. Apparatus used in separation procedure. From left to right are the fine mesh strainer (A), separation chamber (B), and transport/pouring container (C).

Transport/pouring container (Fig. 1, C). A tall 5 liter container measuring 20 x 20 x 22 cm is used for transportation in the field, storage, and as a receptacle when pouring alcohol.

Other equipment. Washing bottles are needed for rinsing specimens from the fine mesh strainer. Different sizes of funnels are used to facilitate the transfer of insects from the strainer into storage containers and for filtering dirty alcohol. An alcohol hydrometer and graduated cylinder are needed to monitor the concentration of alcohol used in the process.

PROCEDURE

Samples should be processed the day of collection to insure maximum efficiency of separation. The contents of a single freezer bag are transferred into the fine mesh strainer. This is easily done by cutting a bottom corner of the bag and pouring the sample into the strainer. If the bag is very full, the sample should be divided in half for processing. Once in the strainer, a gentle stream of water should be played over the sample for 3-4 minutes to flush out the brine. The sample is allowed to drain for a few minutes.

The sample is then transferred to the separation unit and enough 95% ethanol added to nearly fill the nested containers. Insects sink through the bottom screen of the inner container into the larger 4.5 liter container. Plant material such as flowers, leaves, seeds, and stems floats to the surface, or sinks and is restrained by the hardware cloth screen. To insure that the maximum number of insects sinks through the mesh, the sample is agitated for 4-5 minutes by gently shaking the inner container and stirring the debris. This breaks up any plant material packed together on the surface or obstructing the mesh bottom. The inner unit is then lifted out along with the bulk of the plant material, which can be discarded.

The alcohol and insects left in the 4.5 liter container are poured through the fine mesh strainer into the 5 liter container. The strainer traps the insects in the alcohol, and from there the sample is spooned or flushed with alcohol into a suitable container and stored in ethanol for later sorting in the laboratory. The alcohol in the storage containers should be changed after 24 hours. Insects stored in alcohol keep best if housed in a freezer (Masner and Goulet 1981).

Alcohol employed in the separation process which remains clean can be used again. To prevent the deposition of dirt onto specimens, dirty alcohol can be filtered and then reused for the next sample. A vacuum filtering flask is most effective for filtering in the laboratory. In the field, large cone-shaped paper coffee filters inserted into a wide funnel are effective at removing dirt from alcohol. Paper coffee filters are thinner and work faster than standard laboratory filter paper.

FIELD TRIALS

Tests were conducted to determine the effectiveness of this technique. Screen-sweep samples were collected and subjected to the separation process. Floating plant portions were retained and examined to ascertain the number of insects that would potentially be lost with this technique. To save time, we only sorted to certain categories of Hymenoptera (Tables 1 and 2). Of those categories, "Other Chalcidoidea" includes families such as Eulophidae, Eurytomidae, Pteromalidae, and Torymidae. "Other Microhymenoptera" are small non-chalcidoid wasps such as Cynipoidea, Proctotrupoidea, and Scelionoidea. The first three tests used the same 70% ethanol (Table 1).

Specimens which sank would have been retained while those which floated with the plant material would have been discarded. In categories with large sample sizes the percentage of chalcidoid specimens which floated and would have been discarded ranged from 0.7-5.6 percent (Table 1).

In additional tests using the same alcohol, the loss rate reached 10-18% for some categories of Hymenoptera. We hypothesized that the alcohol used in the separation process was becoming diluted with water and allowing more insects to float. In addition to any moisture inherent in the samples, they were being subjected to the brine and a water rinse, all of which could introduce water into the alcohol. To test this hypothesis, two of us swept a local grassy meadow for one hour each. This collecting site is characterized by having a rich chalcidoid fauna in very dense, mature grasses. The total weight of the samples collected was 1.14 kg. The samples were combined and divided into six equal portions based on weight and subjected to the separation process using 50, 70, and 95% ethanol with two repetitions, each using fresh alcohol. The percentage of the total number of insects from each category that would have been discarded is shown in Table 2.

The test using 50% ethanol gave poor results, with losses often exceeding 20% of the total collected. The test with 70% ethanol reflected our earlier findings, with chalcidoid losses ranging from about 1-7% for categories with large sample sizes. The test with 95% ethanol produced the best results, and insect loss was from 0 - 2.8% for all but one category of Hymenoptera (Table 2).

Although alcohol used in the separation process will become diluted, using an alcohol hydrometer to monitor concentration will prevent the undue loss of valuable specimens. Based on 21 freezer bag samples, each bag processed decreases alcohol concentration by approximately 4 percent. We discard our alcohol when the concentration reaches 70-75%, the level where our data show we may begin to lose 5% of the specimens.

Table 1. Results using the same 70% ethanol for consecutive tests in the separation process. Data are expressed as % (N) where % is the percentage of total insects (N) from each category which would have been discarded with the plant material. Specimens collected from Texas, Jim Wells Co., La Copita Research Station, 20.V.1987.

	Test 1	Test 2	Test 3
Aphelinidae & Trichogrammatidae	0.0 (89)	1.8 (108)	0.7 (409)
Encyrtidae	5.6 (125)	4.6 (108)	3.7 (463)
Eucharitidae	0.0 (1)	25.0 (4)	18.7 (16)
Eupelmidae	0.0 (3)	0.0 (1)	0.0 (7)
Mymaridae	1.3 (223)	4.5 (111)	1.0 (380)
Other Chalcidoidea	5.6 (531)	2.3 (683)	5.5 (2023)
Other Microhymenoptera	14.7 (68)	14.0 (71)	14.0 (410)
Ichneumonoidea	3.3 (30)	4.0 (94)	8.6 (29)
Aculeates	75.0 (4)	12.5 (8)	24.4 (41)

Table 2. Percentage of the total number of insects from each category which would have been discarded in two repetitions using fresh 50, 70, and 95% ethanol in the separation process. Data are expressed as % (N) where % is the percentage of total insects (N) from each category. Specimens collected from Texas, Brazos Co., Lick Creek Park, 4.VIII.1987.

	50% Ethanol		70% Ethanol		95% Ethanol	
	Rep. 1	Rep. 2	Rep. 1	Rep. 2	Rep. 1	Rep. 2
Aphelinidae & Trichogrammatidae	26.7 (45)	9.3 (172)	3.1 (159)	2.2 (92)	0.0 (106)	2.8 (143)
Encyrtidae	22.4 (85)	6.5 (138)	4.6 (132)	1.3 (76)	0.0 (128)	2.6 (117)
Eupelmidae	0.0 (6)	0.0 (6)	7.7 (13)	25.0 (4)	0.0 (6)	0.0 (12)
Mymaridae	23.4 (77)	5.4 (167)	6.6 (211)	5.4 (110)	0.7 (136)	1.4 (146)
Other Chalcidoidea	21.5 (195)	6.3 (319)	2.5 (318)	3.2 (190)	0.4 (260)	0.0 (244)
Other Microhymenoptera	41.0 (22)	11.9 (42)	2.9 (34)	22.0 (18)	0.0 (28)	13.3 (15)
Ichneumonoidea	25.0 (4)	15.4 (13)	18.8 (16)	9.1 (11)	0.0 (14)	0.0 (2)
Aculeates	0.0 (1)	—	—	—	0.0 (4)	0.0 (5)

SUMMARY

There are many advantages of this plant separation technique. The required parts are inexpensive, easy to assemble, and readily transportable in the field. We have employed this technique in campgrounds, motels, and the laboratory. The effective removal of extraneous plant material from screen-sweep samples dramatically decreases the time and space required to sort and house them. Although this technique has been shown to be effective for small Hymenoptera, it is hoped that other collectors will utilize it. Using this method, we commonly collect many Collembola, Microcoryphia, Thysanoptera, Hemiptera, Homoptera, Coleoptera, Diptera, and Arachnida. The use of this technique may encourage workers to sample habitats which in the past were unpalatable.

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(Continued on page 315)

A SURVEY OF THE TIGER BEETLES (COLEOPTERA: CICINDELIDAE) OF COLORADO[1]

Michael G. Kippenhan[2, 3]

ABSTRACT: Thirty-three species of tiger beetles representing two genera are recorded from Colorado. This richness of species is a combination of the great geomorphological diversity of Colorado, and the close proximity of Colorado to the area of highest North American tiger beetle diversity, the southwest. Taxonomic clarifications are given for several literature records.

The general distributions of North American tiger beetles are relatively well known (Boyd *et al.* 1982). However, no checklist is presently available for the Colorado species. Wickham (1902) in his catalogue of Colorado beetles provides a list of species. However, the taxonomy is out-of-date and unreliable. The richness of the cicindelid fauna of Colorado is especially interesting because of two factors: (1) the diverse geomorphology of Colorado, with elevations ranging from 1020 m at the Kansas border to numerous peaks exceeding 4000 m in the Rocky Mountains, and (2) the close proximity of Colorado to the center of the highest North American tiger beetle diversity, the southwest (Willis 1972). Colorado is readily divided into three broad physiographic regions: plains, mountains and the plateaus (Fig. 1). The eastern two-fifths of the state is the western extension of the Great Plains. The southern Rocky Mountains rise abruptly, with the eastern most range, the Front Range displaying some of the most striking high-altitude scenery in the world (Chronic and Chronic 1972). The western quarter of the state is characterized by flat-topped plateaus overlooking steep gorges cut by rivers.

Many species of tiger beetles have distinctive distribution patterns associated with these land forms in Colorado. For example, *Cicindela denverensis* Casey, *C. p. pulchra* Say, *C. s. scutellaris* Say and *C. o. obsoleta* Say are restricted to plains. *Cicindela f. formosa* Say and *C. scutellaris* Say, both common widespread eastern and central North American species reach their western limit of distribution in Colorado along the Front Range, except for isolated populations of *C. f. gibsoni* Brown and *C. s. yampae* Rumpp in Moffat County (Fig. 1). *Cicindela duodecimguttata* Dejean also reaches its western limit of distribution in Colorado, whereas *C. o. guttifera* LeConte reaches its eastern most range limit in the Front Range. North-south range limits of several species occur in Colorado. *Cicindela l. limbata* Say reaches its most southern limit and *C. o. obsoleta*

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Say, *C. o. santaclarae* Bates, *C. marutha* Dow, *C. n. nigrocoerulea* LeConte, and *C. n. bowditchi* Leng reach their northern limit in Colorado. *Cicindela theatina* Rotger, orginally described from the Great Sand Dunes, Alamosa County, is only known from a small area of southern Colorado.

The following preliminary checklist follows the classification of Boyd *et al.* (1982). Generally, Willis' (1968) (adaptation of Rivalier, 1954) taxonomic treatment of the species of *Cicindela* was followed. The subfamily Cicindelinae is represented in Colorado by 2 genera and 33 species. The number of species reported herein is less than New Mexico (38) but higher than other surrounding states of Kansas (30), Wyoming (28) and Utah (24) (Boyd *et al.* (1982)). Boyd *et al.* (1982) listed *Megacephala virginica* (L.) from Colorado, but this record is considered here doubtful (R.L. Huber, personal communication), and is not included. This species was listed for Oklahoma near the Colorado border by Drew and Van Cleave (1961). Three additional subspecies records (*C. n. nigrocoerulea* LeConte, *C. o. santaclarae* Bates and *C. p. cinctipennis* LeConte), not originally listed by Boyd *et al.* (1982) from Colorado are included and clarified for the first time. The following species have been collected in surrounding states and may eventually be collected in Colorado: *C. cursitans* LeConte (Kansas and Nebraska), *C. celeripes* LeConte (Kansas, Nebraska, and Oklahoma), *C. sedecimpunctata* Klug (Arizona and New Mexico), *C. sperata* LeConte (Arizona, New Mexico, Oklahoma, and Utah), *C. tenuisignata* LeConte (Arizona, New Mexico, Oklahoma, and Utah), and *C. willistoni* LeConte (Kansas, New Mexico, Oklahoma, Utah, and Wyoming). County records (numbers) following each species refer to Fig. 1.

Tiger Beetles of Colorado

Subfamily Cicindelinae Fisher
Tribe Megacephalini W. Horn
Subtribe Omina W. Horn

Genus *Amblychelia* Say

A. cylindriformis (Say)

This species is known only from the plains physiographic region of Colorado. Counties: 6, 15, 32, 38, 40, 59, 60, 61, 62, 63

A. picolominii Reiche

No specimens of this species were examined during this study. Vaurie (1955) listed a single specimen from Montezuma County. County 50

Tribe Cicindelini Sloane
Subtribe Cicindelina W. Horn

Genus *Cicindela* L.
Subgenus *Cicindela*(s. s.)

C. longilabris laurentii Schaupp

The geographic variation of this species was documented by Spanton (1988). Counties: 1, 3, 5, 18, 21, 26, 28, 42, 50

C. nebraskana Casey

Spanton (1988) did not cite specimens from Colorado, but recent collecting has established its presence well into Colorado. Counties: 4, 32

C. repanda repanda Dejean

This fluvial species can be usually collected wherever suitable habitats occur throughout the state. Counties: 1, 4, 5, 7, 11, 14, 16, 20, 24, 25, 30, 32, 38, 48, 50, 58, 59, 61, 62

C. duodecimguttata Dejean

This fluvial species reaches its western range limit along the Front Range. Counties: 5, 11, 41

C. oregona LeConte

It is expected that this species inhabits all of the western half of the state. The subspecies *C. o. oregona* LeConte, *C. o. guttifera* LeConte, and *C. o. navajoensis* Van Dyke were listed for Colorado by Boyd *et al.* (1982), however, *C. o. oregona* does not occur in Colorado (Freitag 1965).

C. oregona guttifera LeConte

The subspecies ranges from the Front Range to the Western Slope. Counties: 1, 5, 16, 17, 20, 22, 23, 24, 27, 29, 30, 31, 32, 33, 41, 43, 46, 47 48, 51, 52, 53, 54, 55, 56, 59

C. o. guttifera LeConte X ***C. o. navajoensis*** Van Dyke

Specimens of this hybrid form (*sensu* Freitag 1965) have been collected in Mesa County, especially in Colorado National Monument. No specimens clearly assignable to *C. o. navajoensis* were examined from Colorado. Interestingly, Freitag (1965) also did not list any material of this form from Colorado, despite indicating that Colorado is included in the geographical range of this subspecies (his Fig. 18). County 24

C. hirticollis shelfordi Graves

This recently described subspecies occurs throughout Colorado except the extreme western edge (Graves *et al.* 1988). Counties: 5, 6, 9, 14, 15, 38, 61

C. hirticollis corpuscula Rumpp

Twelve specimens from Mesa County, Colorado River, south of Loma in the University of Colorado collection are assignable to this subspecies. Rumpp (1961) did not examine any Colorado material. County 24

C. limbata limbata Say

This species reaches it southernmost limit in northeastern corner of Colorado. Counties: 9, 10, 11

C. theatina Rotger

The type locality of this species is the Great Sand Dunes National Monument, Alamosa County, and is restricted to these sand dunes and adjacent areas. Counties: 43, 55, 57

C. formosa formosa Say

This species reaches its western limit in Colorado along the Front Range, and can be expected to occupy most suitable habitats of the plains physiographic region of Colorado. Counties: 5, 6, 7, 10, 11, 14, 17, 33, 36, 37, 38, 41, 55, 61, 62

C. formosa gibsoni Brown

This is the only population of *C. formosa* west of the Front Range and only known from Moffat Co. Wallis (1961) listed the only other populations of *C. f. gibsoni* Brown from Saskatchewan, Canada. The Colorado population has been recognized as another distinct subspecies by Gaumer (1977) in an unpublished thesis. County 1

C. purpurea group

Various workers disagree on the exact taxonomic status of *C. p. audubonni* LeConte, *C. p. cimarrona* LeConte, *C. s. splendida* Hentz, *C. denverensis* Casey, *C. l. limbalis* and other forms in the *purpurea* group. Until a comprehensive revision treating all these taxa becomes available, Boyd *et al.* (1982) will be followed.

C. purpurea audubonii LeConte

The complete range of this common subspecies in Colorado is unknown. Counties: 5, 6, 9, 14, 16, 17, 20, 32, 33, 56

C. purpurea cimarrona LeConte

Counties: 16, 41, 48, 52, 59

C. splendida splendida Hentz

The plains of Colorado is the western limit of this species, and is apparently uncommon in Colorado. Counties: 6, 7

C. denverensis Casey

The type locality of this species is Denver (Denver County) (Casey 1897). Counties: 5, 6, 7, 13, 39, 60

C. limbalis limbalis Klug

Counties: 3, 5, 17, 21, 32, 61

C. decemnotata Say

This species may be restricted to the western portion of Colorado. Counties: 1, 51

C. pulchra pulchra Say

This grassland species inhabits most or all of the plains physiographic region of Colorado, and is more common in southeastern Colorado. Counties: 5, 6, 14, 32, 40, 41, 52, 58, 60, 61, 62

C. fulgida fulgida Say

Counties: 5, 6, 8, 9, 14, 21, 32, 39, 41, 56, 58, 60, 61, 62

C. scutellaris scutellaris Say

This grassland species reaches its western limit of its range in Colorado. Counties: 6, 7, 8, 9, 10, 12, 32, 40, 41, 58, 61, 62

C. scutellaris yampae Rumpp

The type locality of this apparently endemic subspecies is Moffat County (Rumpp 1986). County 1

C. lengi W. Horn

The three subspecies (*C. l. lengi* W. Horn, *C. l. versuta* Casey, and *C. l. jordai* Rotger) were listed for Colorado by Boyd *et al.* (1982). However, *C. l. jordai* does not occur in Colorado (R.L. Huber, personal communication). The exact status of *C. l. lengi* and *C. l. versuta* in Colorado is unclear. Some populations appear to have both forms represented. Therefore, localities will not be separated except for *C. l. versuta.*

C. lengi W. Horn

Counties: 4, 5, 6, 7, 14, 32, 33, 34, 58, 59 ,61

C. lengi versuta Casey

The following are literature records only (Willis and Stamatov 1971; Lawton 1972), and no specimens were examined. Counties: 1, 55

C. tranquebarica Herbst

Colorado has two subspecies, the eastern *C. t. tranquebarica* Herbst and western *C. t. kirbyi* auct. These subspecies were not separated in this study because of apparent hybrids and incomplete distribution records throughout the range of these forms in Colorado. Counties: 1, 5, 6, 7, 9, 14, 17, 22, 24, 32, 36, 48, 55, 58, 62

Subgenus *Cicindelidia* Rivalier

C. nigrocoerulea nigrocoerulea LeConte

This subspecies was previously reported from adjacent states of New Mexico and Kansas (Boyd *et al.* 1982), but not Colorado. However, Leng (1902) and W. Horn (1930) listed Colorado as part of this species distribution. Willis and Stamatov (1971) reported this species from Boulder County, which is apparently the most northern record of this species. Counties: 17, 32, 40, 58, 60, 62

C. nigrocoerulea bowditchi Leng

The type locality of this subspecies is near Durango (La Plata County) (Leng 1902). Relatively unmarked individuals occur in populations of this subspecies form. Counties: 50, 51, 52

C. obsoleta obsoleta Say

Counties: 6, 14, 32, 39, 40, 58, 59, 61, 63

C. obsoleta santaclarae Bates

Boyd *et al.* (1982) did not list this form from Colorado, however, Leng (1920) (as *C. o. anita* Dow) and W. Horn (1930) recorded specimens from Colorado. Specimens of this subspecies were only examined from counties bordering New Mexico. Counties: 51, 52

C. punctulata punctulata Olivier

Probably the most common and widespread Colorado tiger beetle. Numerous large series of individuals were examined from light trap collections, especially from the plains. Counties: 1, 5, 6, 8, 11, 12, 17, 23, 24, 29, 32, 36, 37, 38, 39, 40,41, 42, 47, 49, 50, 52, 55, 58, 59, 61, 62, 63

C. haemorrhagica haemorrhagica LeConte

Boyd *et al.* (1982) listed this species for Colorado, but no specimens were examined during this study.

Subgenus *Habroscelimorpha* Dokhtourow

C. circumpicta johnsoni Fitch

Counties: 60, 61, 62

Subgenus *Eunota* Rivalier

C. togata globicollis Casey

Colorado is the western most range extension for the form. Counties: 29, 60, 61

Subgenus *Cylindera* Westwood

C. pusilla pusilla Say

Boyd *et al.* (1982) listed this species as *C. terricola* Say. A revision of the *C. pusilla* group is needed to clarify the proper usage of these names. No specimens of *C. p. pusilla* were examined during this study.

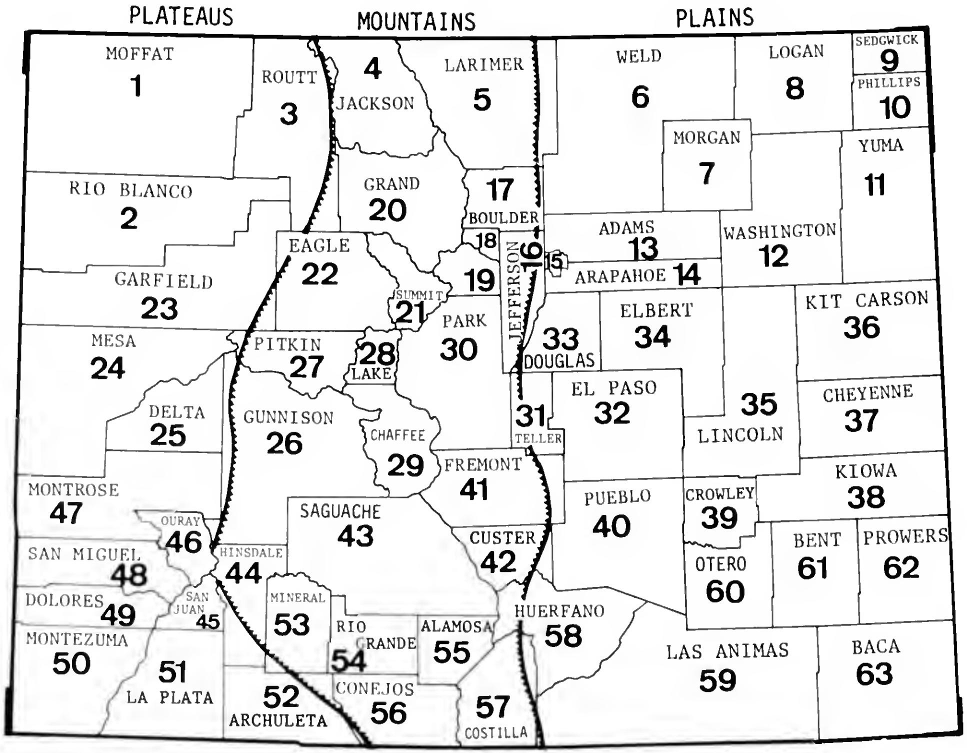
C. pusilla cinctipennis LeConte

Boyd *et al.* (1982) did not include this subspecies from Colorado. Leng (1902) listed Colorado as part of the range of this form, but in 1920 did not include it. Counties: 1, 5, 23, 24, 32, 50, 52, 54

Subgenus *Ellipsoptera* Dokhtourow

C. nevadica knausi Leng

Counties: 29, 38, 58, 60, 61, 62



Denver County - 15; Gilpin County - 18; Clear Creek County - 19

Fig. 1. Map of Colorado indicating counties and three physiographic regions.

C. cuprascens LeConte

Counties: 5, 11, 15,38, 39, 40, 59, 60, 61, 62

C. macra macra LeConte

Willis (1967) provided records for this species. Apparently Colorado is the western limit of its range. Counties: 5, 15

C. marutha Dow

Counties: 24, 39, 61, 62

C. lepida Dejean

Counties: 6, 60, 61, 62

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