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ENTOMOLOGICAL NEWS

OUR CENTENNIAL YEAR

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A NEW *JANUS* (HYMENOPTERA: CEPHIDAE) FROM *QUERCUS*, AND KEY TO NORTH AMERICAN SPECIES[1]

David R. Smith[2], J.D. Solomon[3]

ABSTRACT: *Janus quercusae*, new species, from Mississippi, Maryland, and Virginia is described and illustrated. The larvae bore and feed in young shoots of *Quercus nuttallii*. Biological notes are presented, and a key to the five North American species of *Janus* is given to separate the species.

Larvae of species of *Janus* bore and feed in young stems of trees and shrubs. *Janus abbreviatus* (Say) is associated with *Populus* and *Salix*, *J. bimaculatus* with *Viburnum*, *J. integer* with *Ribes* (Smith, 1978), and *J. rufiventris* with *Quercus* (Hanson, 1986). *Janus abbreviatus* is a pest in nurseries (Solomon and Randall, 1978). In 1983 the junior author discovered larvae of a species of *Janus* in young stems of *Quercus* in Mississippi. A single adult emerged from the infested shoots in 1984, and a second adult was reared from infested *Quercus* stems in 1987. Although only four adult specimens are known, the two reared specimens and additional ones from Maryland and Virginia, significant features distinguish them from other North American *Janus* and this species is described here.

Janus quercusae Smith, new species

Figs. 5, 11

Female. — Length, 6.5-7.0 mm. Antenna black. Head black; mandible and palpi yellow. Thorax black with narrow posterior margin of pronotum, tegula, and short stripe on lower posterior margin of mesepisternum yellow. Abdomen with basal plates and anterior half of 2nd segment black, posterior half of 2nd segment, segments 3-6 and laterally on 7 red, dorsal and ventral portion of 7th segment and segments 8 to apex and sheath black; cercus yellow. Fore- and midlegs yellow; most of anterior surface of hindcoxa black, posterior surface and apex yellow; hindtrochanter yellow; hindfemur orange, basal 1/4-1/3 hindtibia yellow with apical 3/4-2/3 orange; hindtarsus brownish. Wings hyaline, costa and most of stigma ochre, apex of costa and veins brownish. Hindtibia with 2 preapical spurs. Hindbasitarsus shorter than remaining tarsal segments combined (as 2.2:3.0). Forewing with radial vein complete. Lancet as in Fig. 5, serrulae concave at apex, with two rounded teeth and indentation on each side of serrulae about same depth.

[1]Received July 8, 1988. Accepted July 9, 1988.

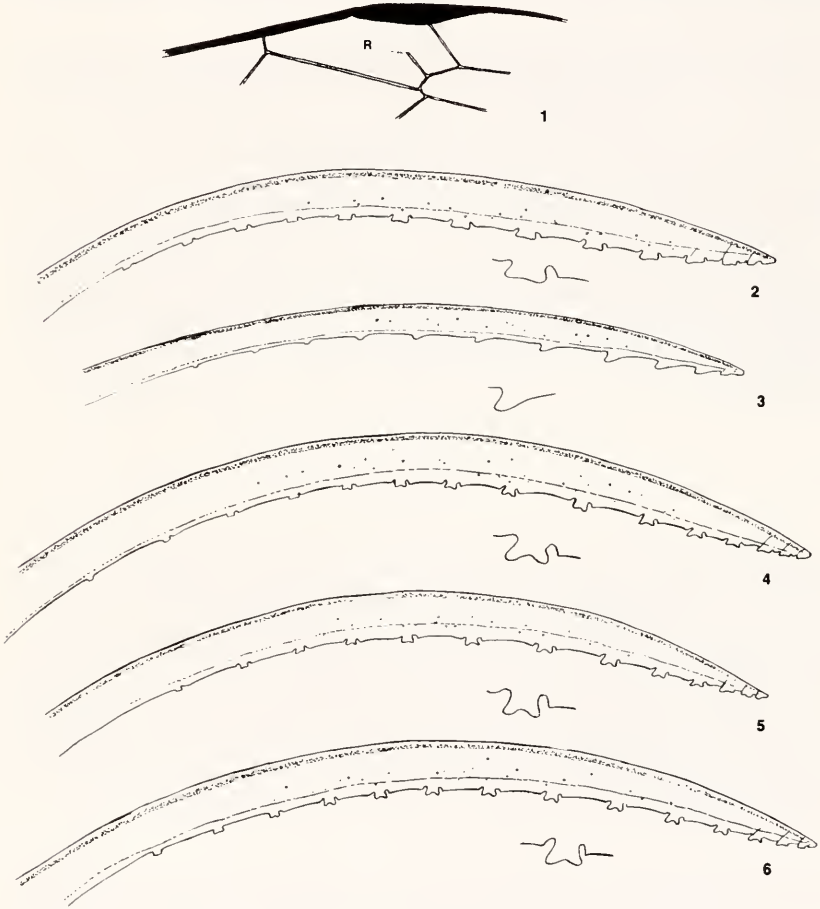
[2]Systematic Entomology Laboratory, PSI, Agricultural Research Service, U.S. Department of Agriculture, c/o National Museum of Natural History, Washington, D.C. 20560.

[3]Southern Hardwoods Laboratory, U.S. Forest Service, U.S. Department of Agriculture, P.O. Box 227, Stoneville, Mississippi 38776.

Male — Unknown.

Holotype — ♀, Leland, Washington Co., Mississippi, Nuttall oak (*Quercus nuttallii* Palmer), stems collected 6-27-83, adult April 1984, J.D. Solomon, No. 27.

Paratypes — MARYLAND: Patuxent Wildlife Refuge. Prince Georges Co., V-II-86. Malaise trap, D. Wahl (1 ♀). **MISSISSIPPI.** Same locality and host as holotype, stems collected April 7, 1987, adult emerged April 16, 1987 (1 ♀). **VIRGINIA:** Louisa Co., 4 mi. S. Cuckoo, V-19-26-1988. Malaise trap, J. Kloke & D.R. Smith. (1 ♀) Holotype and paratypes from



Figs. 1-6. 1, Antero-central portion of forewing of *Janus abbreviatus*. 2-6, Lancets. 2, *J. abbreviatus*. 3, *J. bimaculatus*. 4, *J. integer*. 5, *J. quercusae*. 6, *J. rufiventris*.

Maryland and Virginia in the National Museum of Natural History, Washington, D.C. Other paratype in the Southern Hardwoods Laboratory collection, Stoneville, Mississippi.

Host. — Injured stems have been observed on about two dozen trees in Mississippi, all Nuttall oak, *Quercus nuttallii*. They were not found on other *Quercus* species growing in the

Figs. 7-11. *Janus quercusae*. 7, Flagging shoot on *Q. nuttallii*. 8, Flagging shoot laterals, shoot tip already girdled and broken away. 9, Points of shoot girdling by larvae. 10, Adult exit holes in shoots. 11, Female. (Photographs by J.D. Solomon)

same area. Other oak species possibly of the red oak lineage may serve as hosts since the species is known from Maryland and Virginia which is well beyond the range of *Q. nuttallii*.

Biological notes — Flagging shoots of Nuttall oak (Fig. 7) were first observed in June, 1983, in Leland, Mississippi. A sample of infested stems was collected on June 27, and a single stem-boring sawfly larva was discovered in a gallery in each shoot. On this date, all the sample larvae had completed their feeding and were inside transparent cellophane-like cocoons within the galleries. Infested stems held in the laboratory failed to produce adults in 1983, but a single dead adult was found in the container in April, 1984. Infestations have been scarce since 1983. A small sample of injured branch ends collected on April 7, 1987, produced one adult on April 16, 1987. Mid- to late April appears to be the time of natural adult emergence in Mississippi since the earliest evidence of wilting and drooping oak stems was observed on April 19. Stem dieback begins in early May. Flagged shoots, although uncommon, have been most noticeable from about mid-May to mid-June. Soon afterward, the outer portions of flagged shoots break away (Fig. 8), leaving little evidence of infestation. Points of shoot girdling by larvae and adult exit holes are shown in Figs. 9, 10. Sawfly-injured stems have been observed only on young trees 2-12 m in height. There appears to be one generation a year.

DISCUSSION

Janus quercusae is probably most closely related to *J. rufiventris*. Both species attack oaks and both have structurally similar female lancets. The host of *J. rufiventris*, however, is *Quercus garryana* Douglas, a member of the white oak lineage (Hanson, 1986). The North American species of *Janus* are distinguished in the following key:

1. Forewing with two round black spots, one in cell 3Rs and one in cell 3M (base of vein R atrophied in ♂ (Fig. 1), complete in ♀; hindtibia with 2 preapical spurs) (Que., Ont. south to Va. west to Minn., Ill.) (lancet as in Fig. 3) ..... *bimaculatus* (Norton)
   Forewing hyaline or with one blackish spot below stigma 2
2. Forewing with one black spot below stigma (base of vein R complete; hindtibia with 2 preapical spurs) (Newf., Que. south to Va. west to B.C., Wash., Oreg., Iowa) (lancet as in Fig. 4) ..... *integer* (Norton)
   Forewing hyaline, without fuscous spots or only somewhat infuscated toward apex or along veins 3
3. Hindtibia with one preapical spur; forewing may be lightly infuscated near apex and along veins; abdomen entirely red (vein R of forewing complete) (Calif., Oreg.) (lancet as in Fig. 6) ..... *rufiventris* (Cresson)
   Hindtibia with 2 preacpical spurs; wings hyaline; abdomen with red band at center or near base, black at base and apex 4

4. Base of vein R of forewing atrophied near stigma (Fig. 1); abdomen of female with red band near base, only segments 2-3 and part of 4 red; hindcoxa orange; apical 2/3-3/4 hindtibia and entire hindtarsus black in female; hindbasitarsus only slightly shorter than remaining tarsal segments combined, as 3.0:3.3 (N.S., Que., Ont. south to Va., Miss. west to Alta., Oreg.) (lancet as in Fig. 2).....*abbreviatus* (Say)
Vein R of forewing complete, joined to stigma; at least segments 3-6 of abdomen red; hindcoxa mostly black on anterior surface; apical 2/3-3/4 hindtibia orange; hindtarsus brownish; hindbasitarsus about 2/3 length of remaining tarsal segments combined, as 2.2:3.0 (Md., Miss., Va.) (lancet as in Fig. 5) (male unknown)...*quercusae,* new species.

The hyaline wings and coloration of the body of *J. quercusae* are most similar to *J. abbreviatus,* thus it is most likely to be confused with that species. The features in the above key will separate the two, especially the complete vein R of the forewing in *J. quercusae.* The hindbasitarsus of *J. rufiventris* and *J. quercusae* are only about 2/3 the length of the remaining tarsal segments combined, whereas that of other species are only slightly shorter.

Two species from the Palearctic Region are known to feed on *Quercus, J. femoratus* (Curtis) of Europe and *J. kashivorus* Yano and Sato from Japan. Both differ in color from *J. quercusae,* especially in having an entirely black abdomen, and *J. kashivorus* has only one preapical spur on the hindtibia.

The lancets of all five North American species are illustrated here for the first time (Figs. 2-6). That of *J. bimaculatus* differs from the other four by the single-toothed serrulae; all others have double-toothed serrulae. The serrulae of *J. abbreviatus* are more truncate at their apices and do not appear distinctly double-toothed. The indentation posterior to the serrulae is deeper than the anterior indentation in *J. integer,* whereas each indentation is approximately the same depth in *J. rufiventris* and *J. quercusae.*

ACKNOWLEDGMENTS

We extend our appreciation to the following for reviewing the manuscript: H. Goulet, Biosystematics Research Centre, Agriculture Canada, Ottawa; W.W. Middlekauff, University of California, Berkeley; and J. Kingsolver and E.E. Grissell, Systematic Entomology Laboratory, U.S. Department of Agriculture, Washington, D.C.

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A NEW SPECIES OF *TRICHACIS* (HYMENOPTERA: PLATYGASTRIDAE) FROM TEXAS, ASSOCIATED WITH *SPHAERALCEA* (MALVACEAE)[1]

Matthew W. MacGown[2]

ABSTRACT: *Trichacis crossi* n. sp., associated with *Sphaeralcea* (Malvaceae) is described from Texas. This is only the fifth species of *Trichacis* to be associated with a definite host plant; it is related to *T. huberi* and *T. rufipes.*

Trichacis crossi n. sp. was reared from *Sphaeralcea anqustifolia* (Cav.) in Texas. The hosts for most of the fifteen nearctic species of *Trichacis* are unknown; *T. alticola* Masner is associated with *Populus, T. arizonensis* Ashmead with *Ephedra, T. celticola* Masner with *Celtis,* and *T. cornicola* Ashmead with *Cornus. Trichacis arizonensis* and *T. cornicola* were reared from galls of *Ephedra* and *Cornus,* respectively (Masner, 1983). *Trichacis crossi* is presumed to be parasitic on a cecidomyiid inhabiting *Sphaeralcea anqustifolia,* and was reared by Dr. William H. Cross as part of a study of alternative hosts for the boll weevil and its parasites.

Trichacis crossi MacGown, new species

Figs. 1-14

Female. Length 2.1 mm. Head and thorax black, the head with a reddish cast; abdomen and coxae dark reddish brown, fore legs bright yellow, mid and hind legs reddish brown; wings clear.

Head transverse (52:26), oval in top view; occiput smooth and shining medially, strongly reticulate and hairy at the sides; hyperoccipital carina distinct, with several fine, irregular striae just below; temples smoothly rounded; lateral ocellus slightly closer to eye than to anterior ocellus (8:11); space between lateral ocelli and eye, and lateral ocelli and anterior ocellus reticulate; area between lateral ocelli partly reticulate, the lateral ocelli bridged by aciculation; frons smooth and shining, the inner orbits with a thin line of sparse reticulation below; 4-5 fine striae curving above the antennal toruli and clypeal process; mandibles clasped, the teeth equal; relative length: width ratios of the antennomeres (A-I to A-X) (Fig. 5), measured from a paratype:

I	90:18	VI	14:16
II	25:11	VII	15:18
III	20:10	VIII	14:19
IV	16:11	IX	14:19
V	15:13	X	28:16

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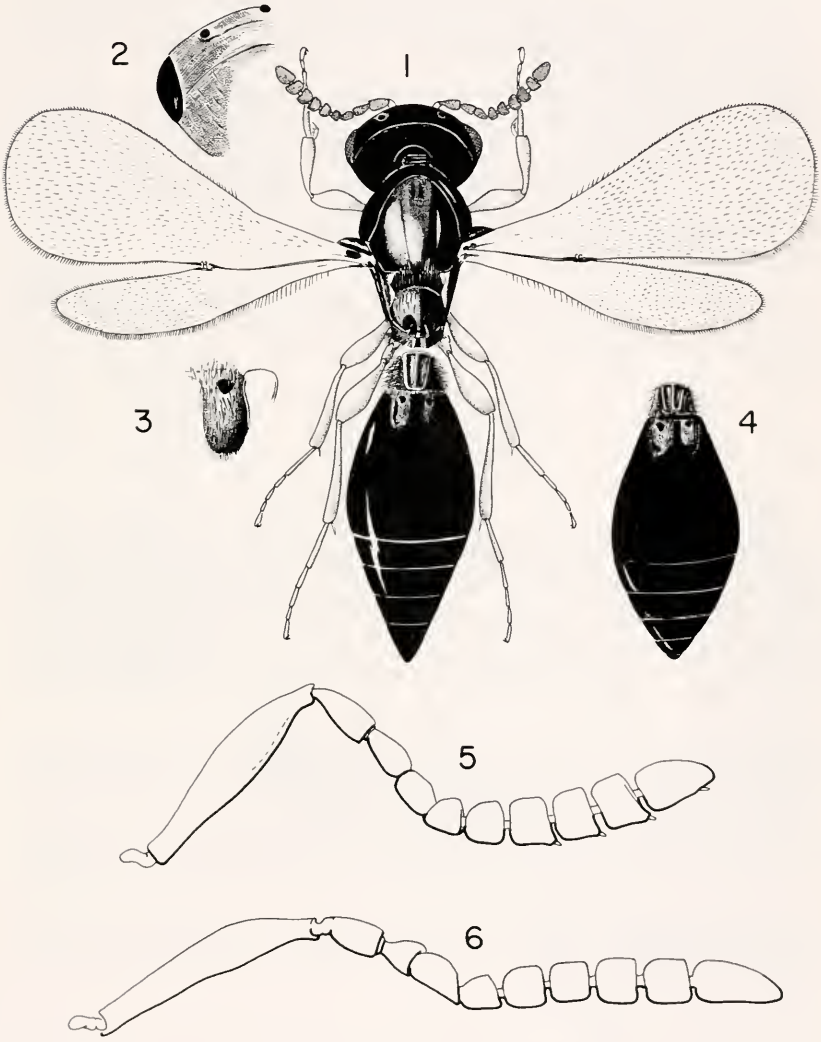


Figs. 1-6. *Trichacis crossi* n. sp. 1. Female, habitus. 2. back of head. 3. Basal foveolus. 4. Male abdomen. 5. Female antenna. 6. Male antenna.

Thorax narrower than head (45:50), somewhat elongate (65:45); notaulices abbreviated slightly before the anterior margin of the mesoscutum; median lobe of mesoscutum densely reticulate on the anterior third, smooth and shiny beyond; lateral lobes with only a thin line of dense reticulation in front, the rest smooth and shiny; prescutellar pit covered by long silvery pubescence; scutellum weakly convex, covered with long silvery pubescence; the specialized medial area heart shaped, with a dense brush of gray setae; forewings not reaching tip of abdomen.

Abdomen elongate and pointed, slightly more than twice as long as wide (118:50); abdominal tergite I (T-I) transverse (15:20), with a central keel in the median plate, the triangular sides broad and very hairy; tergite II elongate (55:48), basal foveoli deep and filled with fine silvery pubescence; middle plate narrow, smooth, ridged at the sides; tergite II apically with a band of fine punctures; tergites III to VI combined nearly as long as the width of tergite II (45:48), tergite III with a punctate band only at the apex, tergites IV to V punctate basally and apically, tergite VI punctate only basally; tergites-III to VI each with long silvery pubescence especially at the sides.

Male. Similar to the female, differing in the following characteristics: forelegs reddish brown, not yellow as in the female; relative length: width ratios of the antennomeres (Fig. 6), measured from a paratype:

I	85:16	VI	15:15
II	20:11	VII	15:15
III	15:12	VIII	15:17
IV	22:12	IX	16:17
V	14:12	X	32:15

Center of occiput depressed, not perfectly smooth, with faint concentric aciculation around the depression, sides of the occiput densely reticulate; hyperoccipital carina sharp; ocellar triangle almost thoroughly reticulated but still weakly aciculate between the posterior ocelli; curved striae above clypeal process and antennal toruli more numerous than in the female, the lower face not mirror-like but with vague transverse sculpture; thorax as in female; abdomen also as in female except shorter, not as pointed, abdominal tergite VII very small; tergites I and II essentially as in the female, middle plate of tergite II slightly more channeled at the edges.

Types. Holotype: female, "Texas, Presidio Co., 35 mi. upriver from Presidio, 14 July 67, W.H. Cross, #101.7; emerged from *Sphaeralcea anqustipennis* [lapsus for *anqustifolia*] 7/25-8/10/67" Deposited in the Mississippi Entomology Museum.

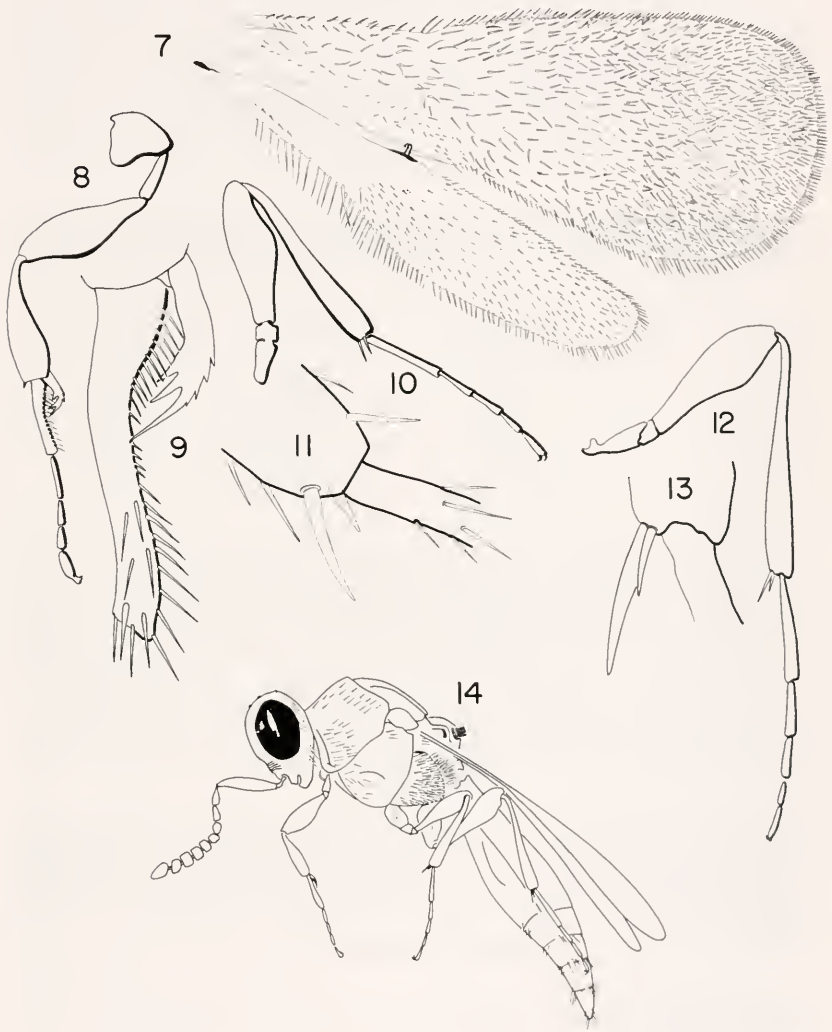
Paratypes: 26 females, 8 males with same data as holotype except with the numbers 101.1 to 101.7. Deposited in the Mississippi Entomology Museum, The U.S. National Museum, and the Canadian National Collection.

Other Specimens. Two other specimens, male and female, possibly the same species: "Texas, Presidio, Slack Bridge, 8-29-65, T.L. Chesnut"; condition of specimens too poor for certain identification.

Distribution. Known only from the types, Texas.

Biology. Presumably parasitic on a cecidomyiid inhabiting *Sphaeralcea anqustifolia* (Cavl.) (Malvaceae).

Variability. Some specimens are predominantly reddish brown



Figs. 7-14. *Trichacis crossi* n.sp. 7. Wings. 8. Foreleg. 9. Fore basitarsus. 10. Midleg. 11. Tip of midtibia. 12. Hindleg. 13. Tip of hind tibia. 14. Female, side view.

(possibly still somewhat teneral) except for the thorax, which remains black; striae above the antennal toruli are faint in some specimens; surprisingly, the occiput is not smooth medially in all specimens but some times has faint to moderately strong concentric aciculation, particularly in the males. In one male with aciculate occiput the middle lobe of abdominal tergite II is also faintly aciculate. This variation is comparable to that in other species of Platygastridae, in which the males are frequently more strongly sculptured than the females.

DISCUSSION

Trichacis crossi has characters intermediate to *T. huberi* Masner and *T. rufipes* Ashmead, and may be diagnosed by the following characters:

	crossi	*huberi*	*rufipes*
Legs:	yellow to light reddish brown	brown	yellow
A-VIII-IX:	transverse	quadrate	elongate
Punctation, T-III-VI:	weakly punctate	weakly punctate	densely punctate
Length, T-III-VI:	equal to width of II	shorter than width of II	shorter than width of II

Masner (1983) described *T. huberi* on the basis of a single female from California, noting that it had "considerably dark antennae and legs", and that it is a "remarkably melanic species", hence not fitting *crossi* at all in this respect, which has brightly colored legs and basal parts of the antennae and an overall reddish cast except for the thorax. Tergites III-VI of *T. rufipes* are thoroughly and densely punctate, whereas in *T. crossi* these tergites are at most crossed by basal and apical bands of fine punctures, leaving the middle smooth.

Etymology. This species is named after Dr. William H. Cross, founder and developer of the Mississippi Entomology Museum, and contributor of many hundreds of parasitic Hymenoptera, among thousands of other insects.

ACKNOWLEDGMENTS

I would like to thank Paul Marsh, USDA Systematic Entomology Laboratory, for sending *Trichacis rufipes* Ashmead for comparison; also R.L. Brown, T.E. Nebeker for reviewing the manuscript.

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RECORDS OF OWLFLIES (NEUROPTERA: ASCALAPHIDAE) FROM MISSISSIPPI, WITH A KEY TO SPECIES[1]

Paul K. Lago, Samuel Testa, III[2]

ABSTRACT: Mississippi records are presented for three species of owlflies (Neuroptera: Ascalaphidae): *Neuroptynx appendiculatus, Ululodes macleayanus,* and *Ululodes quadrimaculatus.* Comments on collecting and distribution within the state are provided along with a key for separation of the species.

Owlflies (Neuroptera: Ascalaphidae) are relatively large neuropterans that superficially resemble dragonflies. The long, clubbed antennae and densely pubescent head and thorax separate adults from the odonates, as well as from other North American Neuroptera. The Nearctic species are normally crepuscular and individuals are most often collected at various types of light traps. As a group, they cannot be considered common in Mississippi. We are aware of only one published record from this state, *Ululodes macleayanus* (Guilding) (as *Ululodes hageni* Weele) from Horn Island, Jackson County, by Richmond (1968).

Two genera of Ascalaphidae occur in America north of Mexico (Penny, 1981), and both are represented in the Mississippi fauna; however, for a variety of reasons, the species of Ascalaphidae have long been in a state of taxonomic confusion. Recently, Shetlar (1977) studied the Nearctic species and attempted to stabilize their nomenclature. Unfortunately, his work has not been published. The following key, adapted from Shetlar (1977), will separate the three species of owlflies occurring in Mississippi.

Specimens examined during this study are primarily housed in the Mississippi Entomological Museum (MEM) at Mississippi State University, and in the insect collection at the University of Mississippi (UM). Additional specimens were provided by Bill Stark (BS), Mississippi College. Bryant Mather (BM), Clinton, kindly provided owlfly records from his collection (O.S. Flint, Jr. determinations). Shetlar (1977) examined a few Mississippi specimens from the collections at Cornell University (CU), Purdue University (PU), University of Kentucky (UK), and the U.S. National Museum (USNM). These records are included herein and are indicated by the appropriate collection abbreviations given above.

[1]Received July 5, 1988. Accepted August 5, 1988.

[2]Department of Biology, University of Mississippi, University, MS 38677.

Key to the Mississippi Species of Ascalaphidae

1. Eyes entire, not divided by a transverse sulcus (Fig. 1); wings petiolate, forewing with appendiculate projection on posterior margin near base (Fig. 2); hind wing never incised in anal area; forewing length 32-44mm ..... *Neuroptynx appendiculatus* (Fabricius)

1′ Eyes divided by a transverse sulcus (Fig. 3); wings not appendiculate; forewing length 25-33mm 2

2. Both pairs of wings with the pterostigmas, or at least the veinlets of the stigmas, dark brown to black; hind wings never notched in posterior basal region (Fig. 4), forewing length 25-28mm ..... *Ululodes macleayanus* (Guilding)

2′ Pterostigmas white or cream colored; hind wings of males with a wide notch at the posterior basal region (Fig. 5), hind wings of female not notched, but often maculate (fig. 6); forewing length 28-33mm ..... *Ululodes quadrimaculatus* (Say)

Neuroptynx appendiculatus (Fabricius, 1793: 96)

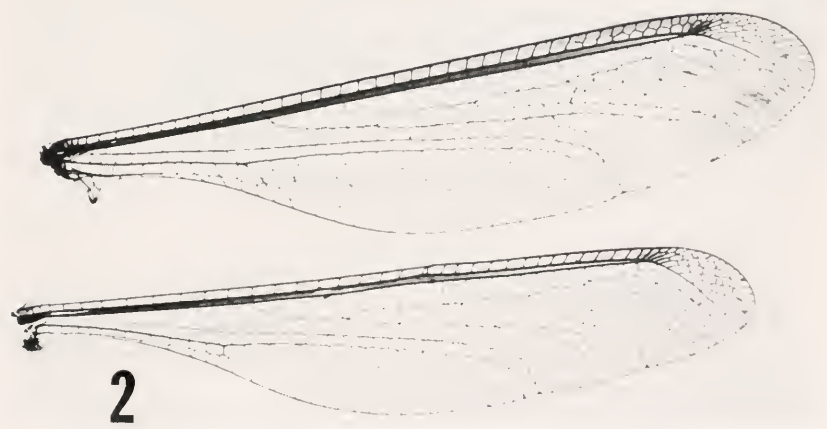
(Figs. 1, 2)

The generic name used for this species has been subject to some confusion (Shetlar, 1977), both *Ascaloptynx* Banks (1915) and *Neuroptynx* McClendon (1906) appearing in recent literature. Shetlar (1977) discussed the problem in some detail and concluded that *Neuroptynx* was the oldest available name, and considered it the valid name for the genus.

This is the largest species of owlfly in Mississippi. Though collection sites are scattered throughout the state, records are lacking from several large areas. We have no records from the Yazoo Delta, the east-central region, or the southwestern counties, and this is probably due to the lack of specific collecting activity. Specimens are apparently not attracted to light. The only collecting notes we have for this species are for specimens flushed from resting places during daylight hours and caught with a standard insect net. Resting places were typically bare stems of tall weeds and shrubs in wooded areas.

Mississippi Records

FORREST CO., 2 mi S McLaurin, 28 May 1987, P.K. Lago, (UM). GREENE CO., 10.5 mi WSW Leakesville, 27 May 1987, P.K. Lago, (UM); 7.5 mi S State Line, 16 Jun 1987, P.K. Lago, (UM). HARRISON CO., 7 mi E Saucier, 18 Jun 1987, P.K. Lago, (UM); Biloxi, 1 Aug 1964, Taylor. (BM) HINDS CO., Clinton, 7 June 1982, B.P. Stark, (BS); Forestry Station, 9 Jun 1987, B.P. Stark, (BS). JACKSON CO., 11 mi N Van Cleave, 5 Jun 1984, R. Brown *et al.*, (MEM). LAFAYETTE CO., Oxford, 1 Jul 1979, P.K. Lago, (UM) OKTIBBEHA CO., Sturgis, 3 Jun 1974, C. Bryson, (MEM). PERRY CO., 4 mi SW New Augusta, 22 May 1987, P.K. Lago, (UM); 4.5 mi WSW New Augusta, 24 May 1987, P.K. Lago, (UM); 5 mi WSW New Augusta, 24 May 1987, P.K. Lago, (UM). PONTOTOC CO., Camp Yocona, 8 Jun 1972, Bryson, (BM); Randolph, 5 Jul 1979, J. Goddard, (UM), T9S-R2E-SEC. 19, 12 Jun 1978, P.K. Lago, (UM). RANKIN CO., Cleary, 1 Jun 1987, W.C. Northern, (UM). WEBSTER CO., 2 mi S Cumberland, 31 May 1971, C. Bryson, (MEM); Cumberland, 25 May 1972, C. Bryson, (MEM). SPECIMENS EXAMINED: 27.



Figs. 1 and 2. *Neuroptynx appendiculatus*. 1, lateral aspect of head. 2, dorsal aspect of wings.

Ululodes macleayanus (Guilding, 1825: 140)

(Figs. 3, 4)

Ululodes macleayanus is widely distributed in Mississippi, but collection records are lacking for the central Yazoo Delta, the extreme north-east, and most southwestern counties. "Black light traps" and "artificial light" are the only specific collection notes we have for this species.

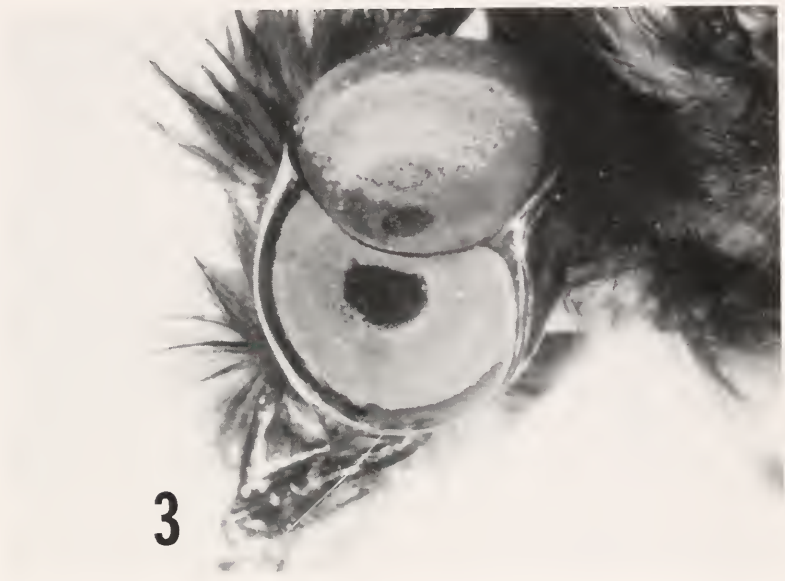
Mississippi Records

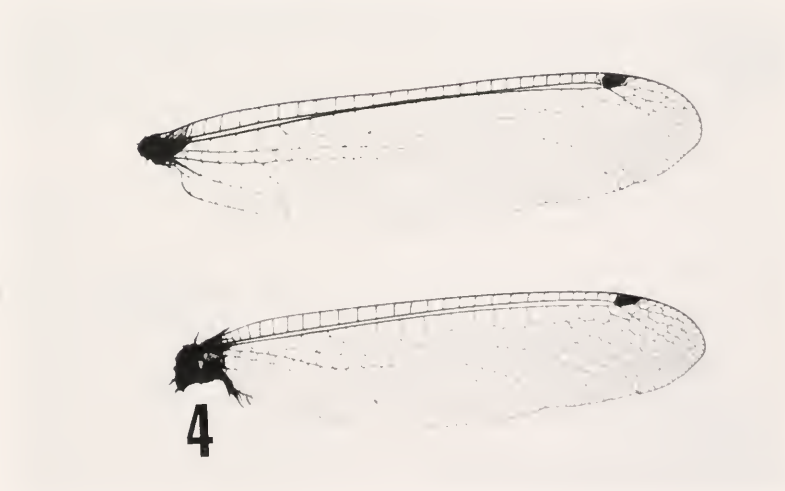
ADAMS CO., Natchez, 11 Aug 1982, A.E. Zuccaro, Jr., (UM). BOLIVAR CO., Great River Road State Park, 19 Jun 1986, S. Testa (UM); 2 mi W Rosedale, 23 Aug 1980, 19 Jun 1981, P.K. Lago, (UM). CLAIBORNE CO., Sand Creek, 4 Jun 1981, A. Kirk, (BS). FORREST CO., 6 mi WSW McLaurin, 23 Jun 1987, P.K. Lago, (UM); HANCOCK CO., Pt. Clear Island, 24 Jun 1986, 12 Aug 1986, P.K. Lago, (UM). HARRISON CO., Pass Christian, 10 Jul 1982, B. Stark, (BS) Biloxi, 30 May 1964, B. Mather, (USNM). HINDS CO., Jackson, 28 Jul 1978, B.P. Stark, (BS); Ridgeland, 12 Jul 1984, G. Burrows, (MEM). JACKSON CO., Orange Grove, 10 Jul 1934, M. Griffith, (UK). LAFAYETTE CO., Oxford, 20 Jun 1977, A.E. Zuccaro, Jr., (UM), Oxford, 13 Jul 1977, 29 Jun 1980, 9 Jun 1987, P.K. Lago, (UM); Oxford, 1 Jun 1986, M.C. Beiser, (UM); Oxford, 21 Jun 1976, G. Lee, (UM), LAMAR CO. Lumberton, 5 Jul 1927, G.F. Arnold, (MEM). MARSHALL CO., T3S-R3W-SEC. 13, 20 Jul 1978, S. Hurdle, (UM). NEWTON CO., Roberts, 20 Jul 1969, 10 Aug 1969, W.I. Luke, (MEM) OKTIBBEHA CO., Starkville, 6 Jun 1982, 9 Jun 1982, W.H. Cross, black light (MEM); Starkville, 9 Jul 1979, P. Ramey, artificial light (MEM); Agr. College, 2 Jun 192(?), (no collector given), (MEM); Agr. College, 12 Jun 1921, I.F. Hyde, (MEM); Agr. College, 22 Jun 1921, G.D. Ratliff, (MEM); Agr. College, 11 Jul 1921, J.A. Welch, (MEM); Agr. College, Jun 1922, J.L. Murff, (MEM); Agr. College, (no date), (no collector given), (MEM); (No locality given), 1 Jul 1969, 1 Jun 1964, 13 Jun 1964, 4 May 1967, 20 Jun 1964, 4 Jun 1965, J.R. McCoy, (MEM). PANOLA CO., 4 mi ENE Como, Jul 1979, W.P. Scott, lt. (MEM); Sardis Lake Reservoir, 2 Aug 1972, J. Spain, (UM). SIMPSON CO., Mill Creek @ Hwy 472, 2 Jun 1986, B. Stark, (BS). WARREN CO., Bovina, 2 Jun 1976, B. Mather, (BS); Vicksburg, 13 Jul 1987, 16 Jul 1972, 2 Jul 1987, 21 Aug 1984, (BM); 21 Jun 1977, (BS); 9 Jul 1987, B. Mather, (BM) WASHINGTON CO., Wayside, 20 Jul 1966, B. Mather, (USNM). *(County not determined),* Stoney, 20 Sep 1954, (no collector given), (PU). SPECIMENS examined: 66.

Ululodes quadrimaculatus (Say, 1824: 305)

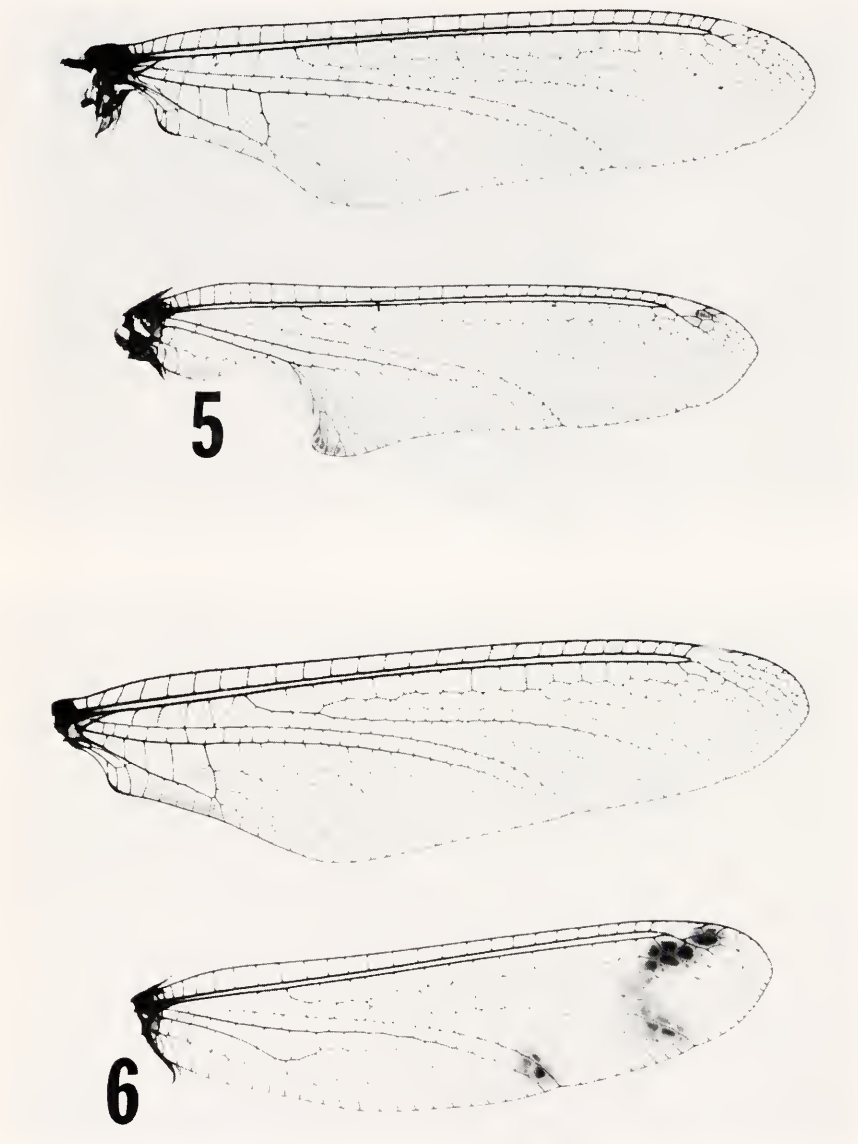
(Figs. 5, 6)

The distribution of Mississippi records for this species is very similar to that of *U. macleayanus.* Individuals of *U. quadrimaculatus* are commonly attracted to black light. We have also collected them during daylight hours from resting places. The resting position is head-down, abdomen protruded at about a 45 degree angle, on barren twigs. The insects may be mistaken for short twigs by the casual observer. In this position, the wings are held against the substrate.





Figs. 3 and 4. *Ululodes macleayanus*. 3, lateral aspect of head showing transverse ocular sulcus. 4, dorsal aspect of wings.



Figs. 5 and 6. Wings of *Ululodes quadrimaculatus*. 5, male. 6, female.

Mississippi Records

FORREST CO., Hattiesburg, 11 Jun 1917, J.W. Champlin, (MEM); P.B. Johnson State Park, 23 Jun 1986, P.K. Lago, (UM). HARRISON CO., Biloxi, 1 Aug 1964, Taylor, (BM); Biloxi, 4 Jul 1964, Taylor, (BM); Gulfport, 1 Jul 1926, K. Harmon, (MEM). HOLMES CO., Holmes Co. State Park, 1 Jul 1986, S. Testa, (UM). JACKSON CO., Gulf. Isl. Natl. Sea., 3-6 Jun 1984, R. Brown *et al.* (MEM). LAFAYETTE CO., 5 mi E Oxford, 27 Jul 1977, 6 Aug 1977, D.F. Stanford, (UM); 11 mi NW Oxford, 25 Jul 1978, H.L. Schuster, (UM); 6 mi ENE Oxford, 15 Jul 1986, S. Testa, (UM); 7 mi S Oxford, 13 Jul 1987, P.K. Lago, (UM); Oxford, 15 Jun 1976, G. Lee, (UM); Oxford, 13 Jul 1977, D.F. Stanford, (UM); Oxford, 27 Aug 1986, S. Testa, (UM); Oxford, 27 Jul 1984, 30 Aug 1976, 10 Jun 1977, 11 Jul 1978, 15 Aug 1978, 17 Aug 1978, 2 Jul 1980, 24 Jul 1981, 25 Jul 1978, 29 Jul 1979, 30 Jul 1978, 4 Aug 1980, 4 Jul 1978, 7 Aug 1981, P.K. Lago, (UM); U.M. Campus, 3 Aug 1978, S. Hurdle, (UM); T7S-R4W-SEC. 24, 17 Jul 1978, D.F. Stanford, (UM), (no locality given), Jun-Jul, 1967, S.R. Foster, (UM). LAMAR CO., 3.5 mi NNE Baxterville, 27 Jun 1986, S. Testa, (UM). MARION CO., Lake Columbia, 27 Jun 1986, S. Testa, (UM). NEWTON CO., Roberts, 20 Jul 1969, W.I. Luke, (MEM). OKTIBBEHA CO., 10 mi W Starkville, 1 Jul 1986, 4 Jul 1985, 9 Jul 1986, G. Head, (MEM); 6 mi SW Starkville, 12 Sep 1984, R.L. & B.B. Brown, (MEM); Additon, 26 Aug 1968, Mrs. Crumpton, (MEM); Dorman Lake, 29 Aug 1981, W.H. Cross, (MEM); Starkville, 2 Jun 1985, R.L. Brown, (MEM); Starkville, 20 Jun 1985, G. Head, (MEM); Starkville, 24 Jul 1981, 25 Jul 1981, 8 Aug 1981, W.H. Cross, black light, (MEM); Starkville, Oct-Sep 1985, R. Altig, (MEM). STONE CO., Perkinston, 26 Jun 1986, P.K. Lago, (UM); UM Forestlands, 12 Jun 1987, P.K. Lago, (UM); UM Forestlands, 26 June 1986, S. Testa, (UM). WARREN CO., Vicksburg, 10 Aug 1983, B. Mather, (BM). WASHINGTON CO., Stoneville, 7 Jul 1986, P.O. Leary, (MEM); Stoneville Exp. Sta., 1-7 Aug 1986, R.E. Furr, JR., (MEM). YALOBUSHA CO., 5 mi SW Coffeeville, 17 Jul 1986, P.K. Lago, (UM). SPECIMENS EXAMINED: 68.

ACKNOWLEDGMENTS

We wish to thank the following individuals who allowed us to examine specimens in their care, or provided records of Mississippi owlflies: R.L. Brown (Mississippi State University); B.P. Stark (Mississippi College); B. Mather (Clinton, MS). P.A. Adams and N.D. Penny reviewed this manuscript and offered valuable criticisms and suggestions. Bill Martin produced the wing photographs.

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A NEW NEOTROPICAL SPECIES OF THE GENUS *HYADINA* (DIPTERA: EPHYDRIDAE)[1,2]

Philip J. Clausen[3]

ABSTRACT: A new species of *Hyadina* from the Neotropical Region is described.

I prefer to publish single species descriptions only when a new species is discovered subsequent to a revision of the genus in which it is to be placed. However, during the course of my current revision of the genus *Hyadina* for the Neotropical Region, Dr. Wayne N. Mathis of the National Museum of Natural History (USNM) collected a long series of specimens of a new species from Wee Wee Cay in Belize, and for his work, has requested a name for this species as soon as possible. Consequently, I am offering the following description without a key. A complete key to this and numerous other new species, as well as the existing species, will be presented later, when the generic revision is completed.

Hyadina bulbosa n. sp.

MALE. Total body length 1.84 to 2.01 mm; shiing black with greyish, silvery, golden and coppery pruninosity.

Head shining black with sparse golden to coppery pruinosity except as noted; length 0.37 to 0.41 mm; 3 very small orbital setae; 1 large pair of convergent inner vertical setae; outer vertical setae absent; vertex shining black with sparse golden to coppery pruinosity above and below; gena black with dense grayish to silvery pruinosity. Face shining brownish to black with sparse golden to coppery and grayish pruinosity; parafacial setae in 2 rows, 4 or 5 upward and outward curved outers, 4 convergent and decumbent inners. Clypeus brown with golden to grayish pruinosity, palpi yellowish. Antenna variable, yellowish to brownish to black except ventral half of segment 3 yellowish, arista brownish to black, all with golden to coppery pruinosity.

Thorax shining black with sparse golden to coppery pruinosity, faint grayish stripes between acrostichal and dorsocentral setal rows; scutum length 0.54 to 0.58 mm; humerus with sparse coppery pruinosity; 1 large and 0 to 3 small mesopleural setae. Scutellum shining black with sparse golden to coppery pruinosity; apical scutellar setae very large, lateral scutellar setae small; length 0.20 mm.

Legs reddish to yellowish, except base of coxae and 2 apical tarsal segments brown to black, all with grayish pruinosity; apex of mesothoracic tibiae with a large black spur and 2 to 4 small black anterior setae.

Wing clear to very slightly clouded with brown, not darkened at crossveins, without whitish spots; veins and all crossveins brown; length from humeral crossvein 1.43 to 1.60 mm; width 0.61 to 0.71 mm; distance from h to R_1 0.31 to 0.34; R_1 to R_{2+3} 0.42 to 0.58 mm;

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[2]Paper No. 16,142, Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul, Minnesota 55108.

[3]Department of Entomology, University of Minnesota St. Paul, Minnesota 55108.

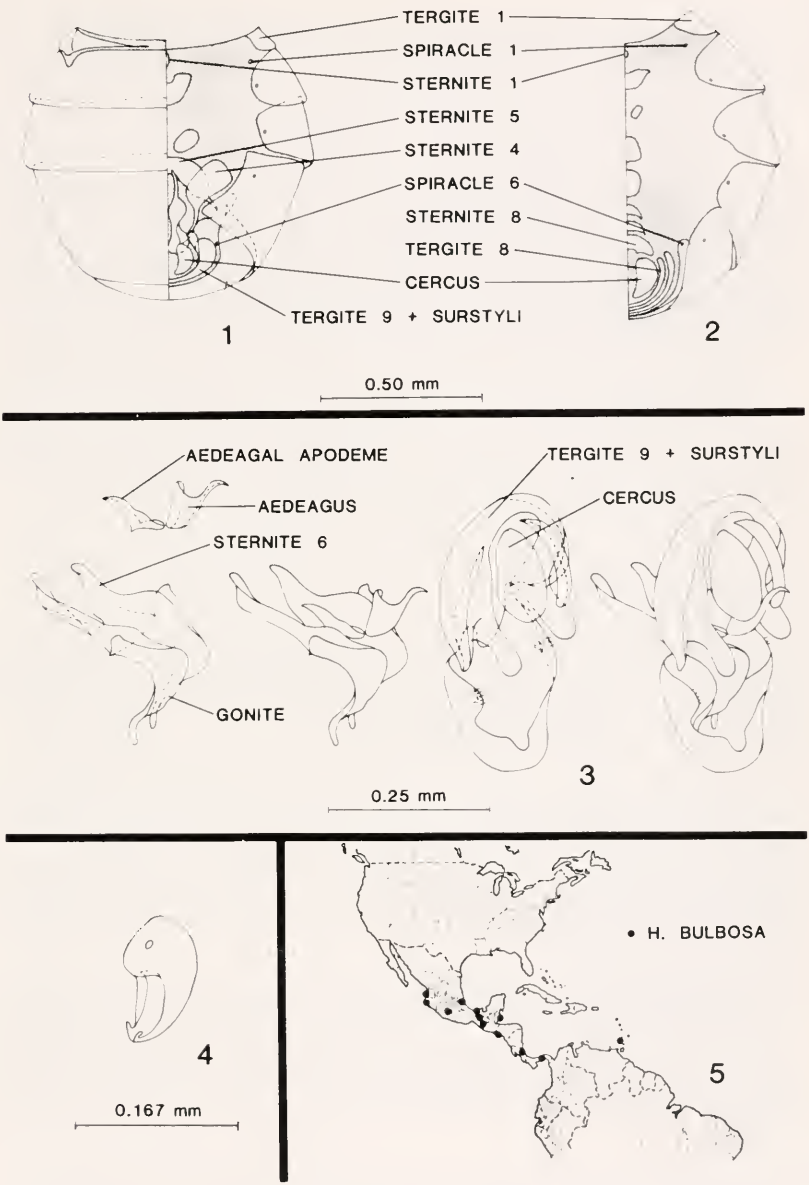

Fig. 1. *Hyadina bulbosa* Clausen. Male abdomen. Fig. 2. Female abdomen. 3. Male genitalia. 4. Ventral receptacle. Fig. 5. Distribution map.

R_{2+3} to R_{4+5} 0.68 to 0.71 mm; R_{4+5} to M_{1+2} 0.17 to 0.20 mm; length R_{4+5} 1.02 to 1.12 mm; length M_{1+2} 0.75 to 0.85 mm; costal section from R_1 to R_{2+3} 0.57 to 0.85 times distance from R_{2+3} to R_{4+5}; halteres light yellow to whitish, sometimes slightly darker apically.

Abdomen as in Fig. 1; shining black with sparse golden to coppery pruinosity, scattered long yellow setae dorsally, without dorsal wrinkles; tergite 4 with extended, angular anterior and posterior margins; tergite 5 with extended and rolled anterior projection lying beneath extended posterior angle of tergite 4; stenite 4 consisting of 2 large lateral fragments, each bearing a long, slender, curved, pointed posterior projection; and large, pouch-like, sternite 5 into which fit the tips of the gonites.

Genitalia (Fig. 3). Note tergite 9 + surstyli with short, small, apically rounded surstyli without significant setae; gonites large, long, curved, pointed, with bulbose median area; gonal arch incomplete; aedeagus short, curved, and pointed apically.

FEMALE: Total body length 1.90 to 2.24mm. Head, thorax, legs, and wings as in males except as follows:

Head length 0.41 to 0.48 mm; parafacial setae in 2 rows, 3 to 5 outers, 3 or 4 inners.

Thorax with scutum length 0.58 to 0.68 mm; scutellum length 0.20 to 0.24 mm. *Wing* length from humeral crossvein 1.67 to 1.77 mm; width 0.68 to 0.78 mm; distance from h to R_1 0.37 to 0.41 mm; R_1 to R_{2+3} 0.54 to 0.61 mm; R_{2+3} to R_{4+5} 0.71 to 0.75 mm; R_{4+5} to M_{1+2} 0.17 mm; length R_{4+5} 1.16 to 1.26 mm; length M_{1+2} 0.88 to 0.95 mm; costal section from R_1 to R_{2+3} 0.72 to 0.86 times distance from R_{2+3} to R_{4+5}.

Abdomen as in Fig. 2. Ventral receptacle as in Figl. 4.

Distribution: Central America from Mexico to Panama and the West Indies (Fig. 5).

Specimens Examined: 122 specimens (58 ♂♂ and 64 ♀♀), including the types, from Belize, Costa Rica, El Salvador, Mexico, Panama, and West Indies (Grenada). Collected most months of the year except January, February, July, September, and December.

Types: Holotype ♂ and 28 paratypes (12♂♂ and 16 ♀♀) from Wee Wee Cay, Stann Creek Dist., Belize, 6-9 November 1987, W.N. and D. Mathis. The holotype and 26 paratypes are deposited in the collection of the National Museum of Natural History, Washington, D.C., and the remaining 2 paratypes (1 ♂ and 1 ♀) are deposited in the collection of the University of Minnesota.

Diagnosis: Wings with all crossveins brown; head with 1 large pair of vertical setae (inners large and convergent, outers absent), legs reddish to yellowish, except base of coxae and 2 apical tarsal segments brown to black; *male* abdomen and genitalia as in Figs. 1 and 3, note gonites with bulbose median area; *female* abdomen and ventral receptacle as in Figs. 2 and 4.

NEW RECORDS FOR *TORTOPUS INCERTUS* (EPHEMEROPTERA) IN MISSISSIPPI AND NOTES ON MICROHABITAT REQUIREMENTS[1,2]

S.S. Knight, C.M. Cooper[3]

ABSTRACT: Specimens of the burrowing mayfly *Tortopus incertus*, typically considered an inhabitant of clay banks in large rivers, were collected in Otoucalofa Creek, a small bluff line stream in Calhoun, Lafayette, and Yalobusha Counties, Mississippi. Intensive reconnaissance of major stream reaches revealed three *T. incertus* colonization sites which represent a major habitat extension and suggest that the size of the stream is less important than the hard clay substrate needed for the construction of burrows. Greater instability of physical characteristics of small streams compared to rivers also indicates tolerance of *T. incertus* to larger environmental fluctuations than previously documented.

During routine sampling of macroinvertebrates on Otoucalofa Creek, two burrowing mayflies of the family Polymitarcidae were discovered in a kick sample taken near Water Valley, Mississippi. These mayflies, identified as *Tortopus incertus* (Traver), have been described by several authors as restricted to hard clay banks of large rivers (Scott *et al.* 1959, McCafferty 1975, Edmunds *et al.* 1976, Unzicker and Carlson 1982, and Edmunds 1984). Otoucalofa Creek is a highly erosive second order stream in the bluff line hills of northern Mississippi and is currently undergoing bank stabilization modifications as a part of a Demonstration Erosion Control Project (DEC) in the Yazoo Basin. Preliminary ecological surveys described Otoucalofa Creek as a small sandy bottomed stream 27 km long. With a width ranging from 0.5 to 8 m and a base flow water depth of 0.1 to 1 m, the creek is distinctly different from the habitat previously described for *T. incertus*. In Mississippi, *T. incertus* has been collected in the Tombigbee River (Monroe County), Bull Mountain Creek at its confluence with the Tombigbee River (Itawamba County), the Leaf River (Lawrence County), the Pearl River, and Bogue Chitto (Pike County) by C.D. Hynes (Scott *et al.* 1959). This mayfly has also been commonly found in clay banks of the Mississippi River (Beckett *et al.* 1983). *T. incertus* has never been reported from small shallow streams. Since discovery of *T. incertus* in Otoucalofa Creek suggested possible new microhabitat criteria, a closer investigation of Otoucalofa

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[2]Contribution of the Sedimentation Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Oxford, MS

[3]Ecologists, U.S. Department of Agriculture, Agricultural Research Service, Sedimentation Laboratory, Oxford, Mississippi 38655.

Creek was needed to determine the extent of *T. incertus* colonization and its environmental requirements.

METHODS

Otoucalofa Creek is typical of most Mississippi bluff line streams in that it is a shallow high gradient stream with more than 95 percent of the bottom substrate consisting of sand or gravelly sand. Approximately 75 percent of the stream has been subjected to channelization within the past 30 years and about 30 percent of its length is devoid of vegetative canopy. Areas of hard clay substrate are occasionally found in the headwaters of the stream's main channel and in tributaries where the depth is usually 3 to 10 cm.

Macroinvertebrates were collected during spring and fall in 1985 and 1986 on Otoucalofa Creek and its tributaries. A general benthos survey was made to compile a list of species, population sizes and habitat preference. Sampling techniques included kick samples, grab samples, snag samples, leaf pack collections and Surber or Hess samples so that all major habitat types could be examined. After initially finding *T. incertus* in a kick sample, 15 cm by 15 cm scoop samples were also included so that hard clay areas could be sampled quantitatively. Otoucalofa Creek and its tributaries were divided into 16 sections representing stream reaches with similar characteristics such as substrate, channel depth, channel width, current or water depth. Each reach was sampled with a minimum of three techniques and at least 2 samples per technique. Physical and chemcial parameters were measured at selected sites to provide water quality data. Measurements of water depth, current and substrate type were also made at each sample site.

RESULTS AND DISCUSSION

Three areas in Otoucalofa Creek watershed supported populations of *T. incertus* (Fig. 1). These areas were all in the upper half of the watershed and had similar physical characteristics. All three habitats were composed of hard clay substrates, with a minimum flow of 30 cm/sec and a maximum baseline depth of 5 cm. These habitats are typically sites of channel degradation where unconsolidated materials have been eroded down to hard clay strata.

Water quality immediately downstream of the collection sites was typical of northern Mississippi bluff line streams (Table 1). The yearly mean pH for Otoucalofa collection sites was 6.4 with a range of 5.4 to 7.4. These mean values were lower than 6.8, the established lower limit for *T.*

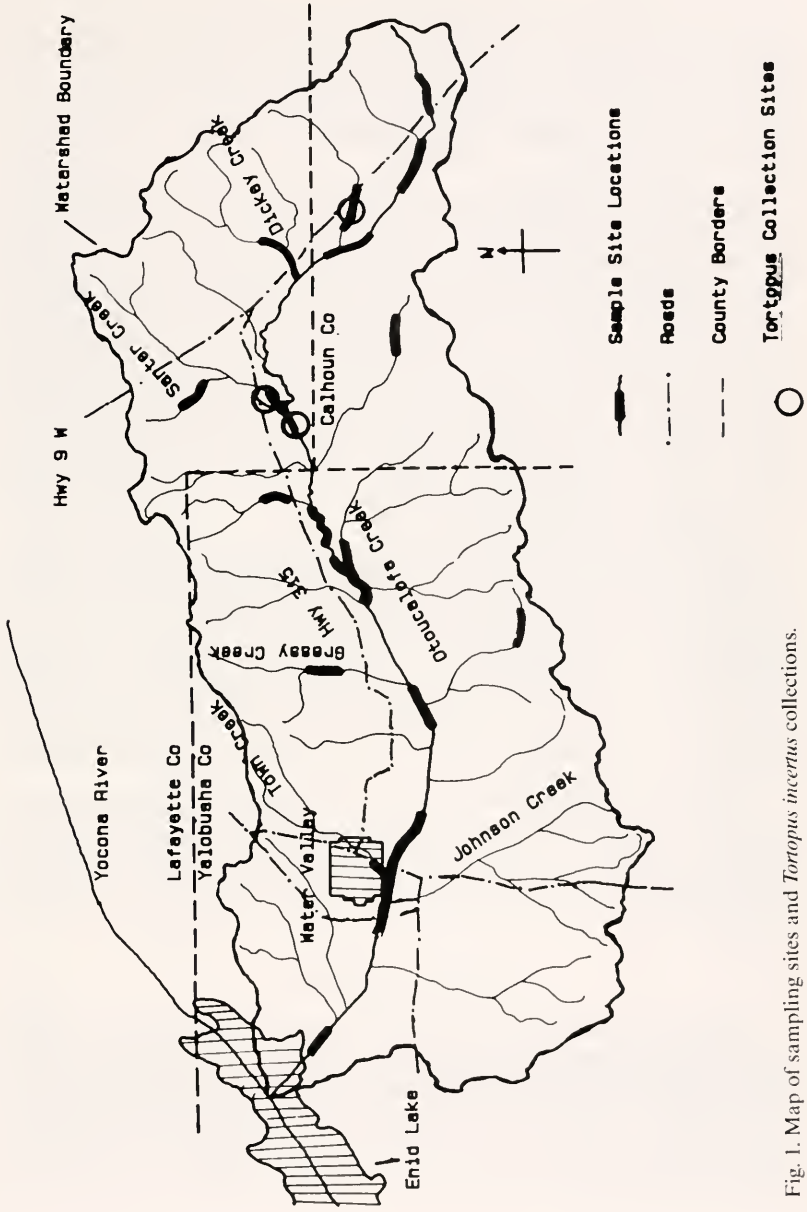

Fig. 1. Map of sampling sites and *Tortopus incertus* collections.

incertus habitat. Average ammonia concentrations of 0.147 mg/L was over 7 times higher on Otoucalofa Creek than the published average of 0.02 mg/L ammonia (Hart and Fuller, 1974) for *T. incertus*. Tsui and Peters (1975) in a study of embryonic development of *T. incertus* found that most rapid morphogensis and earliest hatches occurred at temperatures around 19.5°C. Otoucalofa Creek averaged 18.6°C with a range of 1.2 to 26.9°C.

Densities of *T. incertus* were calculated to be 89 organisms per m^2 on Otoucalofa Creek based on 18 individuals recovered from 9 samples (Table 2). This density is considerably less than 3125 organisms per m^2 reported from the Savannah river by Scott *et al.* (1959). Scott *et al.* (1959) suggested that *T. incertus* may move from burrow to burrow as water level changes. Our study supports this hypothesis since there are numerous exposed burrows above the water level. The locations on Otoucalofa Creek where hard clay substrates are found are usually high energy areas where dramatic erosional processes have scoured down to clay sills, thus suggesting that *T. incertus* nymphs are tolerant of adverse conditions found in small high energy streams and that they colonize hard clay habitats as they become available.

Although it is true that rivers vary in physical and chemical characteristics over an annual cycle, the magnitude of variation is not as great as in small streams specifically in regard to small storm flow events and low flow depths. Depths at the collection sites on Otoucalofa Creek have varied from 5 cm to 3.5 m within a 12 hour period and total solids have been measured that were 1439 mg/L greater than the yearly average of 48 mg/L. Vertical river banks accumulate some silt; however, some clay bottomed areas of Otoucalofa creek are covered with as much as 1 m of sand during 24 hour storms.

T. incertus nymphs have been found in large rivers at depths greater than 2 ft (60.9 cm) and are usually associated with vertical channel banks (Scott *et al.* 1959). In Otoucalofa Creek nymphs were collected predominantly on the horizontal portions of the stream bed at a maximum depth of 5 cm.

CONCLUSIONS

T. incertus is typically considered an inhabitant of clay banks of large rivers but the discovery of *T. incertus* colonies in a small highly erosive stream suggests that the size of the stream is less important than the hard clay substrate needed for burrow construction. Greater instability of physical characteristics of small streams when compared to rivers also indicates the tolerance of *T. incertus* to a wide range of environmental

Table 1. Water quality parameters downstream of *Tortopus incertus* collection sites.

Parameter	Annual Mean	Range	Units
Temperature	18.6	(1.2 - 26.9)	°C
Conductivity	44	(32 - 58)	umhos/cm^2
Dissolved Oxygen	9.7	(7.6 - 12.1)	mg/L
pH	6.4	(5.4 - 7.4)	
Total Solids	133	(54 - 1886)	mg/L
Dissolved Solids	49	(38 - 63)	mg/L
Suspended Solids	85	(0 - 1845)	mg/L
Filterable Ortho Phosphorus	0.01	(0 - 0.30)	mg/L
Total Ortho Phosphorus	0.02	(0.01 - 0.41)	mg/L
Total Hydrolyzable Phosphorus	0.06	(0.01 - 0.52)	mg/L
Total Phosphorus	0.07	(0.02 - 0.62)	mg/L
Nitrate Nitrogen	0.07	(0.01 - 0.80)	mg/L
Ammonia Nitrogen	0.15	(0.01 - 2.65)	mg/L

Table 2. Colony size, sample number, numbers of individuals collected and density estimates for *Tortopus incertus* collected from Otoucalofa Creek, Mississippi.

Site	Colony* Size	Sample Number	Individuals Collected	Density Nos./m^2
1	15 m^2	1	4	177.7
1	15 m^2	2	2	88.8
1	15 m^2	3	1	44.4
1	15 m^2	4	1	44.4
2	5 m^2	1	2	88.8
2	5 m^2	2	4	177.7
2	5 m^2	3	1	177.7
3	1.5 m^2	1	3	133.3
3	1.5 m^2	2	0	0.0
Total		9	18	
Mean				88.8

*Areas of colonization were determined by measuring inundated hard clay surface with visible burrows. These areas change in size as water levels vary seasonally as indicated by the number of "dry" burrows exposed on the bank.

conditions. As suggested by Scott *et al.* (1959), our study showed that *T. incertus* may drift or migrate to more suitable habitat when conditions deteriorate. Water quality parameters measured at collection sites were found to cover a broader spectrum of physical and chemical conditions than have been previously reported (Hart and Fuller, 1974). These conditions, unlike fluctuating water levels, are inescapable via migration or drift. *T. incertus* may have been missed in earlier collections from small streams because clay substrates that are necessary for burrow construction occur infrequently in many streams and are difficult to sample.

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NEW RECORDS OF *SIALIS* (MEGALOPTERA: SIALIDAE) FROM ARKANSAS AND OKLAHOMA[1,2]

David E. Bowles[3]

ABSTRACT: *Sialis joppa* is reported from Arkansas and Oklahoma and *S. vagans* from Oklahoma for the first time. These records extend the range of the former to approximately 95° longitude. Distribution records for other *Sialis* spp. in the two states are provided.

Recent collections of Megaloptera from Arkansas and Oklahoma have produced new state records for the genus *Sialis* Latrielle. *Sialis vagans* Ross was previously recorded from 20 states and four Canadian provinces (Flint 1964; Ross 1937; Stark and Lago 1980; Tarter 1988; Tarter *et al.* 1978), including Arkansas, Kansas and Mississippi. The species has now been collected from Latimer County in eastern Oklahoma. *Sialis joppa* Ross, a common species in the eastern United States (Flint 1964; Ross 1937; Tarter and Woodrum 1973; Tarter *et al.* 1978), is generally not known west of 90° longitude (Canterbury 1978). However, Tarter *et al.* (1978) reported the species from southeastern Louisiana at approximately 91° longitude. The author's collections of *S. joppa* from western Arkansas and eastern Oklahoma extends the known western distribution boundary for the species to approximately 95° longitude. Collection data for *S. joppa* and *S. vagans* from Arkansas and Oklahoma and additional alderfly distributional records for the two states are presented below.

Specimens Examined

Sialis joppa. ARKANSAS: Crawford County, NE 1/4, Sec. 17, T 12 N, R 32 W, Ozark Natl. For., 16 April 1988, D.E. Bowles; 1 male, 3 females. Montgomery County, Ouachita Natl. For., near Little Missouri Falls, 9 April 1988, D.E. Bowles; 1 female. OKLAHOMA: Latimer County, Robbers Cave St. Pk., Rough Canyon, 3 April 1988, D.E. Bowles; 3 males, 4 females. *Sialis vagans.* OKLAHOMA: Latimer County, 6 mi. SW of Red Oak, 11-24 April 1988, Karl Stephan; 4 males, 3 females.

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[2]Published with the approval of the Director, Arkansas Agricultural Experiment Station, Fayetteville, AR 72701.

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Additional Records Of Alderflies From Arkansas And Oklahoma

Records are based on specimens in the University of Arkansas Insect Collection as well as those in the literature (Canterbury 1978; Flint 1964; Stark and Lago 1980; Tarter *et al.* 1978).

S. hasta Ross. ARKANSAS: Garland, Washington, Yell Counties; April, May, July.
S. infumata Newman. ARKANSAS: Garland, Pike, Washington Counties; April-May. OKLAHOMA: Pittsburg County; April.
S. itasca Ross. ARKANSAS: Craighead County; Collection data not recorded. OKLAHOMA: Collection data not recorded.
S. mohri Ross. ARKANSAS: Montgomery, Pike, Washington Counties; March-April, May. OKLAHOMA: Payne County; April.
S. vagans Ross. ARKANSAS: Green, Johnson Counties; March-May.

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BRAZILIAN PARASITOIDS OF GALL-FORMING INSECTS: TWO NEW CHALCIDOID SPECIES AND HOST RECORDS[1]

Luis De Santis[2], G. Wilson Fernandes[3]

ABSTRACT: The geographical distribution as well as new host for *Lochitoencyrtus gahani* (Encyrtidae) are recorded. Two new species of neotropical Chalcidoidea parasitoids of Brazilian insect gall formers are described: *Syrphophagus cecidium* (Encyrtidae) and *Eurytoma minasensis* (Eurytomidae). Brief information on the host insect and their galls is given for each species of parasitoid.

The number of insect herbivores associated with different plant taxa has been widely studied (e.g. Lawton & Schroder 1977, Lawton & Price 1979, Kennedy & Southwood 1984, Strong *et al.* 1984, Fernandes & Price 1988). Hawkins & Lawton (1987) recently studied the variation in species richness of British parasitoid insects and their phytophagous insect hosts. Studies on the richness (e.g. Price 1980, Hawkins & Lawton 1987), abundance, degree of specialization and generalization of parasitoids on their hosts are very important to understand the diversity of fauna and flora.

One of the hypotheses reviewed by Price *et al.* (1986, 1987) on the adaptive significance of insect galls stated that gall formation could be an important adaptation for defense against insect parasitoids. The knowledge of the composition, structure, and richness of the gall-forming insect parasitoid fauna will help understand the ecological mechanisms and the evolutionary processes involved in the formation and diversification of insect galls.

Despite the diversity of the flora and fauna of the neotropical region, there are few studies on the neotropical gall-forming insects (Fernandes & Martins 1985, Fernandes 1986), and even fewer on the gall-forming parasitoids (but see Fernandes *et al.* 1987, Winder 1980). This study is a small portion of a long term study on the insect gall fauna of Brazil (see Fernandes *et al.* 1988) which not only aims to survey the Brazilian insect galling fauna but also to observe its distribution, occurrence, and evolutionary ecology. Here, we report on the taxonomy of three neotropical chalcidoid parasitoids of gall-forming insects and their host plants.

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We give new data on the biology and geographical distribution of *Lochitoencyrtus gahani* (Encyrtidae: Hymenoptera) a parasitoid of *Neolithus fasciatus* (Psyllidae: Homoptera) which induce leaf galls on *Sapium biglandulosum* (Euphorbiaceae); and describe two new species of chalcidoidea of gall-forming insects: *Syrphophagus cecidium* (Encyrtidae: Hymenoptera) a parasitoid of *Trioza* sp. (Psyllidae: Homoptera) which form leaf galls on *Myrcia itambensis* (Myrtaceae), and *Eurytoma minasensis* (Eurytomidae: Hymenoptera) a parasitoid of *Anadiplosis* sp. (Cecidomyiidae: Diptera) which form leaf-rachis galls on *Machaerium aculeatum* (Leguminosae).

MATERIAL AND METHODS

All host plants and their gall-forming insects studied here were present on a secondary "cerrado" vegetation at the Campus of the Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil (for further details see Fernandes *et al.* 1988, Ferrari 1977). Fresh galls were brought into the laboratory, where they were opened carefully by peeling away the outer layers of gall tissue. Adult gall-forming insects were point mounted while fresh to perserve their natural colors; parasitoids and all immature insect stages were preserved in 70% alcohol. As a standard procedure (see De Santis 1964), when there was only one specimen, all the measurements were taken from the holotype specimen. When there were more than one specimen, the description was made based on the holotype, and the measurements taken from a paratype. We made a sub-section entitled "variations" to indicate those characters with significant variation (for an example see the description of *E. minasensis*). The insect parasitoid types described here are in the collection of the Museo de La Plata, Paseo del Bosque, La Plata, Argentina.

RESULTS AND DISCUSSION

Encyrtidae

Lochitoencyrtus gahani De Santis (1964)

This species was previously described by De Santis (1964: 265) in his work on the encyrtids of Argentina. Previous geographic distributional records for this species are from Argentina and Trinidad. In addition to the holotype and allotype, six females were deposited in the collection of the Museo de La Plata. These six females were reared by M.R. Trujillo from leaf galls on *Sapium* sp. (Euphorbiaceae) which were collected in

Itusaingó (Corrientes, Argentina) on October 13, 1986. Here we report on the occurrence of *L. gahani* as a parasitoid of *Neolithus fasciatus* Scott (Homoptera: Psyllidae), a gall former on *Sapium biglandulosum.*

Geographic Distribution: Trinidad; Brazil: Minas Gerais; Argentina: Corrientes, Entre Rios, Santa Fe.

Biology and Hosts. *Lochitoencyrtus gahani* is a parasitoid of *N. fasciatus* which induces galls on several organs of its host plant, *S. biglandulosum.* Galls are frequently found on leaves, stems, inflorescences, and fruits (Fig. 1a). In general, galls are spheroid, reddish, and glabrous. When immature, galls are green in color; but during their development the galls turn reddish. Galls were found throughout November to May during the period of study (1980-1983). Gall size was 3.14mm (SD ±

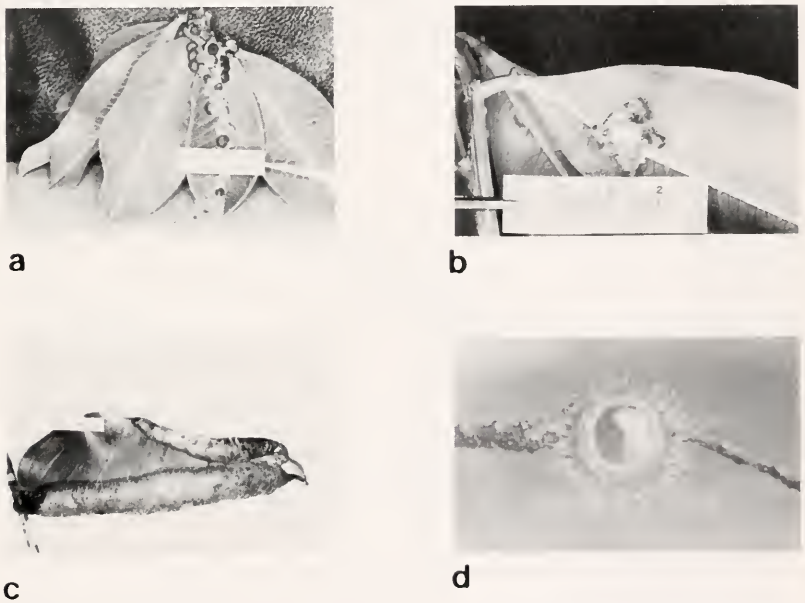

Figure 1a:) Galls of *Neolithus fasciatus* (Homoptera: Psyllidae) on several parts of its host plant, *Sapium biglandulosm* (Euphorbiaceae). b) *Neolithus fasciatus* gall. Mature gall splits open and the adult insect emerges. Parasitized galls do not split open as the unparasitized ones. c) Leaf galls of *Trioza* sp. (Homoptera: Psyllidae) on its host plant, *Myrcia itambensis* (Myrtaceae) Scale is 1cm. d) Leaf rachis gall of *Anadiplosis* sp. (Diptera: Cecidomyiidae) on its host plant, *Machaerium aculeatum* (Leguminosae) with a parasitoid larvae in it. Gall diameter is 0.59mm.

3.00mm, n= 293), and only one gall former developed in the one -chambered gall (n= 500). At the end of the development of the gall, the walls split open and the adult insect emerges for mating (Fig. 1b). Parasitized galls are harder than unparasitized galls and do not split open as easily. Besides *L. gahani,* the psyllid gall former is parasitized by an unidentified species of eurytomid and by an unidentified pteromalid species (Fernandes *et al.* 1988).

Syrphophagus cecidium sp. nov.

Figure 2a, 2b, 2c.

FEMALE: Black; face, pronotum, scutellum, and apical third of the gaster with purple reflections; frontovertex, mesoscutum, and basal third of the gaster with greenish reflections, however stronger in the gaster. Antennae, palpi, trochanters, base and apical third of the forefemora, half basal and apex of the mesofemora, base and apex of the hindfemora, tibiae, tarsi and wing venation yellowish, blackish at the radicle, basal thirds of the pedicel, flagellum, at one sub-basal annulus at the mesotibiae, and at the apical segment of the tarsi. Wings subhyaline, yellowish

Frontovertex reticulate, shallowly punctated at its lateral and posterior regions; mesoscutum also reticulate-punctated; axillae and scutellum with denser reticulation, the latter almost flat and shiny like the gaster; scrobes sub-triangular with rounded edges.

Eyes bare; mesoscutum and scutellum with numerous whitish setae. The distribution of the wing setae is presented in figure 2a.

Head as broad as alitrunk, lenticular, weakly convex; occiput edge sharp; breadths of head and frontovertex at eye level, as follows: 28:9; mandibles broad at their apex, tridentate, maxillary palpi four segmented; labial palpi three segmented; eyes large; cheeks equal to the fourth part of the eyes longitudinal diameter; ocelli in an obtuse triangle, the posterior ones distanced one diameter from the corresponding internal orbits and a little bit less from the edge of the occiput; antennae inserted slightly below the inferior line of the eyes (figure 2b); dimensions of each segment: R 0.052 (0.031) I 0.264 (0.047) II 0.072 (0.041) III 0.052 (0.036) IV 0.057 (0.041) V 0.057 (0.041) VI 0.057 (0.047) VII 0.057 (0.049) VIII 0.057 (0.052) IX 0.062 (0.078) X 0.052 (0.078) XI 0.057 (0.072).

Pronotum conspicuous, mesoscutum broad, entire; axillae slightly separated; scutellum convex; metanotum and propodeum short, spiracles circular. Length of the fore wings 1.473; maximum width 0.572; length of the longer marginal setae 0.041; relative length of the submarginal, marginal, postmarginal, and stigmal veins as follows: 42, 7.5, 5.5, 7. Length of the hind wings 1.029; maximum width 0.254; length of the longer marginal setae 0.057. Middle tibial spurs clearly shorter than the correspondent basitarsi.

Gaster subconic, flattened, shorter than the alitrunk (33:23); the ovipositor originates close to the third basal part and is slightly exserted. Body length is 2mm.

MALE: Frontovertex comparatively broader. Antennae yellowish, but blackish at radicle and at the proximal third of pedicel, as seen in figure 2c; length of each segment: R 0.031; I 0.186, II 0.062; III 0.155; IV 0.114; V 0.109; VI 0.109; VII 0.103; VIII 0.088; IX 0.155. Clava entire. Body length 1.5mm.

GEOGRAPHIC DISTRIBUTION: Brazil: Minas Gerais.

BIOLOGY AND HOSTS: *Syrphophagus cecidium* is a parasitoid of *Trioza* sp. (Homoptera: Psyllidae) which induces leaf galls on *Myrcia itambensis* (Myrtaceae) (Figure 1c). The *Trioza*

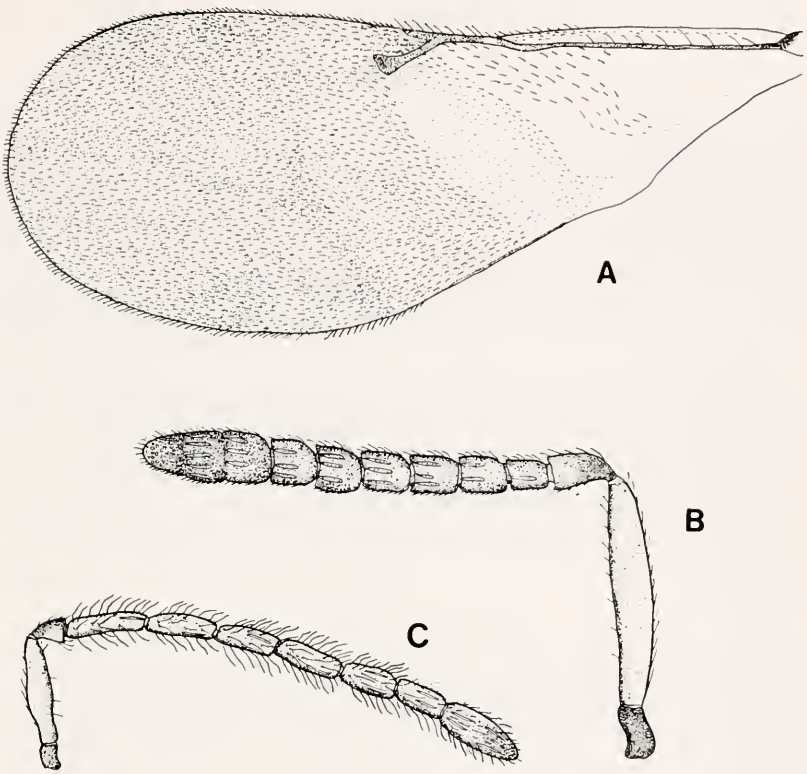

Figure 2: *Syrphophagus cecidium* sp. nov. a) Forewing, female, b) Antenna, female. c) Antenna, male.

sp. leaf galls are greenish, glabrous, unilocular. The average number of galls per leaf is 1.36 (SD ± 0.48, n= 580), and the average number of *Trioza* sp. nymphs per gall is 1.33 (SD ± 0.57, n= 3). Only the parasitoid *S. cecidium* was present in *Trioza* sp. leaf galls (Fernandes *et al.* 1988).

DIAGNOSIS: Because of forewing venation, head features, and mandible dentition, this new species can not be placed in the genus *Psyllaephagus* Ashmead, 1900. As the host is a Psylloidea (see Noyes & Hayat (1984: 338-339) our new species is included in the genus *Syrphophagus* Ashmead, 1900 near to *S. flavicornis* from which it differs mainly in coloration and antennae shape.

MATERIAL EXAMINED: One female holotype, one male allotype, and one female and two male paratypes; 23.XI.1981, Brazil: Belo Horizonte, G.W. Fernandes. The types are deposited in the collection of the Museo de La Plata, Paseo del Bosque, La Plata, Argentina.

Eurytomidae

Eurytoma minasensis sp. nov.

Figure 3.

FEMALE: Black. Eyes and ocelli reddish. Tegulae and legs, except the coxae, testaceous. Antennae also testaceous, blackish at the radicle, on most of the dorsal face of the pedicel and on the flagellum. Knees, tibiae apices, spurs, tarsi, and wing venations pale yellow. Wings hyaline.

Face with convergent streaks in front of the clypeus. Intervals between the punctation on the head and alitrunk reticulate. Prepectus weakly reticulate at superior third and rugose on the remaining. Propodeum reticulate-rugose with a broad medial depression and one pair of central impressions at the half dorsal part. Structures of urotergite VI weakly impressed.

Body setae whitish; setae on urotergite VI to IX as longer as the body setae.

Antennae with triarticulated clava; dimensions of each segment: R 0.041 (0.044) I 0.264 (0.062) II 0.077 (0.057) annelus 0.008 (0.041) III 0.077 (0.077) IV 0.077 (0.088) V 0.072 (0.077) VI 0.072 (0.083) VII 0.072 (0.093) VIII 0.067 (0.062) IX 0.077 (0.062) X 0.072 (0.062).

Length of the fore wing 1.715, maximum width 0.864; length of the longest marginal setae 0.077; relative length of the submarginal, marginal, postmarginal, and stigmal veins as follows: 60, 17, 13, 11; marginal vein thickened.

Petiole and urotergite IX very short. Gaster in a lateral view, oval, width almost twice its height (70:38). Third urotergite almost as long as the fourth urotergite (16:14). Body length 2.6mm.

MALE: Males are different from the females in the following characters; antennal clavae and fore coxa yellowish; hind femora black except at extremities. Funicular joints short-pedunculate and with long setae, as at the triarticulated clava; segment length as follows: R 0.041 I 0.248 II 0.062 III 0.145 IV 0.139, V 0.129 VI 0.119, VII 0.093 VIII 0.078 IX 0.087. Petiole is of same length as the hind coxae; gaster smaller but not compressed. Body length 2.0mm.

Figure 3: *Eurytoma minasensis* sp. nov., female genitalia.

VARIATIONS: Female paratypes with blackish hind femora.

GEOGRAPHIC DISTRIBUTION: Brazil: Minas Gerais.

BIOLOGY AND HOSTS: *Eurytoma minasensis* is one of the four undescribed chalcidoid wasps reared from *Anadiplosis* sp. (Diptera: Cecidomyiidae) leaf rachis galls on *Machaerium aculeatum* (Leguminosae). Besides the species we describe here, LaSalle (1987) described *Tanaostigmodes fernandesi* (Hymenoptera: Tanaostigmatidae) which is an inquiline of the galls. The other chalcidoids belong to the families Eurytomidae (1), and Platygasteridae (2). The *Anadiplosis* sp. leaf galls are spheroid, green, unilocular, and occur preferentialy in clusters [10.05 (SD ± 10.65 galls per leaf), n=307, Fernandes *et al.* 1987, 1988]. Galls have secretory hairs which may trap and kill gall-forming parasitoids. However, only very rarely were *E. minasensis* adults observed trapped by the sticky secretions of the gall's hairs. The galls occur from March throughout December. Only one *Anadiplosis* sp. was found per gall and only one *E. minasensis* was reared per gall (Figure 1d).

DIAGNOSIS: This species runs out couplet 3 in the Bugbee's (1975) key for the *breviura* group of *Eurytoma* species of Mexico and Guatemala. Our species is closely related to *E. subfusca* Bugbee, 1944, but is different in its coloration, in the female genitalia (Figure 3), and in the fourth urotergite which is comparatively short.

MATERIAL EXAMINED: One female holotype, one male allotype, and two female, and one male paratypes; 24.X.1981, Brazil: Belo Horizonte, G.W. Fernandes. The types are deposited in the collection of the Museo de La Plata, Paseo del Bosque, La Plata, Argentina.

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NORTHERN CADDISFLY (TRICHOPTERA) FAUNA IN A REMNANT BOREAL WETLANDS OF WEST VIRGINIA[1]

Ben M. Stout, III[2], James S. Stout[3]

ABSTRACT: Eight species of typically northern Trichoptera are reported from shallow ponds and spring seeps within a red spruce (*Picea rubens* Sarg.) forest in West Virginia (WV). *Platycentropus radiatus* and *Banksiola dossuaria* were dominant species, found here in the highest abundance ever recorded. *Ptilostomis ocellifera* were present in numbers typical of the species. *Limnephilus moestus* adults were rarely collected. *Oligostomis pardalis* and *Nemotaulius hostilis* were rare species in ponds, the former being a new record for WV. *Phylocentropus lucidus*, previously reported from a single specimen in WV, and *Frenesia difficillis* were plentiful in headwater spring seeps.

Areas of the Alleghany highlands of West Virginia having remnant boreal vegetation currently represent the known southern distribution limits of many plants (Strausburg & Core, 1977). Surprisingly little is known about the aquatic insect fauna of these areas, particularly shallow ponds and spring seeps associated with bogs. Permanent and temporary ponds ranging from 5 to 1000m^2 surface area were created by beavers and log skidders 7 years ago near the Sinks of Gandy, Randolph County, West Virginia (elev. 1090m, lat. 38°43′, long. 79°38′W). Permanent ponds were subject to seasonal water level increases of 15-25cm during the wet season (October-June). Temporary ponds were dry in the summer, and wet for 6-10 months depending on basin depth and annual rainfall. Vegetation in seasonal wetlands was dominated by sedge (*Carex* spp.), rush (*Juncus* spp.), and rice cutgrass (*Leersia oryzoides*). Permanent ponds harbored the emergent macrophyte *Sparganium americanum*.

A two-year series of light trappings and larval collections throughout the area revealed an association of eight species of typically northern Trichoptera. One species is reported here for the first time in WV and two species reported earlier from single specimens are now known to occur in specific locations. The purpose of this paper is to describe the unique association of Trichoptera in these ponds, and report the new record for WV.

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Limnephilidae

Platycentropus radiatus (Say) was the dominant caddisfly in shallow ponds throughout the area. Densities of second instar larvae were as high as $386 \pm 101/m^2$ (95% CI) in the submerged vegetation of permanent and temporary ponds, with as many as $50 \pm 23/m^2$ reaching the pupal stage. Eggs were laid in September, hatched in late October, and most larvae reached fifth instar by May. Lab reared specimens required approximately 2 weeks for pupation. Emergence in nature occurred in June and early July. Adults diapaused during the dry summer months, as reported for the other members of the family (Wiggins, 1973). Eggs apparently hatched following inundation during the wet season. Larvae inhabited temporary ponds as small as 5 m^2 surface area and 10-20cm depth. Larval growth was rapid in a pond having a 6 month wet season, and emergence from this pond corresponded with emergence from permanent and temporary ponds that had longer wet seasons. Life cycle features were closely parallel to those reported for *Limnephilus indivisus* in Ontario (Richardson & McKay, 1984). Rainfall levels 8-10cm below normal during the second year of this study resulted in 6 temporary ponds filling to <10cm depth, and *P. radiatus* larvae were absent.

Nemotaulius hostilis (Hagen) is undoubtedly at the southernmost extent of its range in this area of WV (Hill & Tarter, 1978), and occurs in limited populations within specific habitats. This species is found only in permanent ponds having seasonally fluctuating water levels (Richardson & McKay, 1984). Life history in this area was similar to that reported for Alberta (Berte & Pritchard, 1986). Second instar larvae first appeared in August, and larvae reached fifth instar by October. A fifth instar larva collected on October 30 pupated after 2 weeks at room temperature, and emerged November 28. No adults were collected in the field. As with populations in Alberta, this species appears to be closely associated with the emergent macrophyte genus *Sparganium*.

Limnephilus moestus (Banks) has been collected occasionally throughout the Alleghany highlands (Hill & Tarter, 1978). Three adults (two male and one female) and no larvae were collected at this site.

Frenesia difficilis (Walker) adults were extremely abundant in this location during their November emergence. Larvae were confined to headwater spring seeps and were not found in ponds. Life history was similar to that reported for Massachusetts (Flint, 1956), with oviposition occurring in early winter. It appears to be near the southern range limit at this

location since none were reported from November collections by Tarter & Hill (1979) at Cranberry Glades, the southernmost extensive upland wetlands in WV located 85 km to the southwest. Tarter & Hill (1980) reported it from Randolph and Monongalia County, WV.

Phryganeidae

Banksiola dossuaria (Say) was the most abundant species of phryganeid found, with densities of second instar larvae as high as $512 \pm 352/m^2$ near oviposition sites. Adults were most abundant in early May, larvae hatched from eggs in July in a permanent pond, and larvae overwintered mostly as fifth instars. Larvae were most abundant in permanent ponds, and temporary ponds with a wet season lasting more than 9 months.,

Ptilostomis ocellifera (Walker) was present in low densities in permanent and temporary ponds having mid-winter water levels >15cm. Densities were highest in temporary pools ($8.8 \pm 4.6/m^2$)and adults emerged in April. Empty third instar cases were found at densities of $1.2 \pm 0.6/m^2$ in a shallow pond (<10cm deep) where larvae apparently succumbed to low temperatures.

Oligostomis pardalis (Walker) was rare in this area, and a new record for West Virginia. No larvae were collected. A single adult male was collected from the surface of a temporary pond in early June.

Polycentropodidae

Phylocentropus lucidus (Hagen) was relatively abundant in light traps in May. The only other record of this species in West Virginia was a single specimen collected by Tarter & Hill (1979) in Cranberry Glades. Larvae are tube dwellers in sandy substrates of low gradient headwater spring seeps.

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PSEUDOPALINGENIA KERRIEAE, JUNIOR SYNONYM OF *PSEUDOPALINGENIA FEISTMANTELI* (INSECTA: PALAEODICTYOPTERA)[1]

Michael D. Hubbard[2]

ABSTRACT: The name *Pseudopalingenia kerrieae* Hubbard is shown to be a junior objective synonym of *Pseudopalingenia feistmanteli* Handlirsch.

In 1880 Fritsch described [as an Ephemeroptera] the palaeodictyopterid *Palingenia feistmanteli* from fossil wings. He later (Fritsch 1882) redescribed and refigured this species, including the description and figure of what he thought was the body as well.

Handlirsch (1906) established the new genus *Pseudopalingenia* for the specimen on which Fig. 1 of Fritsch (1882) was based and clearly indicated that the body (Fig. 1) did not go with the wing figured in Fig. 2-6 and previously (Fritsch 1880) described as *Palingenia feistmanteli* [= *Propalingenia feistmanteli* (Fritsch)]. He referred to the new species thus created for Fritsch's Fig. 1 as *Pseudopalingenia feistmanteli.* Although it might be argued that this specific epithet would not be available for use for a misidentification, this is clearly an intentional use of *"feistmanteli"* as a misidentification and, according to the International Code of Zoological Nomenclature (Art. 11i and 70c), the species takes date and authorship from this publication because Handlirsch used the name for the type-species of a new genus.

Due to an error, the new name *Pseudopalingenia kerrieae* for *Pseudopalingenia feistmanteli* Handlirsch with a reference to an unpublished paper was inadvertently listed in the non-mayfly section of the Ephemeroptera volume of the Fossilium Catalogus by Hubbard (1987). According to the International Code of Zoological Nomenclature, the new name takes date and authorship from this publication [viz., *Pseudopalingenia kerrieae* Hubbard, 1987]. This new name is unnecessary because of the reasons above and falls as a junior objective synonym of *Pseudopalingenia feistmanteli* Handlirsch, 1906, which is the currently valid name of this species. A synonymy of this species is listed below.

Pseudopalingenia feistmanteli Handlirsch, 1906.
Palingenia feistmanteli [misidentification]; Fritsch, 1882:2, pl. 1 fig. 1 [not figs. 2-6].
Palingenia feistmanteli [partim]; Scudder, 1890:119.

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Pseudopalingenia feistmanteli Handlirsch, 1906:124, pl. 13 fig. 3.
Pseudopalingenia feistmanteli; Handlirsch, 1922:57.
Pseudopalingenia kerrieae Hubbard, 1987:70.

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INTERACTIONS BETWEEN THE PREDATORS *PHIDIPPUS AUDAX* (ARANEAE: SALTICIDAE) AND *HIPPODAMIA CONVERGENS* (COLEOPTERA: COCCINELLIDAE) IN COTTON AND IN THE LABORATORY[1]

Orrey P. Young[2]

ABSTRACT: Visual censuses in Mississippi late-season cotton indicated that the jumping spider *Phidippus audax* was not capturing the ladybird beetle *Hippodamia convergens*, though both were abundant and co-occurring. Laboratory feeding trials demonstrated that *P. audax* would consume a variety of prey, but not *H. convergens*. This suggests the possession of effective defensive mechanisms by *H. convergens* against predation by *P. audax*.

The Convergent Lady Beetle, *Hippodamia convergens* Guerin (Coleoptera: Coccinellidae), is an important beneficial insect distributed throughout the United States and parts of Canada and Mexico (Gordon 1985). This species may be quite abundant locally and is a voracious consumer of aphids (Hagen 1962). In the Delta area of Mississippi, *H. convergens* is abundant in early season on cotton (Dinkins *et al.* 1970) and late season in field margins (Young, unpubl. data). The Jumping Spider *Phidippus audax* (Hentz) (Araneae: Salticidae) is one of the most frequently reported spiders in North America (Taylor and Peck 1975) and is one of the most common spiders in agricultural crops and adjacent habitats (Edwards 1980). In the Delta, *P. audax* is active from March to December and has been recorded preying upon a wide size range and taxonomic diversity of arthropods (Lockley and Young 1986, Young 1988, Young and Lockley 1988). These prey items, however, have not included species of *Hippodamia*. The purpose of this report is to examine the relationship between *P. audax* and *H. convergens* by documenting: (1) the population densities of *P. audax*, *H. convergens*, and other potential spider prey in an old-field site, (2) the frequency of capture by *P. audax* of *H. convergens* and other arthropods, and (3) the results of laboratory feeding trials in which *P. audax* was offered *H. convergens* and three locally abundant crop pests, *Diabrotica undecimpunctata* Barber (Coleoptera: Chrysomelidae), *Nezara viridula* (L.) (Heteroptera: Pentatomidae), and *Lygus lineolaris* (Palisot) (Heteroptera: Miridae).

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METHODS AND RESULTS

Field observations and censuses were conducted during the period 17-31 October 1986 in an old-field habitat managed for wildflowers at the Delta States Research Center, Stoneville, Washington County, Mississippi. This 0.1 ha field contained two center rows of nectaried cotton that had not been harvested and was reflowering. Censuses of the arthropods on cotton were conducted by slowly walking the length of a row (25m) in approximately 10 minutes, recording all arthropods seen on the plants. When *P. audax* was observed, the identity of any captured prey was also recorded. At other times, individuals of *P. audax* on cotton and adjacent plant species were observed for five-minute intervals and their hunting success recorded.

Thirty-five censuses on 7 days were conducted during the period 17-31 October 1986, and 18 prey records for *P. audax* were obtained (Table 1). The highest predation rates were on species that did not occur frequently or in high densities, i.e. *Spissistilus festinus* (Say) (Homoptera: Membracidae) and "other" spiders. *Hippodamia convergens* had one of the highest densities and frequencies of occurrence, yet records of capture by *P. audax* were not obtained.

Observations on other plant species at this site provided 40 additional prey records for *P. audax* (Young 1988). None of these records included *H. convergens,* though the species was abundant. It was concluded that *P. audax* was rejecting *H. convergens* as a prey item or was unable to capture the beetle. The relationship was therefore examined further under laboratory conditions.

Fifteen adult female *P. audax* were captured during October in Stoneville on *Erigeron* sp. (Compositae), brought into the lab, and maintained in individual clear plastic containers (7cm high x 10cm diameter) in a shaded window at approximately 24°C. After 5 days without food, each spider (body length = 13mm, n = 15) was offered one active tarnished plant bug, *Lygus lineolaris* (b.l. = 5mm, n = 15). Within 5 days, 14 of the 15 spiders had consumed the insect. Those 14 werre then each offered one active southern green stink bug, *Nezara viridula* (b.l. = 12mm, n = 14). After 6 days, 12 of the 14 spiders had consumed their stink bug. The 12 successful predators, all with identical feeding histories over the previous 16 days, were then each offered one active convergent lady beetle, *Hippodamia convergens* (b.l. = 6mm, n = 12). No consumption occurred in the next 6 days. Each spider was finally offered one active spotted cucumber beetle, *Diabrotica undecimpunctata* (b.l. = 6mm, n = 12). Within three days, 11 of the 12 spiders had consumed their insect. This sequence of events indicates that *P. audax* did not consume *H. con-*

vergens, even in a contrived laboratory situation in which the spider was starved and the beetle could not escape.

DISCUSSION

It is reasonable to hypothesize that *P. audax* is capable of distinguishing *H. convergens* from other potential prey, that the spider is capable of capturing the beetle, and that *H. convergens* is somehow either distasteful/toxic to *P. audax* or a mimic of such an organism. Jumping spiders (Salticidae) are visual hunters with superior image-detecting and pattern recognition capabilities, and with some color-detecting abilities (Foelix 1982). There is little doubt that *P. audax* can detect the presence of *H. convergens* and that the beetle is within the acceptable prey range for size, shape, and degree/type of movement. The color pattern of *H. convergens*,

Table 1. Arthropod populations and *P. audax* predation rates on cotton foliage. Based on 35 censuses during the period 17-31 October 1986.

Taxon	No. of observations	Freq. of occurrence (%)[1]	Predation rate (%)[2]
Phidippus audax	237	77	-
Diabrotica undecim.	201	100	1.9
Hippodamia convergens	108	83	0
Diptera spp.	53	77	3.7
Spissistilus festinus	49	51	10.2
Lygus lineolaris	46	60	4.3
Hymenop., Ichneumon.	27	46	3.7
Other insects[3]	129	97	0
Other spiders[4]	35	51	11.4

[1]Calculated as the number of censuses in which observed, divided by the total number of censuses (35) times 100.

[2]Calculated as the number observed as prey of *P. audax* divided by the total number observed.

[3]Heteroptera: Pentatomidae, Miridae, Reduviidae, Lygaeidae. Homoptera: Delphacidae, Cicadellidae. Coleoptera: Chrysomelidae, Curculionidae, Carabidae. Lepidoptera: Tortricidae, Hesperiidae. Orthoptera: Gryllidae. Hymenoptera: Halictidae. Mecoptera: Panorpidae. Odonata: Coenagrionidae.

[4]*Eris* sp., *Marpissa* sp., *Metacyrba* sp., *Misumenops* sp., *Metaphidippus* sp., *Neoscona* sp., *Oxyopes* sp., *Pardosa* sp., *Schizocosa* sp., *Thiodina* sp., *Zygoballus* sp.

however, may be the cue that indicates to *P. audax* that the prey is unacceptable. This pattern, red-orange with contrasting black, is characteristic of a large group of organisms that are aposematically colored and toxic to certain predators or mimics of toxic models (Ford 1975). Ladybird beetles (Coccinellidae) such as *H. convergens* emit strongly alkaloid hemolymph from their leg joints when disturbed and thus are well protected from attack by such predators as quail and ants (Harborne 1982). It is possible that the adult female spiders used in the previously described laboratory feeding trials had prior experience with *H. convergens* and had discovered their distasteful properties. Experiments with naive 1st instar *Phidippus regius* C.L. Koch and noxious ants have indicated that unfavorable encounters lead to subsequent avoidance (Edwards 1980).

However, the non-consumption of *H. convergens* by *P. audax* may have a geographic component. Laboratory feeding trials with *P. audax* from north-central Oklahoma indicated a consumption of both larval and adult *H. convergens* (Bailey and Chada 1968). *Phidippus audax* individuals from south-west Virginia have also been demonstrated in the laboratory to consume adults and larvae of *Hippodamia parenthesis* Say (Howell and Pienkowski 1971). The possible intraspecific variation in production of noxious substances by *H. convergens*, and/or similar variation in sensitivity to such substances by *P. audax*, would not be an unusual situation (Harborne 1982). Utilizing naive lab-reared adult and immature *P. audax* and larval and adult *H. convergens* from several locations, additional feeding experiments are contemplated to examine in more detail the interactions between these two predators.

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SOCIETY MEETING OF OCTOBER 19, 1988

When a caterpillar molts it sheds its skin, yet this tissue contains nutrients that can be recycled. Dr. William Cain, an instructor in the School of Life and Health Sciences at the University of Delaware, has been studying how a caterpillar can lose its skin and in a sense save it at the same time. His talk to the first membership meeting of the 1988-89 season was entitled, "Processing Cuticle Proteins in the Larval-Pupal Molt in *Manduca sexta.*"

The cuticle of the tobacco hornworm, *M. sexta,* contains 7% of the protein in the larva. Conveniently, molting fluid containing proteolytic enzymes can be sampled from the larval horn at various defined times through the larval-pupal molt. Contrary to the expectation that cuticular proteins would be degraded to smaller peptides, the only proteins observed by gel electrophoresis of the molting fluid were larger and they did not show signs of destruction during the molt. Abruptly before pupation the molting fluid is transferred in bulk to the gut where, 3 days after molting, it begins to be digested. Eventually after 9 days the proteins of the molting fluid disappear. It remains to be determined whether the cuticular proteins are direct or indirect precursors of the proteins in molting fluid.

Fourteen members and 8 guests attended Dr. Cain's talk in Townsend Hall, Newark. They appreciated his clear explanations of insect physiology and his careful observations of subtle morphological changes that precede molting.

In notes of local entomological interest, Dr. Bill Day reported a success for the USDA Beneficial Insects Laboratory. *Peristenus digoneutis,* a braconid wasp from Europe, has become established as a parasite of the tarnished plant bug, *Lygus lineolaris,* in northern New Jersey where it overwintered last year. Dr. Hal White reported the first records of the dragonfly, *Brachymesia gravida,* for Delaware. A well established population of this brackish-water species was discovered at the Woodland Beach Wildlife Area near Smyrna, DE. This is the northernmost record of this species in the United States.

Harold B. White,
Corresponding Secretary

SOCIETY MEETING - NOVEMBER 16, 1988

The paucity of insects on federal and state threatened and endangered species lists represents a dilemma for entomologists. Certainly, due to the sheer numbers and diversity of insects, there should be correspondingly more threatened and endangered insects than other types of organisms. However one needs adequate documentation to justify inclusion on such lists. The small size, local distribution, unusual habits, and population fluctuations of insects combined with public apathy and the limited number of people with relevant information on specific insects makes thorough documentation difficult. Howard P. Boyd, editor of *Entomological News* and past president of the society, addressed many of these issues in his talk, "Some Threatened and Endangered Insects of New Jersey," presented at the Academy of Natural Sciences of Philadelphia to 14 members and 8 guests.

Mr. Boyd described the interesting case of the post oak locust, *Dendrotettix quercus.* In 1907 an isolated population was discovered in the New Jersey pine barrens considerably northeast of its normal range. Subsequently it was observed to undergo periodic population explosions in which it would defoliate oak trees and then disappear the following year. Oddly, no specimens have been found since 1954 despite many searches. Similarly, the beach tiger beetle, *Cicindela dorsalis dorsalis,* has disappeared from New Jersey as well as from the entire northeast Atlantic coastal region. This beetle was abundant on Atlantic beaches in the 19th century and was even considered common as recently as 1951. However, the last specimens known from the state were taken in 1976. In this case the species has been displaced by the "dune buggy," *Quadricycle jeepensis* (White). Controlled surveys in Virginia suggest that these vehicles destroy the larval habitat. Human activity has threatened another tiger beetle in the state. The cobblestone tiger beetle, *C. marginipennis,* lives only on the upstream side of islands in the Delaware River. If the once proposed plans for the Tocks Island dam are ever carried out, this population will be destroyed according to Mr. Boyd.

While some insects may have suffered the fate of the passenger pigeon without being missed, other species have been mistakenly considered rare or extirpated. Before 1984 two nocturnal or crepuscular tiger beetles, *Megacephala virginica* and *C. unipunctata,* were represented by only a few specimens from New Jersey. Since then Mr. Boyd has taken over 300 specimens of each species using barrier-pitfall traps in the pine barrens. These and other interesting examples presented by the speaker illustrated the difficulty of appropriately assigning insects to the threatened and endangered species lists. Nevertheless there is sufficient evidence to include some insects on both federal and state lists.

In notes of local entomological interest Duke Elsner showed a photograph of a small unidentified sawfly larva and its serpentine feeding path on a cherry leaf. Howard Boyd and Chuck Mason speculated that this unusual pattern may mimic the feeding pattern of certain leaf miners. Mary Berk displayed the elongated and exceptionally well-camouflaged cocoon of the moth, *Tolype velleda* (Lasiocampidae). Apparently the larva excavates a twig in order to lower the profile of its cocoon. The moth that emerged from the cocoon resembled a bird dropping in part due to a dark patch of differentiated scales on the dorsum of its thorax. Chuck Mason reported that the larvae of the european corn borer, *Ostrinia nubilalis,* is exceptionally abundant this year in Delaware with a statewide average of 8 larvae per corn stalk.

Harold B. White
Corresponding Secrtary

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OUR CENTENNIAL YEAR

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A REDESCRIPTION OF THE ADULTS AND LARVA OF *THAUMALEA SUBAFRICANA* (DIPTERA: THAUMALEIDAE), AND FIRST DESCRIPTION OF THE PUPA[1]

APR 26 1989

B.V. Peterson[2], M. Báez[3] and B.J. Sinclair[4]

ABSTRACT: The male, female and last instar larva of *Thaumalea subafricana* from the Canary Islands, Spain, are redescribed and illustrated. The pupa of this species is described and illustrated for the first time, and brief biological notes on the species are provided.

We recently had the opportunity to obtain and study a moderately large series of larvae, pupae, and adults of *Thaumalea subafricana* (Becker). As part of an effort to better elucidate the fauna of the Canary Islands and this species in particular, we redescribe and illustrate its larva and adults, present the first description and illustrations of its pupa, and provide additional biological information. Although Storå (1936) figured and briefly described the larva of this species, both the description and figures are inadequate. We redescribe the larva in greater detail and provide new illustrations to help distinguish it from the larvae of other Palearctic species, and also because the larvae of thaumaleids are generally not well known. We also provide illustrations of the male and female terminalia. Although adults of this species were described by Becker (1908), Bezzi (1913), Edwards (1929), and Lindner (1930), their descriptions and/or illustrations are not fully satisfactory, and undoubtedly were based on fewer specimens than are now available. Therefore, we present these updated descriptions and new illustrations to help make this species better known. In the descriptions we utilize the morphological terminology that was outlined in the *Manual of Nearctic Diptera* (McAlpine 1981, Teskey 1981), and the larval setal numbering system of Saunders (1923). All illustrations were prepared using a Leitz tracing device on a Leitz Ortholux II compound microscope.

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Thaumalea subafricana (Becker)

Figs. 1-17

Orphnephila subafricana Becker, 1908: 70 (male, female) (Orphnephilidae). (Holotype and paratypes not indicated).

Thaumalea subafricana (Becker). Bezzi, 1913: 249 (male, female, fig. 4, distribution); Edwards, 1929: 139 (male, fig. 24, species group, distribution); Lindner, 1930: 14 (male, female, fig. 11s, P1.2 fig. 21, distribution); Storå (in Frey), 1936: 31 (larva, P1.6 figs. 48-49, distribution, ecology); Collart, 1945: 5 (distribution); Schmid, 1958: 4 (species group, distribution); Vaillant, 1963: 26 (male, distribution), 1969: 702 (distribution, species group).

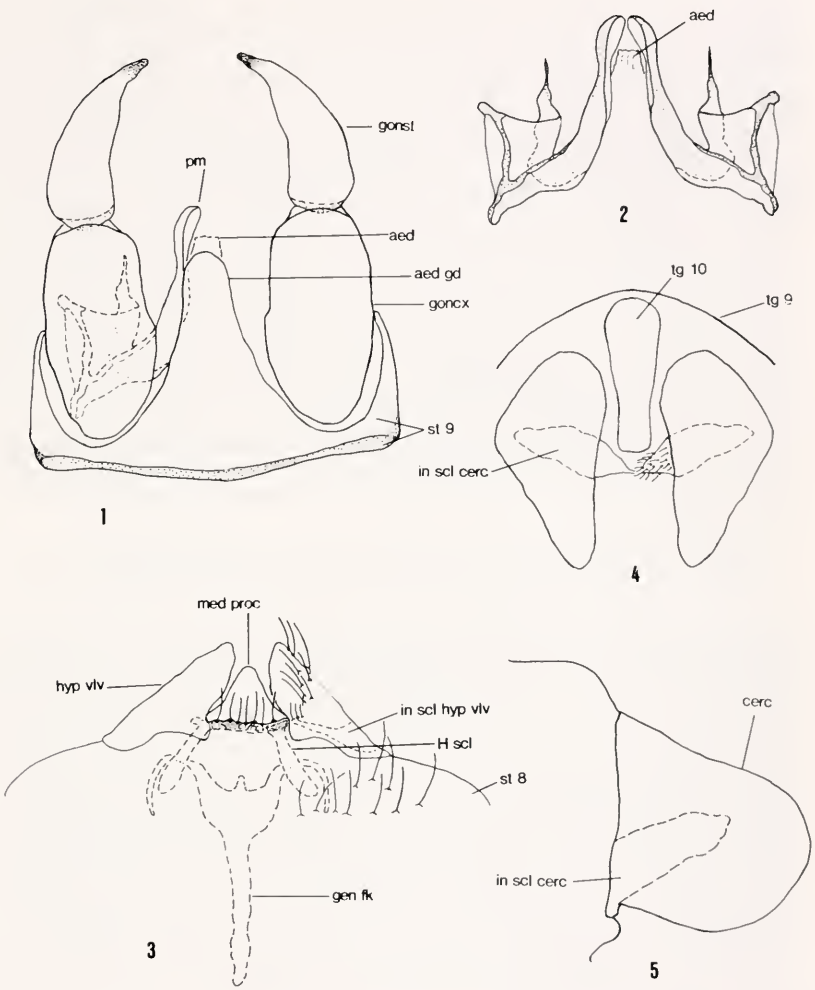
Description

Male: Body, 2.10-3.24 (av 2.51) mm long (dried pinned, and alcohol preserved specimens); wing, 2.76-3.30 (av 2.98) mm long, and 0.96-1.14 (av 1.06) mm in width.

Head: Frons, vertex, and occiput black, evenly but sparsely covered with erect, stiff, black setae; frons small, vertex and occiput prominent; clypeus small, strongly convex, with sparse, erect, black setae, slightly paler than frons and occiput but concolorous with blackish brown antenna and palpus. Scape of antenna reduced; pedicel largest, with sparse short, black setae; flagellum aristate, composed of 8 flagellomeres; first (basal) flagellomere largest, subquadrate but tapered distally, with about 7-10 round sensory pores that are difficult to discern; sometimes basal two flagellomeres weakly or imperfectly separated and appear as one continuous unit. Second flagellomere subconical, with about 4-6 round sensory pores; remaining flagellomeres more cylindrical. Flagellomeres 1, 2, 4, 6, and 8, with long, dark setae at apices, remaining flagellomeres with short setae; proportions of flagellomeres about 17:9:9:9:11:11:9:17 (basal to apical). Palpus with 5 palpomeres, each bearing dark setae; proportions of palpomeres 11:20:38:40:56 (basal to distal), 3rd palpomere without a sensory vesicle.

Thorax: Mostly brown, mottled with patches of both darker and paler color, subshining but varyingly brownish gray microtomentose, generally covered with sparse, mostly erect, short, black setae. Antepronotum visible in dorsal view, consisting of prominent lobe on each side connected by slender, straplike median portion. Postpronotal lobe small, subquadrate to subtriangular. Scutellum prominent, triangular, darker than scutum, with 8-10 black, dorsal, marginal setae; also with 2-8 shorter, finer, more ventral setae along hind rim of scutellum, these highly variable, ranging from 1 to 4 setae on each side but not necessarily in equal numbers on each half. Postnotum strongly convex, concolorous with scutum, bare. Pleuron largely yellowish brown, mottled with darker areas and rather uniformly grayish microtomentose; anepisternal membrane grayish brown, bare; anepimeron with small, but usually distinct, shining callus. Legs slender, generally pale yellowish brown; tarsi slightly darker. Wing distinctly brown, slightly darker in cells c, sc, and bm. Halter long and slender; stem grayish to brownish and only slightly longer than bright yellow knob, both covered with microtrichia, and stem with a row of setae along outer margin which stops at base of knob, and a row of setae along inner margin that continues nearly to tip of knob, knob also with about 4 other irregular, longitudinal rows of setae, at least some of these setae yellow.

Abdomen: Black, shining, hind margins of segments narrowly yellowish or grayish; segments gradually expanded posteriorly to third, fourth and fifth which are widest, then



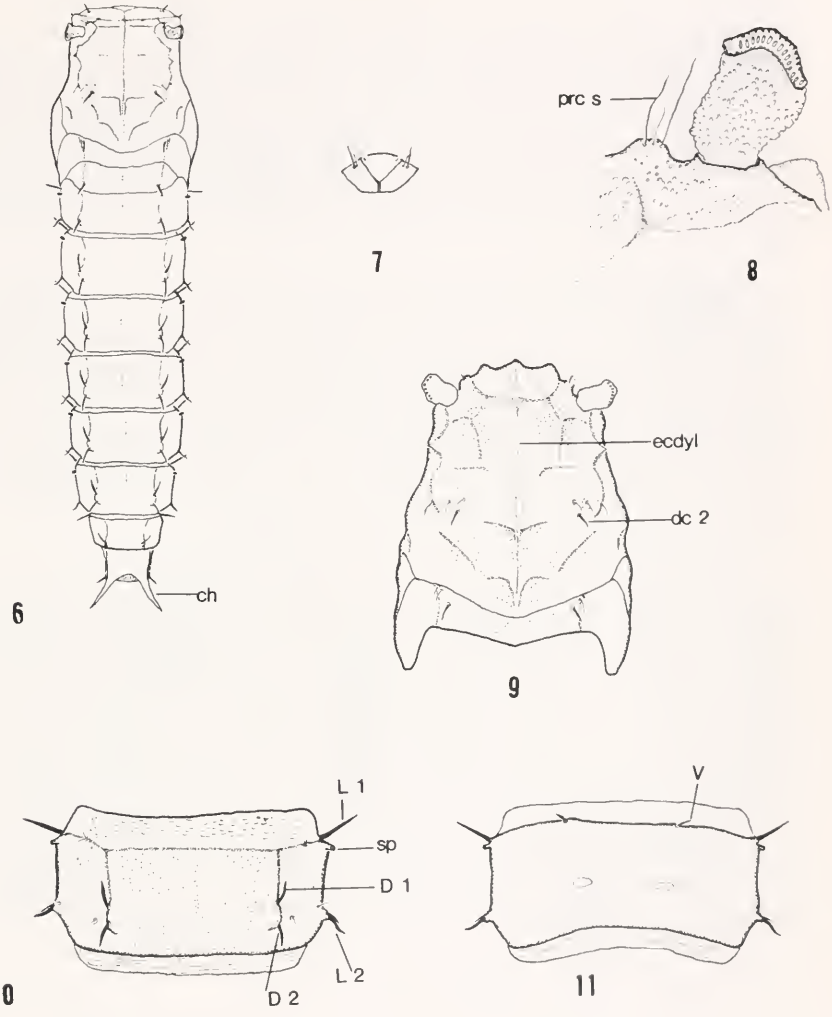
Figs. 1-5. *Thaumalea subafricana.* Adults. Figs. 1-2, Male. 1, Terminalia, ventral view, showing outline of paramere of left side only, setae omitted. 2, Paramere and aedeagus, ventral view. Figs. 3-5, Female. 3, Terminalia, ventral view. 4, Cerci and tergite 10, terminal (end) view, showing sclerites on inner surfaces. 5, Cercus, left lateral view, showing sclerite on inner surface. Abbreviations: aed gd, aedeagal guide; aed, aedeagus; cerc, cercus; gen fk, genital fork (sternite 9); goncx, gonocoxite; gonst, gonostylus; H scl, "H-shaped" sclerite; hyp vlv, hypogynial valve; in scl cerc, sclerite on inner surface of cercus; in scl hyp vlv, sclerite on inner surface of hypogynial valve; med proc, median process; pm, paramere; st, sternite; tg, tergite.

tapered posteriorly; sparsely covered with short, stiff, black setae; tergites sclerotized. Pleural regions of segments 3-7 each with 4 longitudinal rows of setae, next to bottom row set in narrow, brownish sclerite at anterior end of which is situated the spiracle for that segment. Sternite 1 broadly U-shaped, its arms extend from each anterolateral corner to hind margin, area between arms of this sclerite membranous; sternite 2 lightly sclerotized, somewhat triangular with apex directed anteriorly and abutting hind margin of sternite 1; sternites 3-7 rectangular, subequal in size, all sparsely setose; sternite 8 smaller; sternite 9 (hypandrium) slender, heavily sclerotized and thickened rimlike, connected with tergite 9 (epandrium) dorsolaterally forming closed basal ring. Terminalia (Figs. 1-2) contrastingly lighter brownish yellow. Epandrium only moderately enlarged, not obscuring or extending distally much beyond hind margin of gonocoxites, bare on basal 1/3, remainder lightly setose. Cercus small, triangular to subquadrate depending on angle of view, not projected but lying flat in membrane. Situated between bases of gonocoxites, and arising from hypandrium, a lightly sclerotized, distally rounded aedeagal guide extends posteriorly about 1/2 length of paramere. Gonocoxite slender, subcylindrical, slightly tapered distally, about 2.5X longer than gonostylus, lightly setose. Gonostylus conical, about 2X as long as greatest width, slender, tapered distally to narrowly pointed apex bearing a single, stout spinule; in ventral view, apex slightly but distinctly curved medially. Aedeagus simple, membranous tube with round gonopore; closely surrounded and supported by parameres. Paramere stout, heavily sclerotized; each half distally with curved, somewhat L-shaped, troughlike rod obliquely expanded distally near apex of aedeagus; paramere connected to gonocoxite by short, stout, gonocoxal apodeme, and to epandrium by another short, stout apodeme.

Female: Body, 2.40-3.60 (av 2.97) mm long (dried pinned, and alcohol preserved specimens); wing, 2.7-3.6 (av 3.26) mm long, and 1.02-1.32 (av 1.17) mm in width.

Body, wing and legs essentially as in male. Terminalia as in Figs. 3-5; yellowish, contrasted with rest of body; tergite 10 a slender, elongate, weakly sclerotized plate, surrounded by membrane, lying between bases of cerci dorsally. Cercus large, as long as or slightly longer than tergite 9, slightly longer than high, broadly rounded apically; arising from internal anterolateral corner of each cercus is a heavily sclerotized, triangular plate, plates of each side meeting medially between cerci to form bracelike or bridgelike structure. Sternite 8 slightly smaller than sternite 7, setose medially; hypogynial valves triangular with pointed apices and broad, widely separated bases, each with ventral, brushlike row of setae extended posteriorly and set back from medial margin of valve; dorsolateral corner of each valve with an internal sclerotized plate or barlike process that articulates with tergite 9 laterally and extends medially toward that of other valve to articulate with a somewhat H-shaped sclerite situated at and between bases of valves. This H-shaped sclerite has long anterior arms and very short posterior arms; crosspiece with a weakly sclerotized, full width, bare, posteromedian process, and bearing about 10-12 short, stout, pale, posteriorly directed setae. Sternite 9 (genital fork) heavily sclerotized, stem slightly curved dorsally, about 3.5X as long as body of fork; hind margin of body with slender, lightly sclerotized, median process that is almost 1/2 as long as body of fork, and each posteriolateral corner with long, slender, recurved arm.

Pupa: Length 3.2-4.2 (av 3.7) mm. Subcylindrical, broadest across posterior part of mesothorax; only slightly attenuated toward broadly rounded anterior end and evenly tapered toward posterior end; no constriction between head and thorax, or between thorax and abdomen. Wing sheaths extend to posterior margin of abdominal sternite 2, leg sheaths extend slightly beyond wing sheaths.



Figs. 6-11. *Thaumalea subafricana*. Pupa. 6, Habitus, dorsal view. 7, head capsule, posterodorsal view. 8, Thoracic respiratory horn (gill). 9, Thorax, dorsal view. 10, Abdominal tergite 4. 11, Abdominal sternite 4. Abbreviations: ch, caudal hook; D, dorsal seta; dc, dorsocentral seta; ecdyl, ecdysial line; L, lateral seta; prc s, precorneal seta; sp, spiracle; V, ventral seta.

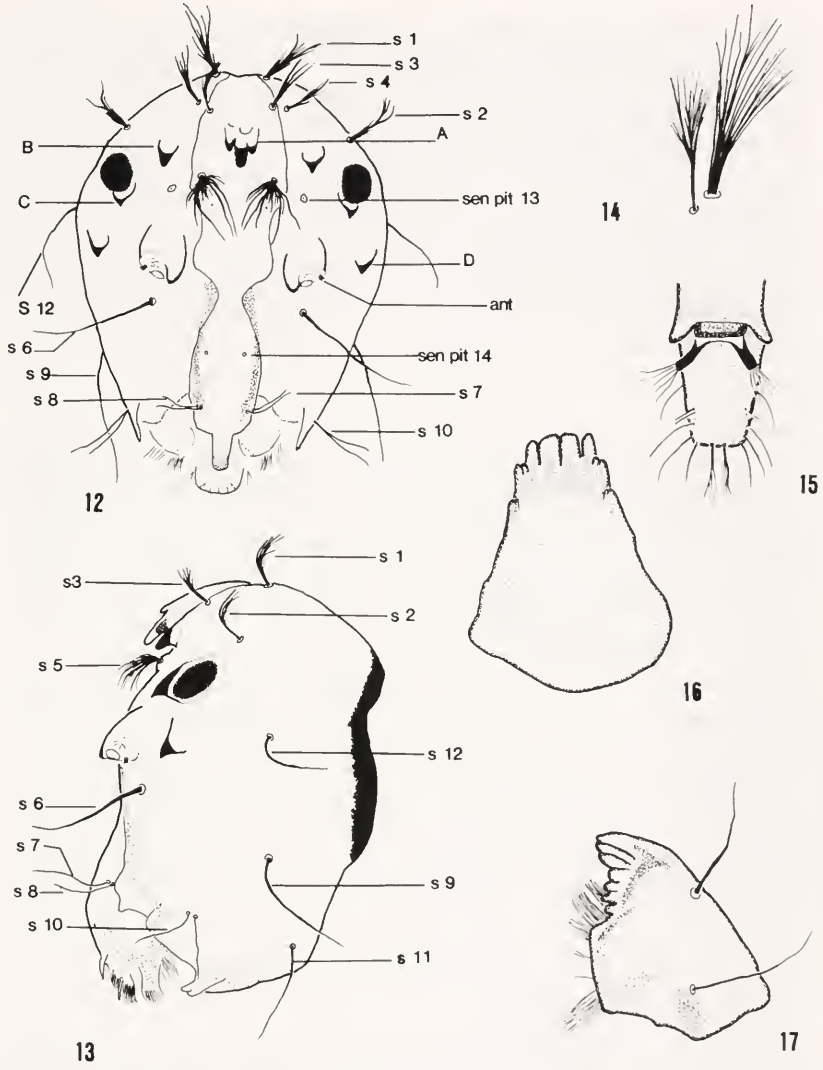
Dorsum of head with Y-shaped ecdysial line dividing head into anteromedian frontoclypeal apotome, and posteriolateral genae; stem of this line continuous with similar one extending posteriorly to hind margin of mesothorax (Figs. 6-7, 9). Frontoclypeal apotome with short, fine, dorsolateral seta on each side; each gena with one long, spinelike seta, and one short, fine, more medial seta. Respiratory horn (gill) short, truncate, with spiracular pits arranged in rows on apex of horn (Fig. 8); with 3 precorneal setae (prc) near base of horn. Mesothorax with 4 dorsocentral setae (dc), dc_{1-3} arranged in a triangle, dc_2 spinelike (Fig. 9). Metathorax with subconical, posterolateral extensions surrounding abdominal tergite 1, and reaching tergite 2; with 3 dorsal setae, posterior seta spinelike (Fig. 9).

Abdominal segments 2-8 angulate laterally with anterolateral and posterolateral corners of tergites acute. Spiracles situated on anterolateral corners of segments 2-7. Tergites 1-2 with one spinelike, posteriorly directed, dorsal seta (D), and basal accessory seta. Tergites 3-7 with 2 curved, spinelike D setae situated together on a low papilla; D_1 directed anteriorly, D_2 directed posteriorly (Fig. 10). Segments 2-7 with 2 long, spinelike, lateral setae (L); L_1 straight, on short papilla anterior to spiracle, L_2 curved dorsally, on low papilla at posterolateral corner, also with basal accessory seta (Fig. 11). Segment 8 with D_2 weak and inconspicuous; L_2 spinelike, straight, located ventrolaterally proximal to median pair of short, spinelike, ventral setae (V). Caudal segment terminating in pair of large, dorsally curved hooks, and a single, spinelike L seta. Sternites 3-7 with submedian pair of short, spinelike V setae on anterior margin of segment (Fig. 11).

Larva (final instar): Body, 7.4-9.2 (av 8.3) mm long; head capsule and dorsal body integument brown, hypostoma, mandible and postoccipital margin of head darker brown. Head capsule (Figs. 12, 13) with 3 pairs of conelike protuberances (B, C, D), and median, unpaired, trilobed protuberance (A) (some specimens with median protuberance reduced or worn, others with 3 well-developed pointed lobes). Antenna with sensory ring and 3 minute, fingerlike processes situated on membranous region on tip of cylindrical, asymmetrically pointed protuberance. Mandible with simple tip and 6 teeth (Fig. 17); hypostoma with 4 smoothly rounded, median teeth and 4 pairs of short, lateral teeth (Fig. 16). Chaetotaxy: 12 pairs of setae (1-12), and 2 pairs of sensory pits (13, 14); setae 1-4 plumose; seta 5 bushlike; seta 8 narrow and pale, remaining setae dark and simple (Figs. 12, 13). Body with 3 distinct thoracic and 9 abdominal segments. Thoracic macrosetae stout and plumose (Fig. 14); anterior spiracle semicircular, with pits on outer margin. Abdominal segments 1-7 each bearing 4 pairs of dorsolateral, plumose setae; segment 8 with 2 pairs of plumose setae. Abdominal segment 8 bearing transverse spiracular plate with 2 lateral, fingerlike procerci, each bearing 5 terminal bristles (Fig. 15). Terminal segment bearing several simple setae and 3 pairs of stout, terminal setae; median pair plumose (Fig. 15).

BIOLOGICAL NOTES

The latitude and the prevailing trade-wind circulation gives the lower elevations of the Canary Islands, especially the low eastern islands, a mainly semi-arid character, while in the mountainous western islands a greater variety of habitats and a forest belt occurs at the middle elevations (Höllermann 1981). The average air temperatures of these forests vary between 11° and 20°C, depending on the season. *Thaumalea subafricana* has been found on the islands of Tenerife, Gran Canaria, and LaPalma,



Figs. 12-16. *Thaumalea subafricana.* Larva. 12, Head Capsule, front view. 13, Head capsule, lateral view. 14, Plumose macrosetae of thorax. 15, Terminal abdominal segments. 16, Hypostoma. 17, Mandible, outside surface. Abbreviations: A, Unpaired, trilobed protuberance; ant, antenna; B,C,D, paired, conelike protuberances; s, seta (1-12); sen pit, sensory pit (13, 14).

and is restricted to the more humid sections of the native laurel forests. The larvae live in the thin film of water flowing over smooth, bare, rocks along the edges of streams in these forests. Sometimes they are found in thin films of water along the edges of small waterfalls and, occasionally, the larvae are found on the wet walls of man-made water tanks which provide a madicolous habitat similar to that along the edges of natural streams. Larvae are present throughout the year, but adults are most common in the spring and summer seasons. Although adults sometimes are found away from madicolous habitats, they generally are found settled on or near wet rocks where the larvae occur. Copulation occurs while landed, and has been seen as early in the year as March. Swarming has not been observed.

DISCUSSION

Comprehensive collections of species of thaumaleids are available in only relatively few museums. Most descriptions of adult thaumaleids are superficial and concentrate largely on characters of the male terminalia that are widely used for species identification. Our descriptions of the various life history stages are somewhat more detailed and include a wider array of morphological features than found in previous descriptions. We hope that others redescribing already named species or describing new species, will also include more detailed descriptions of more morphological features so that a wider range of species and their potential characters can be more thoroughly compared than is now possible without having specimens of the various species at hand.

After examining the pupae of several North American species, it appears that pupal charcters are reliable for the identification of species, perhaps more so, than those of the male terminalia. Furthermore, characters of the pupa are much easier to see and use. This observation will need confirmation, however, and other workers are encouraged to seek and/or rear pupae for study and provide adequate descriptions thereof. Larvae of at least some species are relatively easy to rear to pupal and adult stages using the methods outlined by McLellan (1983), and Sinclair and Marshall (1986).

Until now, *T. subafricana* remained relatively unknown, and being restricted to the Canary Islands, indeed the only species of the family presently known there, has made it relatively unavailable for investigation. Bezzi (1913), Edwards (1929), and Lindner (1930) provided descriptions of *T. subafricana,* and some other authors have mentioned this species, in one way or another, in print. The references cited in the synonymy are not intended to represent a complete bibliographic listing for this species, but do constitute the most important references to this species.

Of special note, the antennal arista of *T. subafricana* consists of 8 flagellomeres with the first flagellomere sometimes imperfectly or not clearly separated from the second flagellomere making it appear that there are 7 flagellomeres. Very few descriptions even mention the antenna; however, Dyar and Shannon (1924) noted that for the American species, the arista was composed of 10 distinct 'joints', and Enderlein (1936) provided an illustration showing 10 flagellomeres. Vaillant (1959) stated that the antenna of *T. americana* Bezzi was 12 segmented, and gave the proportions of the antennal segments showing that there were 10 flagellomeres. He also mentioned that the number of antennal segments in *T. thornburghae* Vaillant was most variable, having from 5 to 8 flagellomeres. Stuckenberg (1961) mentioned that an undescribed South African species of *Afrothaumalea* had an antenna composed of at least 11 segments with an aristate flagellum composed of 9 flagellomeres. It seems apparent from his figure, that what he considered to be the pedicel is really the first flagellomere and, if this is correct, then his species really has 10 flagellomeres. Brothers (1972) indicated that *T. santaclaraensis* Brothers had a 12-segmented antenna which again indicates that the flagellum consists of 10 flagellomeres. Whether this character is highly variable, or whether it has specific significance remains to be determined, another reason for more comprehensive descriptions.

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THE STATUS OF *UROPHORA ACUTICORNIS* AND *U. SABROSKYI* (DIPTERA: TEPHRITIDAE)[1]

Allen L. Norrbom[2]

ABSTRACT: *Urophora acuticornis* is transferred to *Rhagoletis* (Trypetinae). Its relationships to other species of *Rhagoletis* and other related genera, here placed in the new subtribe Carpomyina, are discussed. Hypothesized synapomorphies for the Carpomyina and for the tribe Myopitini (Tephritinae) are also discussed. *Urophora sabroskyi* is considered a junior synonym of *Aciurina bigeloviae*.

Steyskal (1979) provided a much needed review of the genus *Urophora* Robineau-Desvoidy (Tephritinae, Myopitini), including keys to the New and Old World species and descriptions of 20 new species. While reviewing a draft of the forthcoming Handbook of the Tephritidae of America north of Mexico (R.H. Foote & F.L. Blanc, in prep.), I discovered that two of these species, *acuticornis* Steyskal and *sabroskyi* Steyskal, are not true *Urophora* or even members of the tribe Myopitini. *Urophora acuticornis* belongs to *Rhagoletis* Loew (Trypetinae), whereas *sabroskyi* is a synonym of *Aciurina bigeloviae* (Cockerell). To make these changes available for the Foote & Blanc handbook, the relationships and proposed reclassification of these species are discussed. Synapomorphies for the Myopitini and the new subtribe Carpomyina (Trypetinae, Trypetini) are also analyzed.

MATERIALS AND METHODS

Specimens were examined from the following collections: California Academy of Sciences (CAS); National Museum of Natural History, Smithsonian Institution (USNM); and University of Arizona (UAT). The morphological terminology follows McAlpine (1981), except as noted in Norrbom & Kim (1988), and for the wing pattern, Foote (1981).

Rhagoletis acuticornis (Steyskal), *n. comb.*

Urophora acuticornis Steyskal 1979: 43 (holotype ♂ (USNM), Texas: El Paso).

In addition to the holotype, I examined the following specimens of *acuticornis:* 1 ♂ 1 ♀ (USNM), New Mexico, Dona Ana Co., Las Cruces, 22.V.1985, C.A. Sutherland; 1 ♂ (CAS), New Mexico, Sierra Co., Percha

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Dam State Park, 16.V.1986, W.J. Pulawski; and 1 ♂ (UAT), Arizona, Phoenix, Cotton Research Center, 11-14.V.1979, G. Butler. I have not examined the allotype ♀ from California.

A brief redescription based on these specimens is given here because a number of important characters were not included in the original description.

Length 2.9-3.5 mm; all setae dark brown to black, slender., Head: yellow, except most of occiput and postgena blackish; face with strong carina; 3-4 pairs of frontal setael; 2 pairs of orbital setae, posterior pair inclinate; first flagellomere of antenna with distinct dorsoapical point. Thorax: dark brown to black except most of scutellum medially and dorsal anepisternal stripe yellow; postpronotal lobe and all of scutum dark; scutum microtrichose except for anterior 1/4 and posterior 1/3, microtrichose area sometimes divided by narrow bare stripes; dorsocentral setae about even with supra-alar setae; lateral pair of scapular setae well developed, medial pair small. Legs: yellow except hind coxa and base of hind femur usually brown. Wing (Fig. 5): pattern dark brown, reduced, with narrow discal and subapical bands, interrupted subbasal band, and small spot at apex of R_{2+3} and broad spot at apex of R_{4+5} that apparently represent the anterior apical band; accessory costal and posterior apical bands absent; subapical band meeting costa well basal to apex of R_{2+3}; Cu_2 straight or slightly concave. Abdomen: tergites entirely dark, without bands; pleura transparent, membranous; male with epandrium (Fig. 2) short along longitudinal axis; anterior lobe of interparameral sclerite (sternite 10) well developed; outer surstylus about 2 times as long as inner surstylus, with small mesal lobe (Fig. 3) just beyond apex of inner surstylus; distiphallus (Fig. 4) with small, simple, non-setose apical lobe; female with 3 spherical spermathecae; syntergosternite 7 with large medioapical unsclerotized area ventrally, a smaller one dorsally; aculeus about 0.91 mm long, apex elongate, slender, simple.

Urophora acuticornis does not belong in the tribe Myopitini, which is defined by three synapomorphies: 1) the posterior pair of orbital setae absent; 2) vein Cu_2 convex (White & Clement 1987); and 3) the abdominal pleura opaque, darker than the sternites (at least in all species of *Myopites* Blot, *Rhynencina* Johnson, and New and Old World *Urophora* that I have examined). The plesiomorphic states of these characters are present in *acuticornis;* both pairs of orbital setae are present, vein Cu_2 is straight to slightly concave, and the abdominal pleura are light yellow and transluscent. The female of *acuticornis* also has three spermathecae, the plesiomorphic state in the Tephritidae. All Myopitini and other Tephritinae have only two (Hancock 1986). Finally, the holotype of *acuticornis* was reared from a fruit of *Lycium berlandieri* Dunal (Solanaceae), whereas the Myopitini breed in flower heads or stem galls of Asteraceae.

As in the tribe Terelliini (Tephritinae), *acuticornis* has convergent posterior orbital setae, a derived character state within the Tephritidae.

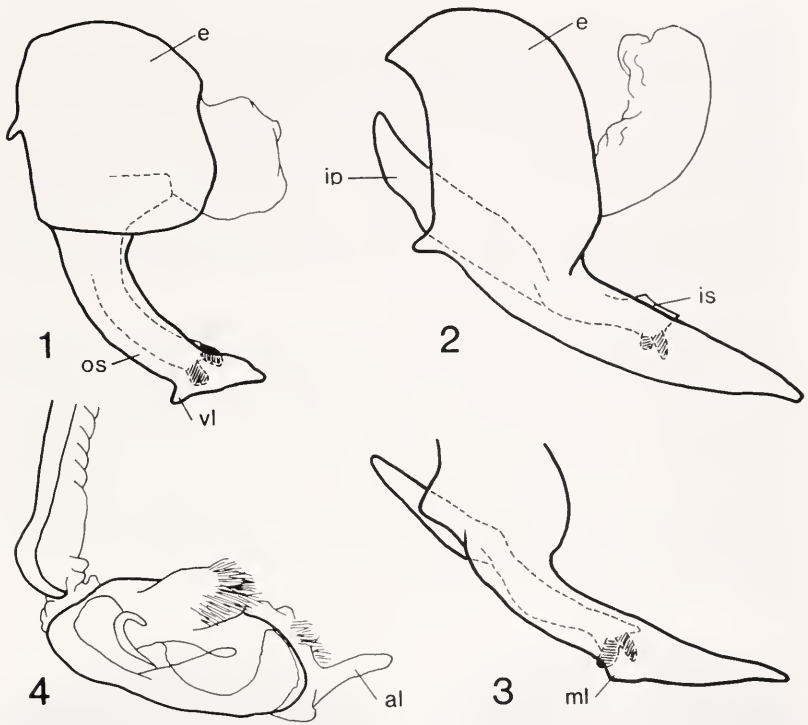

Figure 1, *Aciurina bigeloviae* (holotype of *U. sabroskyi*), epandrium and surstyli, lateral view. Figure 2, *Rhagoletis acuticornis,* Las Cruces, N. M., epandrium and surstyli, lateral view. Figure 3, same, ventrolateral view. Figure 4, same, distiphallus. al - apical lobe of distiphallus, ip - interparameral sclerite, is - inner surstylus, ml - mesal lobe of outer surstylus, os - outer surstylus, vl - ventral lobe of outer surstylus.

Figure 5, *Rhagoletis acuticornis,* Las Cruces, N.M., wing.

In the Foote & Steyskal (1987) key to the Nearctic genera of Tephritidae, it runs with difficulty to *Orellia* Robineau-Desvoidy. This similarity with the Terelliini is due to homoplasy, however. Other apomorphies of the Terelliini (e.g. lyre-shaped scutal pattern, two spermathecae) are not present, and other derived characters indicate that *acuticornis* belongs to the Carpomyina, new subtribe (Trypetinae, Trypetini). This subtribe includes at least the following genera: *Carpomya* Costa, *Myiopardalis* Bezzi, *Goniglossum* Rondani, *Rhagoletis* Loew, *Zonosemata* Benjamin, *Stoneola* Hering, *Haywardina* Aczél, *Cryptoplagia* Aczél, *Rhagoletotrypeta* Aczél, *Cryptodacus* Hendel, and *Lezca* Foote.

The Carpomyina is defined by a single synapomorphy, although at least one other character may be a synapomorphy with some homoplasy due to secondary modification. In all Carpomyina, including *acuticornis*, the apex of syntergosternite 7 of the female has a weakly sclerotized apicomedial area ventrally and usually dorsally, a clearly apomorphic character that I have not observed in any other Tephritidae. In dried specimens this unsclerotized area is visible only as a pair of weak folds (e.g. see Stoffolano & Yin 1987, Fig. 7), but it is distinct in cleared preparations of the terminalia (Fig. 6).

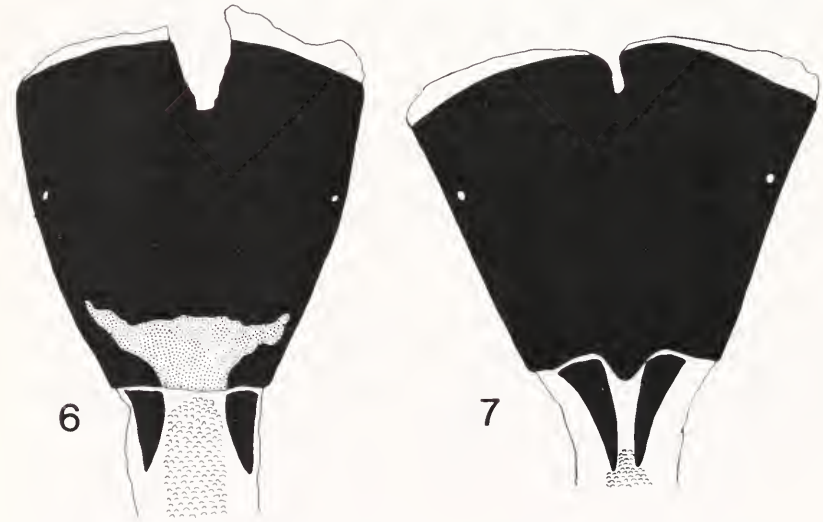

Figure 6, *Rhagoletis pomonella* (Walsh), New Haven, Conn., female syntergosternite 7, ventral view. Figure 7, same, *Oedicarena latifrons* (Loew), Lagunas de Zempoala, Mexico.

Another possible synapomorphy for the Carpomyina is the type of male terminalia found in most species, with the outer surstylus elongate, with a mesal lobe just posterior to the apex of the inner surstylus. The outer surstylus lacks the mesal lobe in some species of *Rhagoletotrypeta* and it is short and without the lobe in *Zonosemata,* but this may be secondary modification from the shape in the other genera. Species of *Paraterellia* Foote, which may be related to the Carpomyina, also have elongate surstyli with a mesal lobe; this similarity may be the result of homoplasy or the shape of the surstylus may be a synapomorphy for a larger taxon including the Carpomyina and *Paraterellia* (Norrbom *et al.,* 1988).

Another character of possible phylogenetic significance is the accessory costal wing band, which is present in *Oedicarena* Foote and about half of the species of Carpomyina, but is rare in other Tephritidae. It may be a synapomorphy for a larger taxon including *Oedicarena* and the Carpomyina, with considerable secondary loss. Berlocher & Bush (1982) suggested a close relationship between *Zonosemata,* some species of *Rhagoletis,* and *Oedicarena* based on electrophoretic data, but unless there has been considerable homoplasy in genetalic characters, *Oedicarena* and *Paraterellia* are at most the sister group of the Carpomyina (Norrbom *et al.,* 1988). Both *Paraterellia* and *Oedicarena* have the apex of female syntergosternite 7 normally sclerotized (Fig. 7) and differ from the Carpomyina in a number of characters of the male terminalia.

Within the Carpomyina I am uncertain of the relationship of *acuticornis* to the other taxa. The antennal first flagellomere in *acuticornis* has a dorsoapical point, an apomorphic character found in *Carpomya, Myiopardalis, Cryptoplagia, Haywardina, Zonosemata,* and most *Rhagoletis,* but the significance of this character is unclear. It is intraspecifically variable in some species of *Rhagoletis* and was probably lost in *Goniglossum,* which appears closely related to *Myiopardalis.* I have discovered no other obvious synapomorphies for *acuticornis* and any other taxa of Carpomyina; *acuticornis* lacks derived characters such as the crease or spur vein in cell r_1 in *Carpomya, Myiopardalis,* and *Goniglossum,* r-m located near dm-cu in *Haywardina,* the distinctively shaped distiphallus and spermathecae of *Zonosemata,* the serrate aculeus of *Cryptodacus* and *Lezca,* and the white or yellow medial sctual stripe found in *Cryptodacus, Lezca, Rhagoletotrypeta, Cryptoplagia, Haywardina,* and *Zonosemata. Paraterellia* have convergent posterior orbital setae like *acuticornis,* but the relationship of that genus to the Carpomyina is unclear, and a close relationship between it and *acuticornis* is doubtful. Except for the convergent posterior orbitals, *acuticornis* fits the diagnosis of Bush (1966) for

Rhagoletis; however, all of the characters in that diagnosis are probably plesiomorphic for the Carpomyina, and *Rhagoletis* as currently composed is probably paraphyletic (Bush 1966, Berlocher & Bush 1982). Although the species of *Rhagoletis,* especially those from the Nearctic Region, have been well studied and segregated into a number of species groups (Bush 1966, Berlocher & Bush 1982, and Foote 1981), the monophyly of the genus has not been demonstrated and its relationships to other Carpomyina are poorly understood.

None of the currently recognized species groups of *Rhagoletis* will easily accommodate *acuticornis.* The *psalida* group (Foote 1981), in which the postpronotal lobe is entirely black and the anterior and posterior apical wingbands are often incomplete, might be related. One species of the group, *metallica* (Schiner), also has the abdominal tergites entirely black like *acuticornis.* However, *acuticornis* lacks other derived characters of the *psalida* group, such as the scutellum entirely black, the scutum without microtrichia, and the subapical band ending anteriorly near the apex of vein R_{2+3}. In addition, the spermathecae, which are rodlike in the *psalida* group, are spherical in *acuticornis,* and both the accessory costal and posterior apical bands, which are at least partially present in the *psalida* group, are absent. At least one of those two bands is also present in the *nova, striatella,* and *ferruginea* groups (Foote 1981), those that also breed in Solanaceae like *acuticornis* and the *psalida* group. The reduced wing pattern of *acuticornis* is unlike any other *Rhagoletis* species; in those in which the accessory costal and posterior apical bands are absent, the other wing bands are broad and well developed. The apical lobe of the distiphallus is simple in *acuticornis,* not distinctively shaped as in some *Rhagoletis* species groups (see Bush 1966).

Despite its uncertain relationship to the other species of *Rhagoletis,* the transfer of *acuticornis* to that genus is the most reasonable classification at its time. The establishment of a new genus for *acuticornis* would be premature without a better understanding of the relationships among the species groups of *Rhagoletis* and the other genera of Carpomyina.

Aciurina bigeloviae (Cockerell)

Aciurina bigeloviae (Cockerell); Steyskal 1984: 592.
Urophora sabroskyi Steyskal 1979: 55 (Holotype ♂ (USNM), Washington: Garfield Co., Wawawai). n. syn.

The holotype of *U. sabroskyi* has one of the diagnostic characters of the Myopitini, the posterior pair of orbital setae are absent. This specimen is not a myopitine, however, and lacks the other synapomorphies of the tribe. Although the basal cubital cell does not have a strong posteroapi-

cal extension, Cu_2 is straight and meets vein A_1 at an acute angle (see Steyskal 1979, fig. 14); Cu_2 is not convex as in the myopitini. The abdominal pleura are light yellow and transluscent, not darker than the sclerites as in the Myopitini.

The absence of the pair of posterior orbital setae is not common in *Aciurina* Curran, but Steyskal (1984), in his diagnosis for the genus, states that they are reclinate or absent, and the *sabroskyi* type runs to this genus in the key of Foote & Steyskal (1987). It also has male terminalia typical of *Aciurina* and the genera *Valentibulla* Foote & Blanc and *Eurosta* Loew; the epandrium is elongate along the longitudinal axis, the surstyli are elongate, posteriorly curved, arising from the anterior end of the epandrium, and the outer surstylus has a small mesally curved subapical ventral lobe (Fig. 1). The postocular setae and the scutal setulae, which are usually black and are always slender in the Myopitini, are all white and slightly sowllen. There are 4-5 pairs of frontal setae, not the usual 2 in the Myopitini.

The holotype of *sabroskyi* runs to *bigeloviae* (Cockerell) in Steyskal's (1984) key to the species of *Aciurina,* and *sabroskyi* is here considered a junior synonym of that species. Steyskal's concept of *bigeloviae* probably represents a species complex (Dodson & George 1986; J. Jenkins, pers. comm.), however, because it includes populations that form several types of galls and, compared with other species of *Aciurina,* a large amount of variation in wing pattern. When this complex is resolved, *sabroskyi* will likely be recognized as a synonym of one of the other species that Steyskal (1984) synonymized under *bigeloviae.* The wing pattern of the *sabroskyi* type (see Steyskal 1979, Fig. 14) is unlike typical *bigeloviae;* it is highly reduced and similar to that of the type of *semilucida* Bates (see Steyskal 1984, Fig. 16). It also resembles that of *notata* (Coquillett) in that there is no dark spot in cell c, but cell sc is elongate as in *bigeloviae.*

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DISONYCHA PUNCTIGERA (COLEOPTERA: CHRYSOMELIDAE): FIRST HOST RECORD OF A LITTLE-KNOWN FLEA BEETLE[1]

A.G. Wheeler, Jr.[2]

ABSTRACT: Crownvetch, *Coronilla varia* L., an introduced herbaceous legume, is recorded as the first known host of the flea beetle *Disonycha punctigera* LeConte. In mid-June, 1987, larvae of this alticine chrysomelid were observed defoliating a small crownvetch planting in the Ozark Mountains of northern Arkansas. A tachinid, *Myiopharus* sp., prob. *ancillus* (Walker), is reported as a larval parasitoid.

Disonycha punctigera LeConte is one of the lesser-known North American members of the large flea beetle genus *Disonycha* Chevrolat, which ranges from Canada to South America (Blake, 1933). Herein, the first larval host of this alticine chrysomelid is reported, and the rearing of a tachinid as a larval parasitoid is mentioned. Arkansas is listed as a new state record for *D. punctigera.*

Disonchya punctigera LeConte

LeConte (1859) described this chrysomelid from Kansas, with the type locality recorded as near the Rocky Mountains. *Disonycha neglecta,* described by Schaeffer (1931) from Kansas, and *D. punctipennis,* described from Iowa in the same paper, are considered junior synonyms of *D. punctigera* (Blake, 1933). Schaeffer's (1931) records of *D. neglecta* from Arizona, Oregon, and Utah refer to a species of *Disonycha* other than *punctigera,* perhaps the wide-ranging *D. alternata,* which is known from those states and which Schaeffer confused with *D. punctigera* (Blake, 1933; Hatch, 1971). Because Blake did not list *D. punctigera* from Minnesota, Schaeffer's record of *D. punctipennis* from that state may also be based on a misidentification of *D. alternata.* From *D. alternata,* which has distinct lateral callosities on the pronotum, *D. punctigera* can be distinguished by having the pronotum evenly convex (Fig. 1). In addition to Iowa and Kansas, *D. punctigera* is known to occur in Alberta, Colorado, Illinois, Montana, Nebraska, New Mexico, and South Dakota (Blake, 1933).

Blake (1933) noted that the food plant was unknown. Beller and Hatch's (1933) record of willow as a host of *D. punctigera* in the Pacific

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Northwest was later referred to *D. alternata* (Hatch, 1971), a species that feeds on *Salix* (De Swarte and Balsbaugh, 1973). Adults of *D. punctigera* were reported as common on corn throughout South Dakota during summer 1965, feeding on silks and kernels; adults also were said to be common in alfalfa (Jones and Nearman, 1965). Even though *D. punctigera* occurs in South Dakota (Blake, 1933; Kirk and Balsbaugh, 1975), it is possible that the adults observed in alfalfa and corn were mistaken for a weed-feeding species of *Disonycha* present in the fields. Several species of the genus feed on common weeds of the Amaranthaceae and Chenopodiaceae (e.g., Duckett, 1920; Hemenway and Whitcomb, 1968; Wilcox, 1979).

Crownvetch as a host plant. — On an insect collecting trip to Arkansas in June 1987, large numbers of yellowish larvae that were stripping the foliage of crownvetch, *Coronilla varia* L., attracted my attention. The population, estimated at several hundred, was present on 17 June in a small colony of this legume (about 50 m^2) in the Ozarks of northern Arkansas, in Robinson Point Park east of Mountain Home, Baxter Co. Mainly third (last) instars were defoliating a portion of the sparse, shaded planting. No larvae were found on nearby herbaceous plants, including several legumes.

When provided with sprigs of crownvetch, larvae fed voraciously for several days, then ceased feeding and burrowed into soil that had been placed in the bottom of the plastic rearing boxes. The prepupal stage lasted about a week, and two adults emerged on 23 July. Voucher specimens of larvae and one adult are retained in the Pennsylvania Department of Agriculture collection (PDA); the other adult has been deposited in the insect collection of Cornell University (CUIC).

Crownvetch, a perennial, herbaceous legume native to central Europe, is widely used for slope stabilization and erosion control, particularly along highways, and is sometimes used for beautifying home grounds (Henson, 1963; McKee, 1971). In Pennsylvania, the economic use of crownvetch dates from the mid-1930's (Grau, 1968). Crownvetch was considered pest-free initially, but an arthropod fauna of about 125 species now has accrued to this plant, including 19 species that sometimes are numerous (Wheeler, 1974). The only significant defoliators observed have been the grasshoppers *Melanoplus differentialis* (Thomas) and *M. femurrubrum* (DeGeer), and larvae of a gelechiid moth, *Syncopacma palpilineella* (Chambers) (Wheeler, 1974; Valley and Wheeler, 1976).

An allomone, 3-nitroproprionic acid (NPA) that is present in crownvetch, is toxic to nonruminant animals and may act as a deterrent to some insect herbivores (Byers *et al.*, 1986). They found that NPA adversely affected growth and development of the tortricid *Sparganothis sul-*

Fig. 1. *Disonycha punctigera,* habitus.

fureana (Clemens) in the laboratory. In the field, they observed larvae of this species and another tortricid, *Argyrotaenia velutinana* (Walker), mainly in autumn, suggesting that late-season attacks on crownvetch are the result of lower levels of NPA in the host compared to earlier in the season. They also noted that Valley and Wheeler's (1976) data for *S. palpilineella* showed a similar trend of higher autumn populations.

Compared to those lepidopteran herbivores, *Disonycha punctigera* is a relatively early-season defoliator of crownvetch. It apparently is the first chrysomelid known to use this naturalized legume as a host in North America. The native host plant of *D. punctigera,* like that of *S. palpilineella* (Valley and Wheeler, 1976), awaits discovery. It would also be interesting to determine whether this flea beetle uses crownvetch as a host in other parts of its range.

At least one other North American species of *Disonycha* may develop on leguminous plants. *Disonycha admirabilis* Blatchley has been reported from *Cassia* sp. and a wild legume (Blake, 1933). Adults have been collected on *Schrankia* sp. in Missouri (Riley and Enns, 1979).

Parasitism by a tachinid. — During 23-25 July 1987, three adults of a blondeliine tachinid, *Myiopharus* sp., prob. *ancillus* (Walker), emerged in

the container used to rear *D. punctigera* larvae. Members of this genus are mainly parasitic on Chrysomelidae; *M. ancillus* has been reared from the galerucine *Diabrotica undecimpunctata* Mannerheim (Arnaud, 1978).

The Arkansas rearing is the first record of a parasitoid on *D. punctigera.* If the tachinid reared is *M. ancillus, D. punctigera* is a new host record. Voucher specimens have been deposited at PDA and in the CUIC.

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FIELD SEMINARS ON INSECTS AND NATURAL HISTORY

The Eagle Hill Wildlife Research Station (EHWRS), located on the edge of the ocean 35 miles east of Bar Harbor, ME, is offering a series of advanced and professional field seminars in natural history from May through September. The seminars on "The Lepidoptera: Moths, Advanced Techniques for Identification" by Dr. Charles Covell and "Forest Entomology for Professionals" by Richard G. Dearborn should be of particular interest to entomologists. For information, write or call EHWRS, Dyer Bay Rd. Steuben, ME 04680, (207-546-2821).

CHARACTERIZATION AND RELATIONSHIPS OF THE SUBGENERA OF *ISONYCHIA* (EPHEMEROPTERA: OLIGONEURIIDAE)[1,2]

W.P. McCafferty[3]

ABSTRACT: Abdominal gill spination is shown to be of limited taxonomic value in North American *Isonychia:* Apical spines vary on gills 1-6 in larvae of the *bicolor* species group of the subgenus *Isonychia,* and apical spines vary on gill 7 of *Isonychia (Prionodes) sayi.* Subgeneric classification is justifiable; however, certain larvae are not separable to subgenus or species. A plesiomorphic phylogenetic position of *I. sayi* within the subgenus *Prionodes* is suggested since it shares some but not all synapomorphies with other *Prionodes.* Two alternative species phylogenies are presented and show *Isonychia* s.s. as either a monophyletic or paraphyletic group depending on the relationships of the *bicolor* group. A new subgenus *Borisonychia* is established for *Isonychia diversa* and is consistent with cladistics showing *I. diversa* to be intermediate between *Isonychia* s.s. and its more apomorphic sister lineage *Prionodes.* Male genitalia are clearly diagnostic of the subgenera. A synopsis of subgeneric and species group classification of the 18 North American species is given.

Isonychia is a well known genus of brushlegged mayflies that was recently revised for North and Central America by Kondratieff and Voshell (1984). Adults were delineated at the subgeneric and specific level in the work, but as the authors admitted, the larvae of certain species remain difficult, if not impossible, to distinguish. My research indicates that distinguishing larvae to subgenera is also problematic.

Examination of the gills of middle to late instar larvae has revealed inconsistencies in subgeneric abdominal gill characterization in the *bicolor* species group of the subgenus *Isonychia* and *I. sayi* of the subgenus *Prionodes.* It is important to recognize potential problems that key users may encounter because *Isonychia* larvae are among the most commonly sampled riffle-dwelling mayflies, especially in central and eastern North America. Ecologists and others often need to identify middle instar and older individuals for meaningful biological assessments. In addition, the method for keying larvae to species is now predicated on their subgeneric placement (see keys of Kondratieff and Voshell 1984).

Isonychia was divided into the subgenera *Isonychia* s.s. and *Prionodes* by Kondratieff and Voshell (1983). Structural characteristics of male adult styliger, female adult subanal plate, and shape of the eggs are distinct for these subgenera, and warrant the division. The condition of the larval forecoxal gills distinguishes these subgenera except for one species.

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Also, adult penes can be clearly divided into two subgeneric types except for one other species. Explanations for these exceptions within the context of cladistics and the establishment of a new subgenus are taken up later under the subject of relationships.

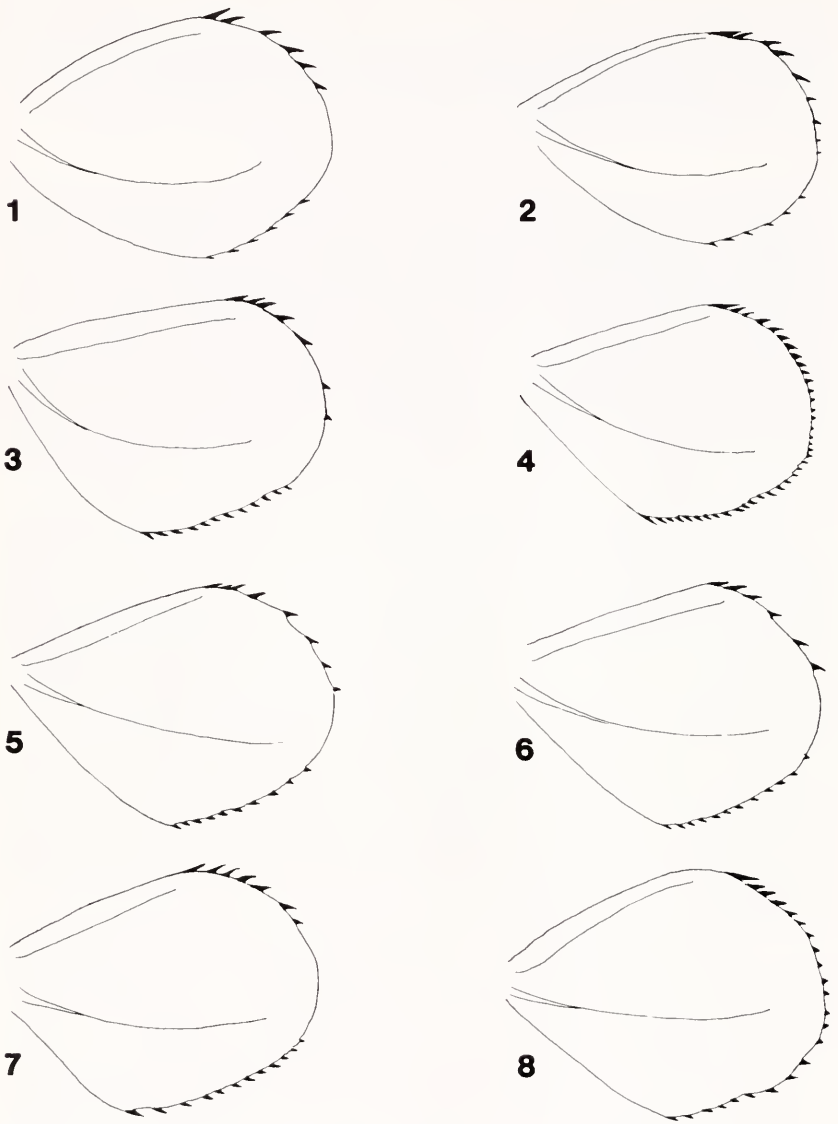
KEY CHARACTERISTICS

In the larval key of Kondratieff and Voshell (1983) *Prionodes* was said to have "posterior gills without apical stout spines" and "forecoxae gills single (except *I. sayi);*" whereas *Isonychia* s.s. was said to have "posterior gills with apical stout marginal spines" and "forecoxae gills in tufts." Under the description of *Isonychia* s.s., however, it was said that spines were on the apical margin "of all gills." Kondratieff and Voshell (1984) maintained use of these traits, with the exception that in their descriptions and key the apical spine character was applied to "abdominal gill lamella," with no specification of exact gills involved. Although abdominal gill 7 was the one illustrated in both of these studies, it must be presumed that the statements referred to all abdominal gills.

My study of the *bicolor* group indicates that abdominal gill spination varies among gills. I have examined *I. bicolor, I. rufa,* and *I. velma* of this group. Gills 1-5, and sometimes 1-6, of these species often lack apical spines (Fig. 1). Ultimate or penultimate instars tend to have apical spines on gills 4-7 (Figs. 3 and 4), but not always. There is also individual and population variation in the number of apical spines and the exact number of gills involved, with the more anterior gills more apt to lack apical spines. The character is further confounded by inevitable differences in interpretation of the actual limits of the apical margin of a rounded gill lamella. Gill 7 does appear always to have apical spines, but these can be weak (Fig. 2), and high magnification and special lighting are sometimes necessary to detect them because of the short, thick setae also situated along the margin. Unfortunately, gill 7 is easily broken off when specimens are collected or handled.

The often distinctively patterned larvae of *I. sicca* (see Provonsha and McCafferty 1982) of the *sicca* species group of *Isonychia* s.s. have apical spines on at least gills 3-7. There is no problem in placing them, and perhaps other *Isonychia* s.s. not treated here, to subgenus.

Larva of *I. sayi,* the only *Prionodes* species that could be confused with *Isonychia* s.s. because of its forecoxal gills, may or may not possess apical spines on abdominal gill 7, even within the same population and age class (Figs. 6 and 8). No other gills, however, possess apical spines (Figs. 5 and 7). Thus, certain individuals can be structurally similar to some of the *bicolor* group, and even the use of gill 7 is not failsafe.

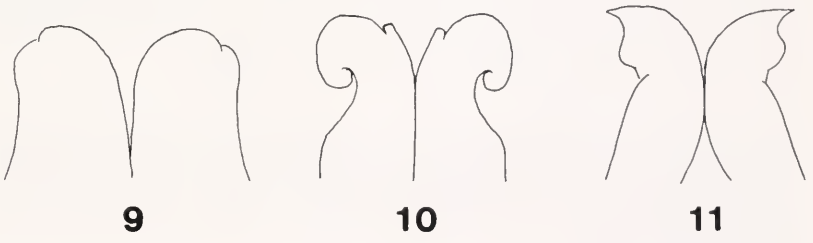


Figures 1-8. *Isonychia* larval abdominal gill lamellae. 1-2. *I. velma* (middle instar, California). 1. gill 6. 2, gill 7. 3-4. *I. bicolor* (last instar, Indiana). 3, gill 4. 4, gill 7. 5-6. *I. sayi* (typical middle instar, Florida). 5, gill 6. 6, gill 7. 7-8. *I. sayi* (atypical middle instar, Florida). 7, gill 6. 8, gill 7.

Using the simple forecoxal gill, larvae of the southeastern species *I. hoffmani, I. georgiae, I. notata,* and *I. obscura* key easly to *Prionodes* and can then be keyed to species. All known *Isonychia* s.s. larvae can be keyed by their multibranched forecoxal gills, but *I. sayi* would also key here. Furthermore, although the keys of Kondratieff and Voshell (1984) were an important advance, once the forecoxal gill type is determined, certain of these larvae may be impossible to key to species using present structural characters. For example, it is still doubtful if midwestern cohabiting *I. rufa* and *I. bicolor* can be differentiated by number of metafemoral cleft spines (couplet 5), and gill spination characters in couplet 2 only work "usually" and are very difficult to interpret (references to "gills 6-8" are obvious typographical errors). Use of color patterns of large series along with distributional data should lead to accurate identification of several species. These data can be gleaned from the comprehensive species treatments of Kondratieff and Voshell (1984), which are superior to those previously available from Traver (1935).

RELATIONSHIPS

Regarding cladistic relationships, *Prionodes* appears to be the most specialized subgenus as is illustrated by the apomorphic penes (Fig. 11) of that group as compared to those of *Isonychia* s.s. (Fig. 9). *Prionodes* penes have uniquely toothed, dorsally recurved, lateral lobes (see figures of Kondratieff and Voshell 1984). The reduction of the forecoxal gill to a single filament in *Prionodes* is also apomorphic. From this, it can be deduced that *I. sayi* is an early branched lineage within *Prionodes* (Figs. 12 and 13) because it does not share this apomorphic forecoxal gill, or an apomorphic two-spot marginal pigmentation of gill lamellae, with the other *Prionodes.* (I recognize these other *Prionodes* species as the *georgiae* species group.) This phylogenetic position may explain the tendency for



Figures 9-11. Outline shapes of *Isonychia* penes. 9, *I. (Isonychia) sicca.* 10, *I. (Borisonychia)* diversa. 11, *I. (Prionodes) obscura.*

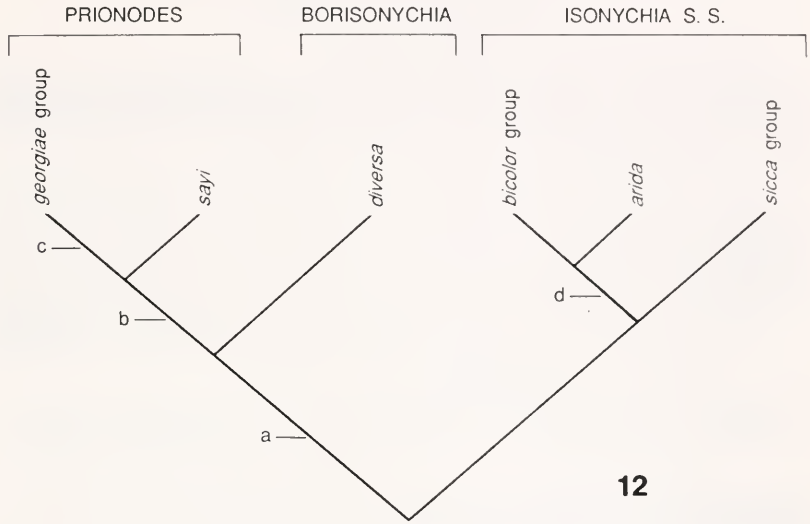
apical spines to remain on gill 7 in some individuals of *I. sayi,* since the characteristic is not totally lost, as it apparently is in the *georgiae* group lineage.

If the above hypotheses are correct it is possible that the *bicolor* group of *Isonychia* s.s. (a lineage that includes *I. arida*) shares an immediate common ancestor with *Prionodes* (Fig. 13). This possible relationship may be supported by the tendency in *bicolor* group species to lose apical gill spination in the anterior gills, sharing such a derivation with *Prionodes.* More cladistic data, however, are required before it can be resolved whether *Isonychia* s.s. is monophyletic (Fig. 12), or alternatively, paraphyletic (Fig. 13).

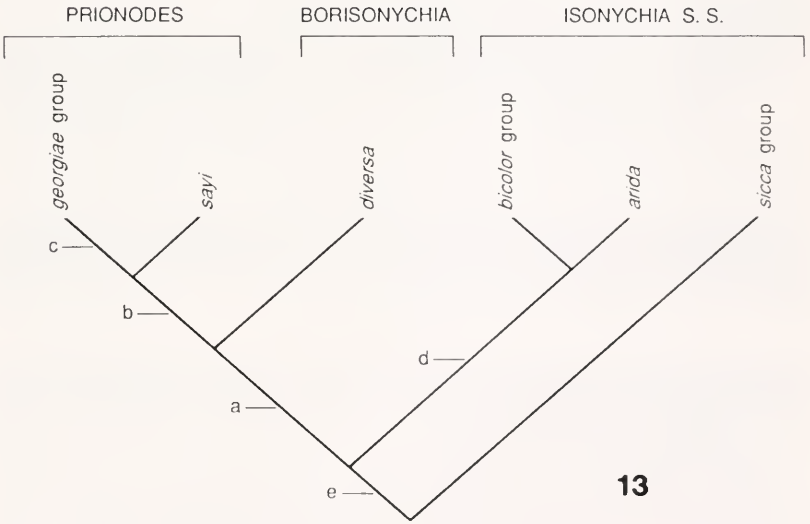
An important additional consideration in the phylogeny of *Isonychia* involves the position of *Isonychia diversa.* This species is known definitely only from the male adult holotype. It was placed in the subgenus *Isonychia* by Kondratieff and Voshell (1983), although they did not place it with any grouping of other species within *Isonychia* s.s. Whereas it retains a plesiomorphic styliger typical of *Isonychia* s.s., its penes (Fig. 10) are highly distinctive and appear intermediate between the plesiomorphic *Isonychia* s.s. (Fig. 9) and more apomorphic *Prionodes* (Fig. 11) penes types. The phyletic position of this species (Figs. 12 and 13) shows it to be a sister lineage to *Prionodes,* sharing initial lateral modifications of the penes. Regarding a female adult apparently taken with the holotype of *I. diversa,* Kondratieff and Voshell (1984) stated that, "this badly damaged specimen is similar to females of the *sicca* and *bicolor* groups." Even if this female is *I. diversa,* it is of no aid cladistically because of the plesiomorphic nature of the *sicca* and *bicolor* group females.

Isonychia diversa could be considered a primitive (early derived) member of *Prionodes,* and such a classification would be more consistent with its cladistic relationships than is the prior *Isonychia* s.s. classification. Moreover, the recognition of a separate subgenus for *I. diversa* is also consistent with its cladistics. Because its genitalia are highly distinctive, and because the male genitalia are definitive descriptors of the subgenera as established by Kondratieff and Voshell (1983), I am herewith establishing a new subgenus for *I. diversa.* I am pleased to name this taxon after the given name of Dr. Boris Kondratieff.

Figures 12 and 13. Hypothetical phyletic relationships of *Isonychia* species and species groups in North America. 12. First alternative cladogram showing monophyletic subgenus *Isonychia.* 13. Second alternative cladogram showing paraphyletic subgenus *Isonychia.* Indicated synapomorphies: a - penes latterally developed, b - penes with acute lateral processes, c - forecoxal gill single, d - penes with dorsal flap, e - tendency for loss of spination on anterior abdominal gills.


PRIONODES
BORISONYCHIA
ISONYCHIA S. S.
georgiae group
sayi
diversa
bicolor group
arida
sicca group
c
b
d
a

12


PRIONODES
BORISONYCHIA
ISONYCHIA S. S.
georgiae group
sayi
diversa
bicolor group
arida
sicca group
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a
e

13

Borisonychia new subgenus

Type species: *Isonychia diversa* Traver, 1934:244.

Diagnosis: *Borisonychia* is distinguished from other *Isonychia* subgenera by the adult penes (Fig. 10) that..."are suddenly incurved and then curve outward again forming more or less rounded apical lobes, which are separated by a median V-shaped notch. Each lobe bears a slight indentation on its apical margin." (Traver 1934).

The classification of North American *Isonychia* can thus be summarized as follows:

Subgenus *Isonychia* s.s.
sicca species group: *I. berneri* Kondratieff and Voshell; *I. campestris* McDunnough; *I. edmundsi* Kondratieff and Voshell; *I. intermedia* (Eaton); *I. sicca* (Walsh).
arida species group: *I. arida* (Say).
bicolor species group: *I. bicolor* (Walker); *I. rufa* McDunnough; *I. tuscalensis* Berner; *I. velma* Needham.

Subgenus *Borisonychia* McCafferty
diversa species group: *I. diversa* Traver.

Subgenus *Prionodes* Kondratieff and Voshell
sayi species group: *I. sayi* Burks.
georgiae species group: *I. hoffmani* Kondratieff and Voshell; *I. georgiae* McDunnough; *I. notata* Traver; *I. obscura* Traver; *I. serrata* Traver; *I. similis* Traver.

ACKNOWLEDGMENTS

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A NEW SPECIES OF *STYLOGASTER* (DIPTERA: CONOPIDAE) WITH NOTES ON SOME TYPES[1]

Sidney Camras[2]

ABSTRACT: *Stylogaster sinaloae* is described from Mexico. Information on some damage to types is given.

The holotype of this unique species was misplaced, and was not studied during the preparation of the review of New World *Stylogaster* (Camras and Parrillo, 1985). The Allotype was recognized as new, but a single female, collected in alcohol, was not appropriate for naming a new species.

Stylogaster sinaloae, sp. nov.

Holotype. ♂ MEXICO: 4.6 mi. E. of Chupaderos, Sin., VIII-22-1964. E.I. Schlinger (University of California at Berkeley).

Head rufous. Ocellar triangle partly, and tubercle entirely black. Occiput partly black above. Antenna rufous. Arista black. First antennal segment about one-fifth length of second. Second and third segments subequal. Proboscis black, yellow at base and on labella.

Thorax rufous, with faint suggestion of dark lines on dorsum. Coxae and legs rufous. Two dark bands on metafemur. Metatibia black on apical two-fifths, middle fifth mainly pale haired. Protarsus and mesotarsus partly black. Metatarsus entirely black. Anterior and posterior bristles on procoxa black. Halter rufous, blackish on club. Costal hairs on wing very short.

Abdomen elongated, almost entirely rufous. Some brownish areas apically on tergites. Fifth sternite with a few black bristles laterally. Bristles on sides of first and second tergites black. Length: 9 mm.

Allotype. ♀, MEXICO: 7 mi. W. Santa Lucia, Sin., 3000', 12.VIII. 1964, W. Mason (University of California at Riverside). Similar to holotype. First and second segments of ovipositor rufous. Slightly brownish on sides of second segment. Third segment dark brown to blackish dorsally, with yellow narrowly at base and apex, and on egg guides. Median process dark brown dorsally and yellow ventrally. Length: 12 mm, of which ovipositor is 4 mm.

This distinctive species is immediately recognizable by the almost entirely rufous coloration, without black pattern on the thorax. This species belongs to the *stylata*-group of species. In the key to males it goes

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to *dispar* which has prominant black areas. In the key to females it goes to *biannulata.* This is the first record of the genus from Western Mexico.

On returning the material from the Canadian National Collection, some specimens with vials came loose, resulting in considerable damage.

Of the following holotypes, a loose head or abdomen was found or the damage was not extensive: *plumidecorata, penai,* and *inca.*

The following holotypes were completely or extensively damaged, but the species can be identified from the paratypes: *dispar, longispina,* and *tarsia.*

On the top of page 122 of the review, the paratypes of *plumidecorata* should have been recorded as females.

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Camras, S. and P.P. Parrillo. 1985. Review of New World *Stylogaster* (Diptera: Conopidae). Am. Ent. Soc. Am. 78: 111-126.

FIRST RECORD OF *CRYPTOLESTES DYBASI* (COLEOPTERA: CUCUJIDAE) OUTSIDE FLORIDA[1]

James E. Throne[2], L. Daniel Cline[2], Michael C. Thomas[3]

ABSTRACT: *Cryptolestes dybasi* was collected for the first time outside Florida on a sticky trap located at a grain storage site in South Carolina.

Thomas (1988) lists 19 species of *Cryptolestes* from North America. The genus includes six economically important pests of stored products in North America. The biology of the economically important species has been intensively studied; however, the biology of the non-economically important species is not well known.

Cryptolestes dybasi Thomas was described from specimens collected in January, 1980, from under the bark of a dead oak tree (unpublished collection information provided by M.C. Thomas) and in May, 1978, at a black light trap in Dixie Co. in the northwestern portion of peninsular Florida (Thomas 1988). There has been no further information published about this species. We report here the collection of this species from South Carolina.

The specimen was collected on a sticky trap (30 x 30 cm clear plexiglass coated on both sides with Tangle Trap[4] and placed vertically oriented ca. 1.2 m above the ground on a wooden stake) on 2 September 1987 near Scotia, Hampton Co., in southwest South Carolina. Eight sticky traps were maintained and changed weekly at this site from 18 March 1987 to 6 April 1988. Only one *C. dybasi* (a male) was collected during this period, whereas 1,499 *C. pusillus* and 187 *C. ferrugineus* were trapped during the same period. *C. pusillus* and *C. ferrugineus* were particularly abundant the week *C. dybasi* was caught (192 and 36 specimens trapped, respectively). Similar trapping procedures at sites near Blackville (Barnwell Co.) and Ehrhardt (Bamberg Co.), SC, yielded no *C. dybasi* during the same one-year trapping period.

[1]Received September 6, 1988. Accepted November 28, 1988.

[2]Stored-Product Insects Research and Development Laboratory, ARS/USDA, P.O. Box 22909, Savannah, GA 31403.

[3]Florida State Collection of Arthropods, P.O. Box 1269, Gainesville, FL 32602.

[4]Names of products are included for the benefit of the reader and do not imply endorsement or preferential treatment by USDA.

The collection site was a grain storage area of four cylindrical metal bins, three of which contained corn and one which contained sunflower seeds for most of the trapping period. The site was bordered on the south side by a poorly maintained pecan grove of ca. 50 trees. The pecan grove and grain bins were bordered by soybean or corn fields on three sides and by a meadow on the east side. The nearest woods were ca. 80 m east of the bins. The trap on which the specimen was collected was positioned tangent to and ca. 0.6 m from the western edge of the westernmost grain bin. The weather during the collection week was hot (mean maximum - 33.7°C.; mean minimum - 22.8°C.) and moist (2.4 cm precipitation) (NOAA 1987).

Thomas (1988) reported that the non-economically important species of *Cryptolestes,* including *C. dybasi,* usually live under the bark of logs and are fungivorous or predaceous. It is most likely that this specimen was not associated with the stored grain at the site, but came from the pecan grove or surrounding wooded areas.

ACKNOWLEDGMENTS

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NEW RECORDS OF CADDISFLIES (TRICHOPTERA) FROM OHIO, WITH PARTICULAR REFERENCE TO STILLFORK SWAMP, CARROLL COUNTY[1]

J.D. Usis, B.A. Foote[2]

ABSTRACT: Known ranges of *Hydroptila delineata, H. gunda, H. lonchera, H. metoeca, Oxeythira grisea* (Hydroptilidae: Trichoptera), and *Limnephilus perpusillus* (Limnephilidae: Trichoptera) are extended to include northeastern Ohio. A total of 219 caddisfly species are now known to occur in Ohio, and 22 species are newly recorded for Stillfork Swamp in Carroll County.

Although northeast Ohio's caddisfly fauna has been relatively well documented (McElravy *et al.,* 1977; McElravy and Foote, 1978; Masteller and Flint, 1979; Huryn and Foote, 1981, 1983; Petersen and Foote, 1980; MacLean and MacLean, 1980, 1984; Usis and MacLean, 1986; Garono and MacLean, 1988), new taxa are still being discovered. Weekly blacklight trap collections made during the adult emergence period in 1986 at Stillfork Swamp in Carroll County, a relatively undisturbed, unglaciated 50.6 ha wetlands owned by The Nature Conservancy, resulted in a total of 97 species in 39 genera, representing 11 families.

RESULTS

Additions to the list of caddisfly species known for Stillfork Swamp (Usis and MacLean, 1986) are given below. Species with (*) indicate new records for Ohio. The flight period of each species is given, followed by the number of each sex collected.

Polycentropodidae

Cyrnellus fraternus Banks (Aug. 20, 1 ♀)
Neureclipsis crepuscularis (Walker) (Sept. 4, 11; 1 ♂, 3 ♀♀)
Nyctiophylax affinis (Banks) (Sept. 4, 3 ♂♂)

Glossosomatidae

Glossosoma nigrior Banks (Oct. 3, 1 ♀)

[1]Received May 2, 1988. Accepted Sept. 11, 1988.

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Hydroptilidae

**Hydroptila delineata* Morton (Sept. 4, 4 ♂♂)
**Hydroptila gunda* Milne (Aug. 20, 1 ♂)
**Hydroptila lonchera* Blickle & Morse (Sept. 4, 11, 2 ♂♂)
**Hydroptila metoeca* Blickle & Morse (Aug. 20, Sept. 4, 11, 3 ♂♂)
Ochrotrichia wojcickyi Blickle (Aug. 14, 2 ♂♂)
Oxyethira michiganensis Mosely (Aug. 14, 20, 1 ♂, 4 ♀♀; Sept. 4, 11, 26, 2 ♂♂, 6 ♀♀)
**Oxyethira grisea* Betten (Aug. 14, 20, 17 ♀♀; Sept. 4, 20, 26, 2 ♂♂, 26 ♀♀)
Neotrichia vibrans Ross (Aug. 14, 2 ♂♂)

Limnephilidae

Limnephilus moestus Banks (June 11, 1 ♂)
Limnhephilus ornatus Banks (Sept. 4, 1 ♂)
**Limnephilus perpusillus* Walker (June 27, 1 ♂)

Lepidostomatidae

Lepidostoma sommermannae Ross (Oct. 12, 2 ♀♀)
Lepidostoma costalis (Banks) (Aug. 20, 1 ♀)

Molannidae

Molanna blenda (Aug. 20, 1 ♂, 1 ♀; Sept. 4, 1 ♂)

Leptoceridae

Triaenodes nox Ross (May 30, 1 ♂, ♀)

The new records presented above bring the total number of caddisfly species recorded for Ohio to 219 (Huryn and Foote, 1983). All of the newly recorded hydroptilids appear to have eastern or northeastern distributions in North America (Blickle, 1979). *Hydroptila gunda* has been reported from New Hampshire, Virginia, Georgia, South Carolina and Alabama. Its presence at Stillfork Swamp indicates that its range extends west of the Appalachians. *Hydroptila lonchera* has been reported for the New England states and Alabama (Harris, 1986). Kelley (1985) indicated that the distribution range for *Oxyethira grisea* includes most of the eastern United States and Canada south to South Carolina.

Limnephilus perpusillus, originally described by Walker (1852), was redescribed by Milne (1935) as *Colpotaulius rhaeus* with records for Ontario, Manitoba, and Saskatchewan. Ross (1938) described *L. perpusillus* under the synonym *L. merinthus,* reporting a flight period in July for Manitoba. It has since been reported from Minnesota, North Dakota, and Wisconsin as well as the Canadian Provinces of Quebec and New-

foundland. Its occurrence in Ohio represents a southern range extension and seems to support Stein's (1974) suggestion that the swamp may serve as a refugium for many northern plants and animals.

ACKNOWLEDGMENTS

The authors wish to thank David B. MacLean, Youngstown State University, Ohio and Alexander D. Huryn, University of Georgia, for critically reviewing the manuscript. We are indebted to O.S. Flint, Jr., Smithsonian Institution for confirming *Limnephilus perpusillus* and *Glossosoma nigrior*. K.L. Manuel, Duke Power Co. at Huntersville, NC and S.C. Harris at the Geological Survey of Alabama, Tuscaloosa, aided in the confirmation of certain *Triaenodes* and *Hydroptila* species. Partial funding by the Ohio Chapter of The Nature Conservancy is gratefully acknowledged.

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NEW RECORDS OF BUTTERFLIES FROM NORTH ANDROS, BAHAMAS[1]

Donald J. Harvey,[2] John W. Peacock[3]

ABSTRACT: Seven previously unrecorded butterfly species are reported from North Andros, Bahamas. These are: *Calisto sibylla* Bates (Satyridae); *Eunica monima* Stoll, *Eunica tatila tatilista* Kaye, and *Vanessa atalanta rubria* Fruhstorfer (Nymphalidae); *Hemiargus ceraunus ceraunus* Fabricius and *Brephidium exilis isophthalma* Herrich-Schäffer (Lycaenidae); and *Eurema nicippe* Cramer (Pieridae). These seven new records increase to 60 the number of butterfly species now known from North Andros.

The first comprehensive list of butterflies for Andros Island, Bahamas, was provided by Clench (1977). Additional collecting on North Andros by the authors during 1978 (DJH) and 1983 (JWP) has added seven new species to the North Andros fauna. The following are accounts of these new Andros records, with notes on locality, dates of capture, habitat and behavior. To conform with Clench (1977), the sequence of taxa in Riley (1975) is followed. Specimens are deposited in the authors' personal collections; a voucher of *Eunica tatila tatilista* taken by JWP is deposited in the Carnegie Museum of Natural History (Pittsburgh) and vouchers of the four species collected by DJH have been deposited in both the Carnegie Museum of Natural History and the Allyn Museum of Entomology (Sarasota).

Satyridae

Calisto sibylla Bates

Two females and a male of this butterfly were collected on 6 June 1978 near the town of Red Bay. The adults were local in distribution and were only seen in a narrow strip of shrubby vegetation, about 15 meters long, that bordered the road between the shore and the settlement of Red Bay. The butterflies flew close to the ground, usually underneath the shrubs. Adults appeared in the open only when visiting the flowers of *Cordia bahamensis* Urban (Boraginaceae). All specimens were collected while visiting these flowers. Other shrubs along this strip included *Forestiera segregata, Metopium toxiferum, Jacquinia* sp. and *Coccoloba* sp. Beyond these shrubs was a plain dominated by sedges, with some grasses and scattered palmettos. During brief visits to this site on 9 and 13 June 1978, two additional specimens, a female and a male, were also taken. *Eup-*

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toieta claudia Cramer, *Dianesia carteri* Holland, *Strymon martialis* Herrich-Schäffer, *Eurema messalina blakei* Maynard, *Pyrrhocalles antiqua eleutherae* Bates and *Wallengrenia misera* Lucas were also found at this locality.

Red Bay is the only settlement on the western coast of Andros, and the only locality accessible there by road. *C. sibylla* may be more widely distributed on this side of the island, but the region is poorly collected. Aside from these specimens, the species is known only from the type, collected on New Providence in 1894, and a pair collected by Clench at Yeho Pineyard, South Andros, in 1974.

Nymphalidae

Eunica monima Stoll
Eunica tatila tatilista Kaye

A single male *Eunica monima* was taken near Fresh Creek, on 12 July 1983, along with five males and two females of *Eunica tatila.* The butterflies were captured on or near the vicinity of overripe fruit on a species of *Ficus* (probably *F. citrifolia),* which was growing near a commercial establishment known as the "Androsia Factory". The tree was located along the edge of a rather dense thicket of small trees representing numerous species. Most of the butterflies were high in the tree (5-8m), and were easily flushed from the fruit on which they were feeding. Some returned to the upper reaches of the crown while others would fly to lower branches on the tree within netting distance. Almost all returned to the *Ficus* when disturbed, and attempts to locate these species on nearby trees, which included a blooming *Acacia,* were unsuccessful. At least two dozen *E. tatila* were sighted on the *Ficus* over the period of about 45 min at midday. The habits of *E. monima* were indistinguishable from those of *E. tatila,* and very likely the capture of only a single *E. monima* in association with the *Ficus* fruit is not a true indication of its abundance in the area.

E. tatila was placed on Clench's hypothetical list for Andros on the basis of a book illustration. The collections listed above confirm its occurrence on North Andros. *E. tatila* and *E. monima* apparently are very rare in the Bahamas; the only other records are from San Salvador (Elliot *et al.,* 1980).

Vanessa atalanta rubria Fruhstorfer

A single worn female was taken at Stafford Creek, on 11 July 1983 in a live trap baited with a two-year-old mixture of fermented peaches, molasses, and brown sugar. *V. atalanta* has been reported from Bermuda and as a stray on Cuba, Jamaica and Hispanola (Riley, 1975). Owing to the worn condition of the individual taken on North Andros, it is very possible that this specimen was a stray from the U.S. mainland.

Lycaenidae

Hemiargus ceraunus ceraunus Fabricius

Six adults were collected in a weedy field adjacent to the San Andros Airport on 7 June 1978. This species has been recorded for South Andros.

Brephidium exilis isophthalma Herrich-Schäffer

Ten adults were collected in a low area with white mangrove near Love Hill on 1 and 8 June 1978. They were not numerous, and were closely associated with patches of *Salicornia* sp. (Chenopodiaceae), a succulent herb which could possibly serve as a larval host plant at this locality.

Pieridae

Eurema nicippe Cramer

This species was frequently encountered in a field near the San Andros Airport, where *H. ceraunus* was also taken. Two females were collected on 31 May 1978, and seven additional adults were taken on 7 June 1978. These specimens confirm Clench's sightings of this species on North Andros.

These seven new records increase to 60 the number of species known on North Andros, and raises Clench's total for all Andros from 58 to 63. Andros has more recorded butterflies than any other island in the Bahama archipelago, 10 more than the 53 species recorded for New Providence (West, 1966).

ACKNOWLEDGMENTS

We thank the Ministry of Agriculture, Fisheries and Local Government of the Bahamas for providing collecting permits. We are indebted to the staff of the Forfar Field Station (Stafford Creek, North Andros), particularly Rose Blanchard, for providing facilities and transportation on the island, and for providing advice on collecting localities. DJH was supported in part by a National Science Foundation graduate fellowship. JWP is grateful to Steven Long and Donald Bumgarner for their encouragement and for their assistance in making possible his four trips to North Andros. We thank Lee D. Miller and John A. Shuey for their useful comments on this manuscript.

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OUR CENTENNIAL YEAR

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DRAGONFLIES AND DAMSELFLIES (ODONATA) OF ACADIA NATIONAL PARK AND VICINITY, MAINE[1]

Harold B. White, III[2]

ABSTRACT: An annotated list of 97 species of Odonata now known from Mount Desert Island, Hancock County, Maine is presented. Included for the first time are: *Lestes inaequalis, Enallagma durum, E. geminatum, E. signatum, Ischnura posita, Aeshna verticalis, Libellula incesta, Erythemis simplicicollis, Pachydiplax longipennis, Tramea carolina, Pantala hymenaea,* and *Tarnetrum corruptum.* These 12 were found within Acadia National Park and, with the exception of *A. verticalis,* all are at or near their northeastern limit of distribution in North America. This is the first time *E. durum, T. carolina,* and *T. corruptum* have been reported for Maine. Also included are the first Odonata records from Isle au Haut, Knox County, Maine.

Mount Desert Island on the coast of Maine has virtually all of the aquatic habitats typical of the nearby mainland except for rivers and large streams. Its glacier-scoured pink granite hills rise to 1530 ft (467 m) and provide a region of unusual beauty much of which is preserved as part of Acadia National Park. Although Acadia is one of the most popular National Parks, most visitors are drawn to the rugged shore, leaving many of the freshwater habitats relatively undisturbed. These habitats are populated by close to 100 species of Odonata, a diversity that is difficult to find in a comparable area (108 mi^2; 280 km^2) anywhere in the world this far north (44°N).

While the Odonata of specific regions of Maine have been surveyed by Wadsworth (1890, 1891, 1894, 1898), Harvey (1891, 1892, 1898, 1901), and Borror (1940, 1944, 1951, 1957), Mount Desert Island is the only region that has been repeatedly surveyed for almost a century. Bullock (1891) reported eight species from the island. Three additional species he collected were reported by Calvert (1894). Howe (1917-1920; 1921) added more species to the list, most of which were taken by Charles W. Johnson, curator of collections of the Boston Society of Natural History.

Presuming that Mount Desert Island should have an insect fauna as fascinating as the flora documented by 19th century botanists, the Boston Society of Natural History initiated a comprehensive insect survey in 1918. With the exception of 1925, Johnson spent part of each summer until 1926 collecting on the island. He published *The Insect Fauna* as Part I of the *Biological Survey of the Mount Desert Region* (Johnson, 1927) with the help of Dr. William Procter, wealthy summer resident, naturalist.

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and a director of the Procter and Gamble Co. (Alexander, 1952). Among the thousands of species of insects reported were 46 species of Odonata. The Society's expectations had been realized and in addition Procter expanded his interests from the marine life to include the terrestrial life of the island. After Johnson's death in 1932 (Brues, 1933), Procter went on to revise *The Insect Fauna* as Parts VI and VII of the *Biological Survey of the Mount Desert Region* (Procter, 1938; 1946). The later annotated list of 79 species included a number of rarer species taken by Carsten Ahrens, a Ranger-Naturalist at Acadia in 1940 and 1941 (Ahrens, 1941).

It was Ahrens' paper that first interested me in the Odonata of Mount Desert Island. Since my first visit in 1968 I have visited the island most years for about two weeks in August usually near the middle of the month. Some of the more interesting new records have been published (White, 1969; 1974). All of the published records and my previously unpublished records are summarized here. Also included are records of 26 species of Odonata recorded between August 16 and 19, 1988, from the Isle au Haut portion of Acadia National Park, Knox County, Maine.

The lure of finding boreal species at or near their southern limit of distribution has been an attraction for naturalists visiting Mount Desert Island. Perhaps as a consequence familiar species with southern affinities have been overlooked. That this may be the case for the Odonata is suggested by the fact that eleven of the twelve species reported here for the first time for Mount Desert Island are also known from Florida (Byers, 1930; Needham and Westfall, 1955) and most states between Maine and Florida; only *Aeshna verticalis* is not. In contrast, of the eleven that are known from Florida, only *Ischnura posita, Tarnetrum corruptum,* and *Pantala hymenaea* are also known from New Brunswick or Nova Scotia in nearby Canada (Walker, 1953; 1958; Walker and Corbet, 1975; Martin, 1970). While it is possible that these species with southern distributions have become established recently, most of them have been known for some time from elsewhere in southern and central Maine (Borror, 1944; 1951).

Of the 85 species previously known from the Mount Desert Island area, I have confirmed all but 17 and those are predominantly species with flight seasons that are over by August. In the annotated list that follows, detailed locality information is given only for those species that are relatively uncommon. Representative localities are provided for the common and familiar species. New species for Mount Desert Island are indicated with (*), those new to Maine with (**), and those that have not been observed in this study with (+). The earliest and latest records for Mount Desert Island are presented for each species. Place names are those used on the 1:24,000 scale U.S. Geological Survey topographic map of Acadia National Park and Vicinity, 1956.

ANNOTATED LIST

Zygoptera

Calopterygidae Four species in this family are known from Maine. Only one is known from Mount Desert Island.
Calopteryx maculata (Beauvois), the familiar black-winged damselfly, is common on the permanent streams of the island from June through August. (6/26-8/21)

Lestidae Nine species of spread-winged damselflies are known from New England and all have been found on Mount Desert Island. All are pond species and are most abundant where there are few fish and lots of emergent vegetation.
Lestes congener Hagen. This species is well-known from Mount Desert Island though rarely is it common. It has the latest flight season of all damselflies in New England with records as late as October 22 in Massachusetts (White, 1979). Many were emerging at The Featherbed, a shallow pond at 1000 ft on the south ridge of Cadillac Mountain, on August 13, 1973. (8/11-9/22)
L.d. disjunctus Selys is probably the most common *Lestes* on the island. It has been found in a variety of habitats ranging from bog ponds to lakes. It was the only *Lestes* observed on Isle au Haut from August 16-19, 1988. There it was particularly common at Merchants Cove. (7/29-9/1)
+*L. dryas* Kirby, reported by Johnson (1927), is very local and prefers temporary ponds. (7/13-7/29)
L. eurinus Say is the largest *Lestes* on the island. It has a preference for bog ponds. Ahrens (1941) found it in the bog at Seawall. A female was taken at Sargent Pond August 7, 1982. It was also taken at Blunts Pond in East Lamoine August 3, 1976, about two miles north of the island. (8/3-8/7)
L. forcipatus Rambur was fairly common August 21, 1986 at The Featherbed and August 11, 1988 at a small beaver pond just south of the Bee Hive. Both are small grassy temporary ponds. It has also been taken at Sargent Pond and in a heath near Duck Brook. (7/24-8/29)
**L. inaequalis* Walsh. Although previously known from Maine (Borror, 1944), a male collected August 14, 1986, near the dam at Long Pond Outlet, is the only record for Mount Desert Island.
L. rectangularis Say tends to stay among shaded vegetation in protected backwaters. It is known from a number of locations on the island. (late July-8/31)
L. unguiculatus Hagen. Procter (1938) reported this species from Seawall. I have taken it only once, on August 12, 1973, near the south shore of Great Cranberry Island in the Great Heath. Published records suggest

that this species was more common in the past. (8/12-9/8)
L. vigilax Hagen is much more established than Procter (1938) indicated. It is frequent to common in August around Round Pond, Witch Hole Pond, Somes Pond, the south end of Seal Cove Pond, and has been found at a number of other locations. (6/13-8/21)

Coenagrionidae Of the 28 species of damselflies in this family known from Maine only 15 are also known from Mount Desert Island. Of those, four are reported here for the first time.
Argia fumipennis violacea (Hagen). This is a common species around larger ponds and on brooks. It is particularly common in August on Duck Brook and on the brook between Long Pond Outlet and Ripple Pond. It has also been seen at Long Pond on Isle au Haut. (7/1-8/30)
A. moesta (Hagen) is common along the rocky shores of Eagle Lake, Jordan Pond, Long Pond, and Bubble Pond. (6/20-8/30)
+*Chromagrion conditum* (Hagen). Johnson (1927) reported this species for Bar Harbor on June 11. It has an early flight season and has not been observed in August.
Enallagma aspersum (Hagen) has been abundant at Sargent Pond in August. It has also been found at a number of other locations but tends to be most common around ponds with boggy margins. It was seen at Merchants Cove Pond, Isle au Haut. (8/3-8/23)
E. boreale Selys was emerging around Witch Hole Pond and Big Heath on May 30, 1971. Big Heath is the only locality on the island where this species has been found during August. (5/30-8/15)
E. carunculatum Morse. The only Maine record for this species is from Eagle Lake on August 27, 1970 (White, 1974). It has not been taken subsequently on Mount Desert Island. However, a male was collected August 15, 1987, at Tunk Lake about 25 miles north of Eagle Lake in Hancock County.
E. civile (Hagen) is common and can be found around the shallow bays of the larger ponds throughout the summer. It was taken at Merchants Cove and at Long Pond on Isle au Haut. (6/8-8/28)
+*E. cyathigerum* (Charpentier) is an early season species reported by Johnson (1927). Gloyd (1943) described the related *E. vernale* that occurs in New Hampshire (White and Morse, 1973) and Massachusetts (White *et al.,* 1974) and should occur in Maine. It is possible that the specimens identified as *E. cyathigerum* were in fact *E. vernale* or that both species occur on the island. (7/11)
***E. durum* (Hagen). A well established population of this species was discovered around Adams Bridge in the Bass Harbor Marsh on August 8, 1988. Because this species prefers brackish water, a habitat not usually expected for Odonates, its presence in Maine has been overlooked. It

undoubtedly occurs in favorable habitats elsewhere along the Maine coast. An unidentified large bright blue *Enallagma*, seen at Merchant Cove on Isle au Haut on August 17, 1988, may have been this species. Calvert (1894) reported this species from Woods Hole and Cuttyhunk Island in Massachusetts. I found it to be common at Bartlett Pond behind White Horse Beach, also in Massachusetts, on July 18 and 24, 1971. This species is not known from Canada but in light of its presence on Mount Desert Island, it should be anticipated at salt marshes in New Brunswick and Nova Scotia. A recent search of the Procter collection now at the University of Massachusetts revealed a specimen of *E. durum* collected by Frank Shaw on 2 July 1955 in Tremont, the town where the Bass Harbor Marsh is located. Thus *E. durum* is not new to Mount Desert Island. (7/2-8/8)

E. ebrium (Hagen) is not very common but it has been found at a variety of habitats including Bass Harbor Marsh, The Featherbed, Witch Hole Pond, and at the tarn near the summit of Penobscot Mountain. (7/31-8/21)

E. exsulans (Hagen) was common along the south shore of Eagle Lake on August 8, 1973. It was frequent at Seal Cove Pond on August 18, 1987. It is likely to be present on all the larger lakes and the permanent streams on Mount Desert Island. (8/8-8/23)

**E. geminatum* Kellicott. Although known from Maine (Borror, 1944; 1951) with dates ranging from June 30 to August 20, this species has not been recorded from Mount Desert Island or from nearby Canada. A pair was collected at Round Pond on August 23, 1973 and a male was seen at Witch Hole Pond on September 1, 1968. This species is common in eastern Massachusetts where its flying season extends from May 26 to October 1 (White, 1979).

E. hageni (Walsh) is wide-spread and commonly found around beaver ponds and marshes such as those along the carriage road between Eagle Lake and Witch Hole Pond. While it is frequently encountered in August, its peak abundance is in June and July. The August 27, 1970 records from Witch Hole Pond are quite late. A male was taken August 17, 1988 at Merchants Cove on Isle au Haut. (6/8-8/27)

E. minusculum Morse. Procter (1938) considered this species to be scarce; however, it has been fairly common for the past two decades in its preferred habitat. It can be found on the sparse vegetation emerging from sandy bottomed coves and bays of the larger lakes and ponds on the island. It regularly occurs at Eagle Lake, Bubble Pond, Witch Hole Pond, Long Pond, and Seal Cove Pond. (7/12-8/21)

**E. signatum* (Hagen). A male was collected and another seen at Round Pond on August 4, 1976. These are the only records for this species on Mount Desert Island. It is known from western Maine (Borror, 1951) but

it has not been reported from the Canadian provinces to the east. Its flight season in eastern Massachusetts is from June 13 to September 16 (White, 1979).

E. vesperum Calvert is active late in the day when it can be found perching on lily pads in the bays of the larger ponds. These habits result in sparse records for a species that is probably fairly common. It has been recorded from Round Pond, Witch Hole Pond, and Seal Cove Pond. (8/4-8/27)

**Ischnura posita* (Hagen) has not been recorded from the island before. I have seen it on three occasions: July 31, 1969 at Aunt Betty Pond; August 13, 1973 at the Mill Pond in Somesville; and August 2, 1976 at the pond at Seawall. Because it is known from Nova Scotia (Walker, 1953) and elsewhere in New England, its presence on Mount Desert Island was expected. (7/31-8/13)

I. verticalis (Say) is perhaps the most widely distributed damselfly in New England. It can be expected at all freshwater habitats on Mount Desert Island and Isle au Haut. (5/30-9/1)

Nehalennia irene (Hagen) is a well-camouflaged species and can easily be missed among bog and marsh vegetation even when it is common. It is widely distributed on the island and can be found regularly at The Featherbed and at Big Heath. (6/11-8/21)

Anisoptera

Cordulegasteridae Two of the three species of *Cordulegaster* known from Maine occur on Mount Desert Island.

+*Cordulegaster diastatops* (Selys). According to Procter (1938), this species is on all the streams of the island. Its flight period peaks in June and is usually over by August. (6/20)

+*C. maculata* Selys. Procter (1938) reports this species from Bubble Brook and Duck Brook. (6/16-7/20)

Gomphidae This family is generally, although not exclusively, associated with flowing water. Because there are no rivers or large streams on Mount Desert Island, many of the 17 species known from Maine do not occur on the island. Those that do occur on the island are associated mostly with streams or lake shores that experience wave action.

Hagenius brevistylus Selys can be found along shores of large ponds and along larger brooks where it can sometimes be seen capturing other Odonata. (7/29-8/23)

+*Ophiogomphus rupinsulensis* (Walsh) is normally associated with large rivers but was recorded from Eagle Lake by Howe (1918) based on a specimen in the Museum of Comparative Zoology, Harvard University.

Stylogomphus albistylus (Hagen) was first reported by Ahrens (1941) from the stream that flows into New Mill Meadow (Great Meadow). It is regular but scarce in August on the stream that flows into Ripple Pond. (7/16-8/18)
+*Lanthus parvulus* (Selys) was reported from Jordan Pond and the beaver dam on Norway Drive by Ahrens (1941). (7/19-8/7)
Gomphus exilis Selys is common around ponds in the early summer with a few still present in August. The August 18, 1988, record at Long Pond on Isle au Haut is a rather late date. (6/6-8/18)
G. spicatus Hagen was observed emerging on May 30, 1971 at Witch Hole Pond where Procter (1938) reports it from as late as July 30. (5/30-7/30)
Dromogomphus spinosus Selys is restricted to the rocky shores and open water of larger ponds such as Eagle Lake, Long Pond, and Seal Cove Pond. (8/8-8/28)

Aeshnidae This family of conspicuous large dragonflies is well-represented on Mount Desert Island. All but three of the 16 species known from Maine are found here and several of the rarer species are locally common.
Boyeria vinosa (Say) is probably found on all streams on the island in late summer. It was particularly common on shaded parts of Heath Brook south of the Seal Cove Fire Road on August 20, 1987. It also has been found patrolling the shores of Echo Lake and Long Pond. (7/25-9/8)
Basiaeschna janata (Say) occupies a similar habitat to that of the previous species; however, its flight season is quite different. The August 4, 1976 and August 8, 1973 records for Ripple Pond outlet and Eagle Lake, respectively, are very late for a species that is among the first to appear in the spring. (late May - 8/8)
+*Gomphaeschna furcillata* (Say). Procter (1938) found this species to be common hawking along the carriage roads near Breakneck and Witch Hole Ponds on June 7.
Anax junius Drury can be found most anywhere from May until late September. In the late summer recently emerged adults swarm over fields and clearings in preparation for a southward migration along the coast after the passage of cold fronts (Bagg, 1958). Premigratory swarming was observed at Head Harbor, Merchants Cove, and Duck Harbor on Isle au Haut and at several places on Mount Desert Island. (8/2-September)
Aeshna canadensis Walker is perhaps the most common *Aeshna* found on Mount Desert Island. It is likely to be found around any beaver pond, tarn, or wetland pool. It has been taken at Merchants Cove and Long Pond on Isle au Haut. (6/15-9/1)

A. clepsydra Say, while not common, is regularly found patrolling the shores of ponds with boggy margins such as Round Pond, Somes Pond, and Witch Hole Pond. (8/12-8/27)
A. eremita Scudder is very common at Sargent Pond in August. It is also found at The Bowl and other mountain ponds but in smaller numbers. (7/17-8/20)
A. i. interrupta Walker is found at a variety of habitats but is most common around old beaver ponds with stumps and floating vegetation such as The Bowl and a muddy pond adjacent to Witch Hole Pond. As with other *Aeshnas,* it can be found feeding far from its aquatic habitat. (8/3-10/10)
A. sitchensis Hagen. For many years Big Heath was the only habitat in New England for this species (Ahrens, 1941; White, 1974). It has now been found at Sunken Heath and at a heath along Duck Brook on Mount Desert Island. It was at virtually every heath explored along the southern end of Isle au Haut from Duck Harbor to Head Harbor during mid-August 1988. Curiously, females are very difficult to find. (7/31-8/30)
A. subarctica Walker. The population discovered at Big Heath has remained healthy for almost 20 years since its discovery in 1969 (White, 1974). No other localities have been found despite the exploration of many superficially appropriate habitats. (7/31-8/26)
A. tuberculifera Walker. Although this species was first reported from Mount Desert Island in 1969 (White, 1969), it has subsequently been taken at Witch Hole Pond, The Featherbed, and at 12 other locations on the island. In this species the females are brightly colored like the males and have similar behavior. Consequently, in contrast to other species of *Aeshna,* females are often seen. (8/6-9/1)
A. u. umbrosa Walker is often found foraging along carriage roads or patrolling small streams flying in and out of the shadows. It was very common along Heath Brook at the Seal Cove Fire Road on August 20, 1988, during a period of dry weather. In this same area on August 7, 1983, when the water was high and beaver dams had flooded the meadow, *A. umbrosa* was not present but *A. canadensis* was very common. *A. umbrosa* was taken August 18, 1988 in a field near the south end of Long Pond on Isle au Haut. This is one of the last dragonflies to be seen in the fall and therefore the flight season on Mount Desert Island undoubtedly extends well beyond that indicated. (8/7-9/1)
**A. verticalis* Hagen looks very similar to *A. canadensis* but has a different habitat. Thus the species are not usually found together except in foraging swarms away from water. For example, at Sunken Heath, *A. canadensis* is common at the small bog ponds whereas *A. verticalis* is restricted to a wet grassy meadow at the southwest corner of the heath. Other locations include Big Heath, Heath Brook, summit of Beech Mountain, and Great

Head. Of the species being reported for Mount Desert Island for the first time here, this is the only one that is not at or near its northeastern limit of distribution. Borror (1944) reported this species to be the most common *Aeshna* in southcentral Maine. (8/12-8/20)
+*Epiaeschna heros* (Fabricius). Ahrens' (1941) record of an ovipositing female on Squid Creek on July 18, 1940 remains the only one for this species on Mount Desert Island.

Macromiidae Two species within this family are known from New England and Mount Desert Island.
Didymops transversa (Say). Procter (1938) describes this species as common on all parts of the island from mid-June to August. I have not found this species in August but have found its exuviae on the underside of protected boulders along Jordan Pond. (6/11-7-17)
Macromia illinoiensis Walsh. Ahrens (1941) describes this species as not uncommon hawking along carriage roads. A female was taken at the summit of St. Sauveur Mountain on August 7, 1983 and a male was seen over the fire road near the Seal Cove Pond boat launch area on August 18, 1987. The later date is the latest date for this species in New England. (7/8-8/18)

Corduliidae All but five of Maine's 21 species of *Corduliidae* have been found on Mount Desert Island.
+*Williamsonia fletcheri* Williamson. There is one Mount Desert record for this rare, early season resident of spruce bogs (Montgomery, 1943). It is quite likely that the Breakneck Carriage Road locality is not the only place it occurs on the island. (6/6/35)
Dorocordulia lepida (Hagen) is a regular resident of peat stained ponds. Although not common in August, it has been found at a number of different locations such as Round Pond and Big Heath. It was taken at Merchants Cove on Isle au Haut on August 17, 1988. (6/8-8/23)
D. libera (Selys) is similar to the previous species but is much less common, at least in August when it has been taken only twice, three miles apart on the same day along the Seal Cove Fire Road. It was also taken at Round Pond July 27, 1957 by T.W. Donnelly. (6/8-8/7)
+*Helocordulia uhleri* (Selys) is a stream species with an early flight season that extends into July. Johnson (1927) took it at Eagle Lake on July 12. (June-end July)
Somatochlora cingulata (Selys). The only Maine record for this species is from Mount Desert Island (White, 1974); however, the species, though elusive, is not rare and probably can be found throughout northern and eastern Maine. T.W. Donnelly collected it in the vicinity of Little Pillsbury Pond and Haynock Lake, Piscataquis Co. on 20-21 July 1982. It is a resi-

dent of large clear lakes such as Echo Lake, Eagle Lake, and Long Pond. Since it flies rapidly over open water, it is rarely encountered at close quarters there. In August it is one of the species regularly seen foraging at the summits of Cadillac, Sargent, Acadia, and Beech Mountains. (8/8-8/17)

S. elongata (Scudder). The only previous specimen from Mount Desert Island was taken by C.P. Alexander on June 16, 1935, along Breakneck Brook (Procter, 1938). I have found it there and also along Heath Brook and the boggy tributaries on the west side of Somes Pond. (6/16-8/20)

S. forcipata (Scudder). A female taken by Ahrens (1941) at Echo Lake on July 3, 1940 is the only Mount Desert Island record. A male was taken in a heath west of Merchants Cove on Isle au Haut on August 17, 1988 where it was in association with *S. incurvata.* This is a very late date for this species. (7/3-8/17)

S. incurvata Walker. The only records for New England were from Big Heath (White, 1969). It has now been found at Sunken Heath and a heath on the west side of Duck Brook. It was fairly common with *Aeshna sitchensis* at a number of bog-heath habitats on Isle au Haut August 17-19, 1988. (8/11-8/30)

+*S. kennedyi* Walker. A single male taken by Ahrens (1941) at Eagle Lake on July 3, 1940 is the only Mount Desert Island record.

+*S. minor* Calvert. Two females taken by Ahrens (1941) along a small tributary of Aunt Betty Pond on August 14, 1940 are the only records.

S. tenebrosa (Say). Ahrens (1941) occasionally found this species along shady streams in August. I have collected it once on August 13, 1980 at the parking lot by the Beech Mountain Trail.

S. walshi (Scudder) can regularly be found along the path to Wonderland, Heath Brook, and the boggy tributaries of Somes Pond. There are several additional records from the island. Single males were taken along roads near Duck Harbor and Merchants Cove on Isle au Haut. (7/21-8/20)

S. williamsoni Walker. In addition to a single record from lower Northeast Creek (Ahrens (1941), I have taken it at the summit of Beech Mountain on August 13, 1980 and at a marsh at the northern tip of Long Pond on August 14, 1986. (7/21-8/14)

Cordulia shurtleffi Scudder is common around boggy ponds and beaver ponds in the early summer (Johnson, 1927). My only August record is from nearby Blunts Pond in East Lamoine north of Mount Desert Island. (6/6-8/3)

Tetragoneuria cynosura (Say) was reported from Echo Lake by Johnson (1927). It was frequent near Witch Hole Pond on May 30, 1971. (5/30-7/12)

+*T. spinigera* Selys was reported from Breakneck Road and Witch Hole (Procter, 1938). (6/6-6/12)

Libellulidae Twenty-one of the 32 libellulids known from Maine have been found on Mount Desert Island.

Nannothemis bella (Uhler) is a resident of bog pools and is probably found in any appropriate habitat throughout the island. The only August record is August 14, 1986 in the bog at the upper end of Somes Pond. (6/13-8/14)

Celithemis elisa (Hagen). Isolated individuals have been taken at a number of locations around the island. It is regularly found at Ripple Pond into the later half of August. It was seen at Merchants Cove and Long Pond on Isle au Haut on August 18, 1988. (6/15-8/21)

C. martha Williamson and *C. elisa* are often found together. A male was taken at Long Pond on Isle au Haut. (8/6-8/23)

Libellula exusta Say is common around all small ponds in June. There are, however, only seven sightings in August. The August 23, 1973 record for Round Pond is a very late date. (6/13-8/23)

**L. incesta* Hagen is a regular resident of Mount Desert Island that heretofore has gone undetected. It has been found at Round Pond, Witch Hole Pond, and Long Pond Outlet. It was rather common at the Mill Pond in Somesville on August 12, 1988. (8/4-8/23)

L. julia Uhler. Ahrens (1941) reported this species to be fairly common at the bog ponds at Seawall in August. I have taken it several times at nearby Big Heath. The male taken at Great Meadow in Bar Harbor on August 31, 1968 is a very late record. (8/2-8/31)

L. lydia Drury is an occasional resident of abandoned beaver ponds and artificial ponds. It was seen at Merchants Cove, Isle au Haut, on August 18, 1988. (6/11-8/18)

L. pulchella Drury has been found at a number of localities on the island; however, it does not seem to be as common as reported by Ahrens (1941). It was fairly common at the fresh water pond behind the sea wall at Merchants Cove, Isle au Haut, on August 17, 1988. (7/31-8/25)

L. quadrimaculata Linné is common around the ponds and marshes of the island. Many tenerals were observed near Witch Hole Pond on May 30, 1971. Normally the flight season is over by August; however, it was seen at Merchants Cove and Duck Harbor on August 17, 1988. (5/30-8/17)

+*L. semifasciata* Burmeister is a resident of marshy ponds and has an early flight season (Procter, 1938). (6/15)

**Erythemis simplicicollis* (Say). A single male seen August 18, 1971 at Big Heath is the only Mount Desert record. It was first reported from Maine by Borror (1951)

**Pachydiplax longipennis* (Burmeister) has been seen twice on the island, once at Big Heath on August 21, 1973 and once at a beaver pond on

Breakneck Brook, August 12, 1976. There are only two other records for Maine (Borror, 1951). Neither this nor the preceding species has been reported from Nova Scotia or New Brunswick in nearby Canada.

Sympetrum costiferum (Hagen) is fairly common around the larger bog-margined ponds such as Witch Hole Pond and Round Pond. It has also been found at a number of other ponds and near the summits of several mountains. As with the other *Sympetrums,* the flight season undoubtedly extends well into September. (8/4-8/27)

S. danae (Sulzer). Ahrens (1941) took four males in a tide swamp on Great Duck Island. A single male was taken August 13, 1973 at The Featherbed and remains the only record for Mount Desert Island proper. This is near the southern edge of this species' range. (8/3-8/13)

S. internum Montgomery is a common and wide-spread dragonfly of late summer. It is usually found perching on vegetation near the borders of meadows and other wetlands. Records for *S. rubicundulum* (Say) in previous publications most certainly are this species. There are still taxonomic difficulties here and *internum* records may include more than one species on this island and on Isle au Haut. (7/31-9/8)

S. obtrusum (Hagen). A single male taken at Big Heath August 12, 1973 is my only record. Procter (1938) reports it from several locations. It appears that this species was more common in the past. (8/12-8/18)

S. semicinctum (Say) is fairly common and wide-spread on the island. It usually is found in the vicinity of wet meadows with flowing water or around beaver dams. Ripple Pond and Half Moon Pond are good places to find it. It was found at Merchants Cove, Isle au Haut. (8/5-8/27)

S. vicinum (Hagen) is the last *Sympetrum* of the fall in New England. It is common at Round Pond and Sunken Heath on Mount Desert Island and at Merchants Cove on Isle au Haut. (8/4-10/17)

***Tarnetrum corruptum* (Hagen) is a migratory dragonfly abundant in the western United States. The few records from southern New England (Howe, 1921; Garman, 1927) are from coastal areas. A single male, captured by hand at the pond behind Sand Beach August 8, 1980, represents a new record for Maine. Martin (1970) reported it from Sable Island, Nova Scotia.

Leucorrhinia frigida Hagen typically is found perched on lily pads. Thus shallow ponds such as Aunt Betty Pond and Ripple Pond are preferred habitats. The August 21, 1986 record from The Featherbed may be the latest date for this species. (6/13-8/21)

L. glacialis Hagen. Tenerals were observed at Witch Hole Pond and Big Heath on May 30, 1971. In August it has been found regularly only at Big Heath and at Duck Pond on the Long Pond Fire Road. The August 21, 1973 record from Big Heath is the latest record for this species in New England. (5/30-8/21)

L. hudsonica (Selys). Many tenerals were seen at Witch Hole Pond and Big Heath on May 30, 1971. There are only two August records from Mount Desert Island: August 7, 1982, at Sargent Pond and August 21, 1987, at Heath Brook. (5/30-8/21)
+*L. intacta* Hagen is common at ponds in June and July according to Johnson (1927). (6/1-8/1)
+*L. proxima* Calvert was reported by Johnson (1927). (6/11-7/24)
****Tramea carolina*** (Linné) is a new record for Maine. A male was observed for about five minutes as it hawked over a small temporary pond near the base of the Bee Hive on August 11, 1988. The bright red color at the base of its wings distinguished it from the black-colored *T. lacerata* probably observed by Borror (1957) in Lincoln County.
Pantala flavescens (Fabricius) is a regular migrant along the coast each summer. It is often seen hawking over parking lots, rocky headlands, and mountain summits. Many were observed at the summit of Gorham Mountain on August 15, 1982. It was also seen along the south shore of Isle au Haut on August 17, 1988. (8/7-8/28)
P. hymenaea (Say). Heretofore the only published record for this species in Maine was from Muscongus Island (Borror, 1944). It was seen once at Great Head near Sand Beach on August 17, 1981. In 1988 I made numerous sightings of this species in a variety of places in the northeastern United States where it had rarely, if ever, been seen before, including Maine. A male was collected at Merchants Cove, Isle au Haut, on August 17, 1988, and it was seen many times along the south shore of that island being more common than *P. flavescens.* It was also seen in downtown Bar Harbor on August 23, 1988. (8/17-8/23)

In addition to these 97 documented species, there are a number of other species that should or could occur on Mount Desert Island and undoubtedly will be found when the appropriate habitats are explored in June and July. The following nonexclusive list attempts to identify a few additional species that are most likely to occur on the island. Also listed are the preferred habitats of these species.

Coenagrion resolutum (Hagen) (marshy ponds and beaver dams)
Enallagma vernale Gloyd (ponds)
Nehalennia gracilis Morse (sphagnum bogs)
Gomphus borealis Needham (beaver ponds)
Somatochlora franklini (Selys) (bogs)
Tetragoneuria canis (McLachlan) (beaver ponds)
Erythrodiplax berenice (Drury) (salt marshes)

Additional Notes on the Odonata of Maine

An earlier publication that reported new Odonata for the state of Maine (White, 1974) overlooked a publication by Harwood (1959) in which *Calopteryx amata* Hagen was reported. In 1979, Mingo *et al.* reported the nymph of *Macromia taeniolata* Rambur from the St. John River. This is a southern species not known north of Delaware. Thus it is unlikely that the species occurs in Maine. *Boyeria grafiana* Williamson, previously unreported from Maine, was seen by the author along a small stream at the Route 3 roadside rest area about 3 mi east of Dixfield, Oxford Co.

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RESPONSE OF LARVAL *CULEX PIPIENS* (DIPTERA: CULICIDAE) TO LIGHT PRODUCED BY LIGHT EMITTING DIODES[1]

R.G. Weber[2]

ABSTRACT: In tests with subaquatic light traps, light from green light emitting diodes (LED's) was more attractive to larval *Culex pipiens* than light from any other source tested. Light from amber LED's was as attractive as white (full visible spectrum) light from incandescent lamps typically used in subaquatic traps. All four larval instars were equally attracted to these light sources. Orange, red, infrared and unlit LED's were all much less attractive than white light and did not differ significantly from each other. Light emitting diodes offer significant advantages over incandescent lamps as attractors for subaquatic traps.

Knowledge of relative species abundance, or presence of a particular species, is important in mosquito surveillance and control operations. Aerial light traps are widely used as mosquito surveillance tools because adult mosquitoes of many species are attracted to light. Less well known is the fact that larvae of various mosquito species also are attracted to light. Since Hungerford *et al.* (1955) first reported mosquito larvae among the arthropod fauna entering submerged aquatic (subaquatic) light traps, there have been additional reports of culicid larvae entering such traps (Husbands, 1967; Ervin and Haines, 1972; Brown, 1976).

Subaquatic light traps used specifically to sample populations of mosquito larvae have been tested by Washino and Hokama (1968), Bertram *et al.* (1983) and Weber (1985). In several instances, subaquatic traps collected larve of various *Aedes, Anopheles* or *Culex* species in larger numbers than other capture methods indicated were present (Husbands, 1967; Washino and Hokama, 1968; Weber, 1985). Traps used in those three studies had, as attractants, incandescent lamps which emitted white light.

Other light sources and colors of light have been tested for attractancy to mosquito larvae. These include various colors of Betalights, glass tubes containing tritium and a phosphor (Bertram *et al.*, 1970; Service *et al.*, 1983) and "chemical light" in the form of Cyalume lightsticks[3] (Service *et al.*, 1983).

The possibility of using solid state light sources as attractors in suba-

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quatic traps has not been examined. This paper reports the relative attractiveness to *Culex pipiens* L. larvae of light produced by commercially available colors of light emitting diodes (LED's) and responses of the four instars to these colors.

MATERIALS AND METHODS

Tests were conducted on 13 nights during the summers of 1985 and 1986. Testing was done outdoors in pools made by lining 1 m^2 by 19 cm deep wooden frames with 0.15 mm (6 mil) thick, black plastic sheet. These were filled to 15 cm with 151 liters of tapwater which had been aged 24-48 hours. After each test, pools were drained and allowed to dry out thoroughly so no larvae wre carried over to later tests.

Larvae for tests were taken from populations in outdoor artificial breeding sites maintained for *Culex* studies (Weber and Weber, 1985). Two hundred *C. pipiens* larvae were used in each test, 50 of each instar. These were counted out late in the afternoon prior to a test and kept in beakers, segregated by instar, until 20:00 Eastern Daylight Time, when they were placed in test pools. Larvae were released into the center of a pool and allowed to disperse for 30 minutes before trap lights were turned on. Trap contents were collected at 08:00 the following morning, before trap lights were turned off. Formaldehyde was added to each sample to kill and preserve larvae until counting and instar determination.

Table 1 presents color and technical data for the light sources used. The white (full visible spectrum) light source was a clear, tungsten filament incandescent lamp of the "grain of wheat" type. The green, red, orange and amber light sources were commercially obtained LED's. The infrared (IR) light source was an IR emitting diode (IRED). The unlit trap contained an LED which was not turned on during tests. Traps with unlit and white lamps served as controls. The unlit one was used to determine whether the physical trap alone was attractive. The white lamp was used because it had been tested in previous subaquatic trapping experiments and was known to be attractive to mosquito larvae (Weber, 1985). An IR source was included in these tests because IR wavelengths have not previously been tested for attractancy to mosquito larvae but have been reported to be attractive to *Aedes aegypti* (L.) adults (Mangum and Callahan, 1968).

Figure 1 shows the arrangement of traps and colors during tests. Subaquatic traps containing the light sources to be tested were similar to those described by Weber (1985), but somewhat smaller, and were equipped with translucent, funnel-shaped gates. They were equidistantly spaced, 41.9 cm apart, around a 94 cm diameter floating plastic ring, held

centered in the pool by wires. Trap openings faced toward the pool's center and were centered 32 mm below the water surface with the long axis of traps parallel to the surface. The order of colors around the ring was kept constant for all tests. Clockwise, this order was white, unlit, green, red, orange, amber and IR.

To minimize possible interactions between trap colors and moonlight, or skylight, two replications of the test setup were made on each night of testing. In one, the ring was oriented so the trap with the white light

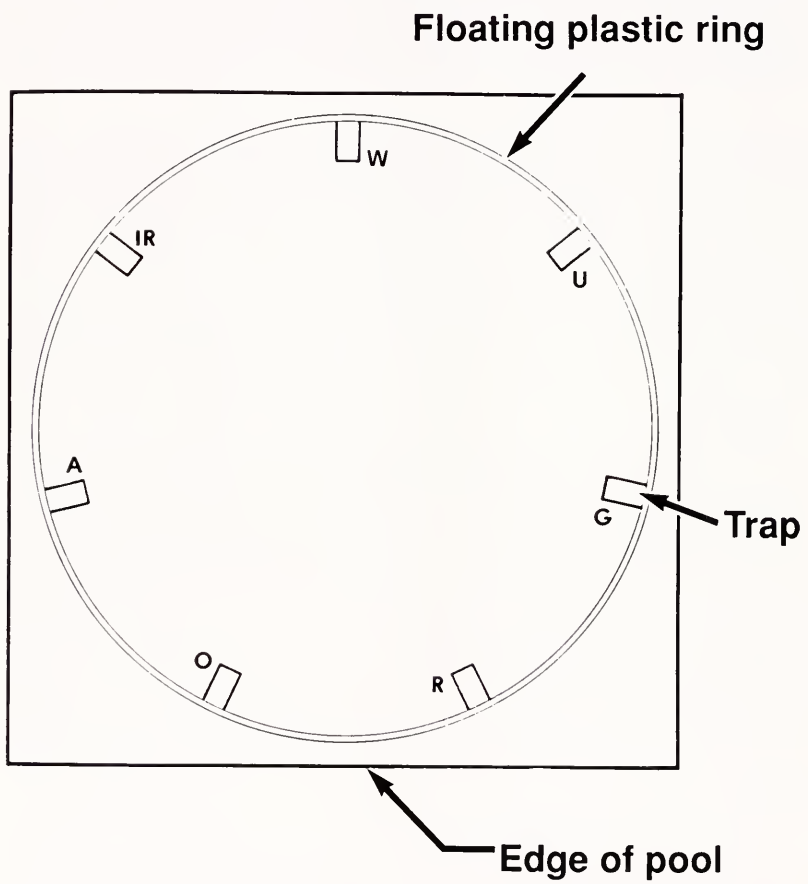

Figure 1. Arrangement of traps and colors during tests (top view). Colors tested were W (white), U (unlit), G (green), R (red), O (orange), A (amber) and IR (infrared).

source was North; in the other, South. Moonlight is believed to compete with trap lights and has been found to decrease aerial light trap catches of adult mosquitoes (Pratt, 1948; Provost, 1959; Barr *et al.,* 1963; Bidlingmayer, 1967) and adults of other insect taxa (Williams, 1936; Williams and Singh, 1951; Bowden and Church, 1973). Skylight, a downward reflection from clouds, was considered important during these tests because of light from a metropolitan area 1 km north of the research site.

Catches of adult mosquitoes in aerial light traps are directly related to power output (brightness) of incandescent lamps used as attractors (Pratt, 1944; Barr *et al.,* 1960; Barr *et al.,* 1963). No data suggest that larval mosquitoes might differ from adults in this response, or that LED attraction might not vary with brightness. For these reasons power outputs of all light sources were adjusted to similar levels (Mims, 1973; GTE Products Corporation, 1984). For LED's this was achieved by incorporating a 1/2 watt, 5% fixed resistor into each circuit, which limited LED and IRED currents to 21.4 milliamperes (mA) ± 0.8 mA. Voltage applied to the tungsten lamp was adjusted so that filament current was 20.9 mA. All light sources had the same physical size, 8 mm long x 4.5 mm diameter. Power for all sources was supplied by 6-volt rechargeable batteries.

Data were analyzed using SAS Institute's General Linear Models Procedure (PROC GLM, SAS User's Guide, pp 433-506) (SAS Institute, 1985). Because the fraction of the instar population attracted to a particular color was from a fixed number of larvae (50), it was appropriate to use the arcsine-square root transformation. Data were then analyzed as a split-split plot design (Gomez and Gomez, 1984) where nightly trials were the blocks (replications), trap orientation the main plot factor, response by instar the split plot factor. For each factor, means were compared using the LSD procedures (SAS User's Guide, p 471) (SAS Institute, 1985). Significance reported below was determined at the 5% level.

RESULTS AND DISCUSSION

Nightly catches of larvae varied significantly. Of the 200 larvae in each test, total number captured per night by the 7 traps in a pool ranged from 90 (45%) to 1 (0.5%), with the nightly average being 16.5 larvae (8.25%). Several factors could explain variability in nightly captures. One is that traps were operated from 20:30 to 08:00 regardless of daylength. Over the period of testing this resulted in varying amounts of actual darkness during the operating period, with corresponding variability in nightly trapping time. Other factors possibly contributing to nightly variation relate to the phase of the moon and the amount of nightly cloud cover, thus to varying competition with sky or moonlight.

Orientation of traps with the white light North or South had no significant effect on catch, but larval response to colors was significant. This indicates that whatever the source of *nightly* catch variation, differential catches by the traps were not due to interaction between their light sources and light from the sky or moon.

Total catches of the four instars varied significantly; however, response by instar to the various colors did not. In decreasing numbers of larvae captured, the instars ranked 4th, 3rd, 2nd, 1st (184, 108, 85, 51 larvae respectively), but the difference between 3rd and 2nd instar catches was not significant. Because instar response was greatest for larger (4th instar) larvae and progressively less for each smaller instar, it seems reasonable to attribute differential response to differences in size of the larval instars. Simply put, smaller larvae had a greater distance to travel (relative to body size) from the release point to a trap than did larger larvae, although all instars were equally attracted to particular colors.

Colors varied significantly in attractiveness (Table 2). Green LED's were significantly more attractive than any other light source. Amber LED's and white incandescent lamps did not differ significantly in attractancy. All other colors, and unlit, were significantly less attractive than white lamps. Larval responses to orange, red, IR and unlit sources did not differ significantly. Comparison of total catches of the white and unlit sources (68 and 6 larvae, respectively) indicates that the trap itself was not attractive to larvae. Infrared and unlit sources caught less than any others (7 and 6 respectively), indicating larval *C. pipiens* are not attracted to IR at the wavelength and power output level used in these tests.

These results show that larval *C. pipiens* are attracted to light produced by green and amber LED's. Light from green LED's captured 3 times more larvae than did light from white incandescent lamps and amber LED's captured 1.4 times more than white incandescent sources, but that difference was not significant. All larval instars appear to be equally attracted to these sources. Additional, preliminary testing, has shown that pupal *C. pipiens* are also attracted to light from LED's of these colors. Experiments are underway to determine what other mosquito species are attracted, as larvae, to solid state light sources.

Solid state light sources are readily available and offer several advantages over incandescent lamps. These include low cost (20 to 40 cents), long life (about 1,000 h at maximum current ratings), energy efficiency (low voltage and current requirements), plus consistent color output over life of the device and resistance to rough handling because they do not produce light by means of a heated wire filament.

Table 1. Light source color and technical data.

Visual Color	Principal Wavelength[1]	Half Width[1]	Light Source Model Number	Supplier[2]
Green	565 (nm)	30 (nm)	LN31GPHL[3]	Digi-Key Corp.
Amber	590	30	LN41YPHL[3]	Digi-Key Corp.
White	N.A.	N.A.	C22505	Chaney Electronics
Orange	630	40	LN81RPHL[3]	Digi-Key Corp.
Red	700	100	LN21RPHL[3]	Digi-Key Corp.
Infrared	880	N.A.	XC-880-A	Radio Shack

[1]Taken from manufacturer's literature. N.A. = Not Available.

[2]Addresses: Digi-Key Corporation, 701 Brooks Ave. South, P.O. Box 677, Thief River Falls, Minnesota, 56701-0677. Chaney Electronics, Denver, Colorado, is no longer in business and this lamp is not available. Radio Shack carries a 1.5 volt incandescent lamp of the same size,, style and amperage which could be substituted. Radio Shack has outlets located worldwide.

[3]The manufacturer's (Panasonic Industrial Company) optoelectronic device part number.

Table 2. Response of ***Culex pipiens*** larvae to Light Emitting Diode colors.

Visual Color	Total Capture[1]	%	Daily Range	Mean[2]
Green	206	3.96	0-21 larvae	7.92[A]
Amber	96	1.85	0-9 larvae	3.69[B]
White	68	1.31	0-5 larvae	2.61[B]
Orange	28	0.54	0-4 larvae	1.08[C]
Red	18	0.35	0-4 larvae	0.69[C]
Infrared	7	0.13	0-1 larvae	0.27[C]
Unlit	6	0.12	0-4 larvae	0.23[C]

[1]Total larvae captured during the tests, regardless of instar.

[2]Average daily catch by all traps of that color. Means followed by the same letter are not significantly different from each other based on Fisher's Least Significant Difference Test ($\alpha = 0.05$).

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THREE NEW *DROSOPHILA* SPECIES (DIPTERA: DROSOPHILIDAE) FROM BRITISH COLUMBIA, HAWAII, AND THE CANARY ISLANDS[1,2]

Haruo Takada, Jong S. Yoon[3]

ABSTRACT: *Drosophila canadiana* n. sp. from Smithers, British Columbia, Canada, *D. canaryana* n. sp. from Tenerife, Canary Islands, and *D. soonae* n. sp. from Kona, Island of Hawaii, are described. Their relationships to other species in the *virilis* species group, the *obscura* species group, and the modified mouthparts species group, respectively, are discussed.

The National *Drosophila* Species Resource Center (NDSRC) at Bowling Green State University, Ohio, maintains a collection of living cultures of *Drosophila,* totaling more than 350 named species and several undescribed species. This is the largest collection of living eukaryotic organisms ever assembled whose evolutionary relationships and genetic biology have been studied extensively.

In order to maintain the quality of stock and to provide better services for the scientific community, it is necessary to verify the authenticity of the stock, and to identify unnamed species. During the course of this study, three of these unnamed species are described: the first species is from British Columbia, the second is from the Canary Islands, and the third is from the Island of Hawaii.

Drosophila canadiana n. sp.

(Figs. 1-2)

Diagnosis: Distinguished from other members of the *virilis* species group by cylindrical shaped spermatheca, phallosomal index of 2.3-2.5, and evenly scattered dorsal hairs on the aedeagus.

Description:

External characteristics of adults: Male and female. Arista with usually 7 branches including a terminal fork. Antennae brown, third joint darker. Frons dark reddish brown, ocellar triangle dark brown. Anterior reclinate orbital bristle less than 1/2 length of pro-

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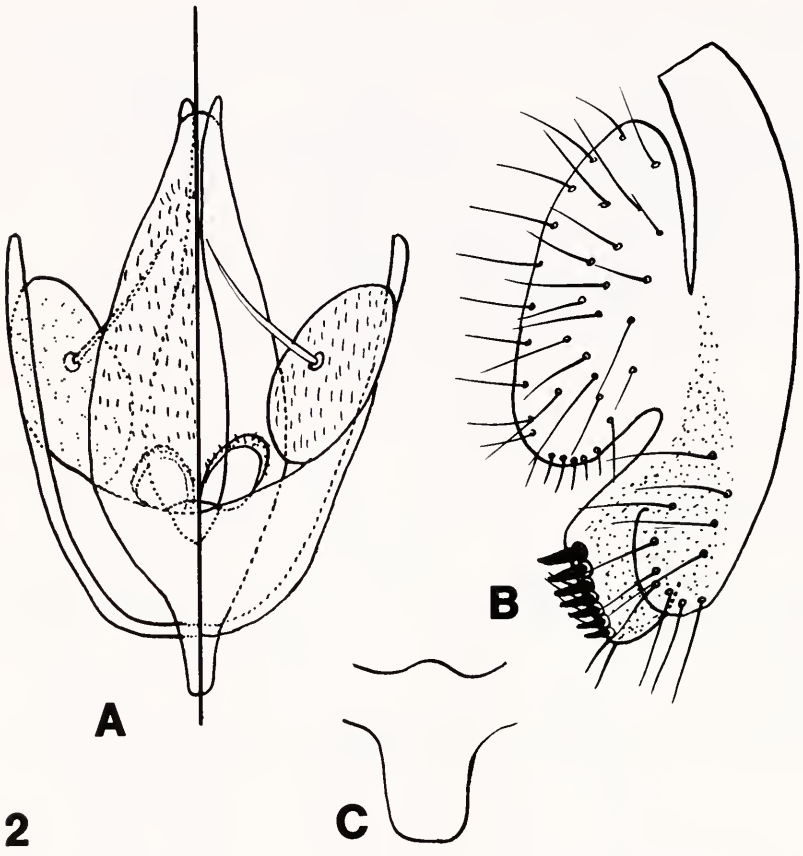

Fig. 2. *Drosophila canadiana* n. sp. A. phallic organs of male; left half in dorsal aspect and right half in ventral aspect B. periphallic organs of male; right half in posterior aspect C. bridge connecting claspers.

since 1961. This strain exhibited distinctive differences in karyotype and longevity (Durbin and Yoon, 1987, and unpublished data).

D. canadiana belongs to the *virilis* species group of the subgenus *Drosophila*. It is closely related to but clearly differs from the European *D. littoralis* Meigen 1830. *D. canadiana* has a cylindrical shaped spermatheca, phallosomal index of 2.3 - 2.5, and evenly scattered dorsal hairs on the aedeagus, while *D. littoralis* from Switzerland has a hemispherical spermatheca, phallosomal index of 1.4 - 1.8, and aedeagal hairs on only the dorsal half.

Drosophila canaryana n. sp.

(Figs. 3-5)

Diagnosis: Distinguished from other members of the *obscura* species group by male sex combs with a row of long black teeth on each basal and second tarsal segment of foreleg.

Description:

External characteristics of adults: Male. Body blackish brown. Eye dark red with dark pile. Arista with 3 dorsal and 2 ventral branches in addition to terminal fork. Antennae brown, third joint blackish brown, pollinose. Clypeus and carina pale brown, front dark brown. Ocellus pale yellowish brown. Two prominent orals. Middle orbital about 1/2 length anterior proclinate, 1/3 that of posterior reclinate. Palpus with single prominent bristle. Carina narrow above, gradually widening below, somewhat rounded, not sulcate. Cheeks grayish yellow, narrow, their width less than almost 1/5 greatest diameter of the eyes.

Mesonotum and scutellum dark brown. Acrostichal hairs in 8 rows, anterior scutellars convergent. Anterior dorsocentrals 1/2 length posterior dorsocentrals. Pleura dark brown. Anterior sternopleural 1/2 length posterior; middle one undeveloped.

Legs pale grayish yellow. Fore femur swollen, with a row of bristles on posterior surface, and inner surface of posterior end clouded. Basal tarsal segment of fore leg with row of long black teeth, 26 in number, the row placed slightly obliquely on the segment. Second tarsal joint also with large prominent sex-comb, consisting of a row of long black teeth slightly curved to apex, 20-25 in number, placed obliquely, not parallel, to axis. Position and size of these combs are shown in Figure 1 d and e.

Abdominal tergites brownish black, slightly shining. Haltere white. First tergite paler than others.

Wing hyaline; two prominent bristles at distal costal break. Third costal section with heavy bristles on basal 1/3. Coastal index 2.9; 4th vein index 1.7; 4C index 0.9 and 5x index 2.0.

Length of body 2.2 mm. Wings 2.2 mm.

Female. As above, except that no tarsal combs are present. Spermathecae small spherical bodies, dark brown in color and chitinized.

Male genitalia: Periphallic organs. Middle and lower portions of genital arch with 28 or more bristles, upper portion with 7 bristles; toe elongate and swollen. Primary clasper without prominent process; 8 primary teeth, 9 spines on posterior tip of anal plate in two rows.

Phallic organs. Hypandrium semi-elliptical in shape with a short pair of paramedian spines. Anterior parameres as long as posterior parameres and with 8 sensilla. Aedeagus bifurcate and rather longer than both parameres. Phallosomal index 0.6.

Eggs: Two filaments, with distal ends expanded.

Chromosomes: 2n = 12, 5R1D. Karyotype observed in brain ganglion of third instar larvae of male.

Types: Holotype male. The original specimen collected in December, 1971, at Tenerife, Canary Islands; Stock No. 1410-1211 (3265.1) of the NDSRC. Allotype female and paratype males and females are same as above. Type specimens have been deposited at the AMNH.

Remarks: On the basis of the external morphology this species appears to be closely related to *Drosophila subobscura* Collin, 1936 (see Pomini, 1940), subgenus *Sophophora,* Genus *Drosophila,* but can be separated from all known members of the *obscura* species group by the phallic organs and sex-combs of the male.

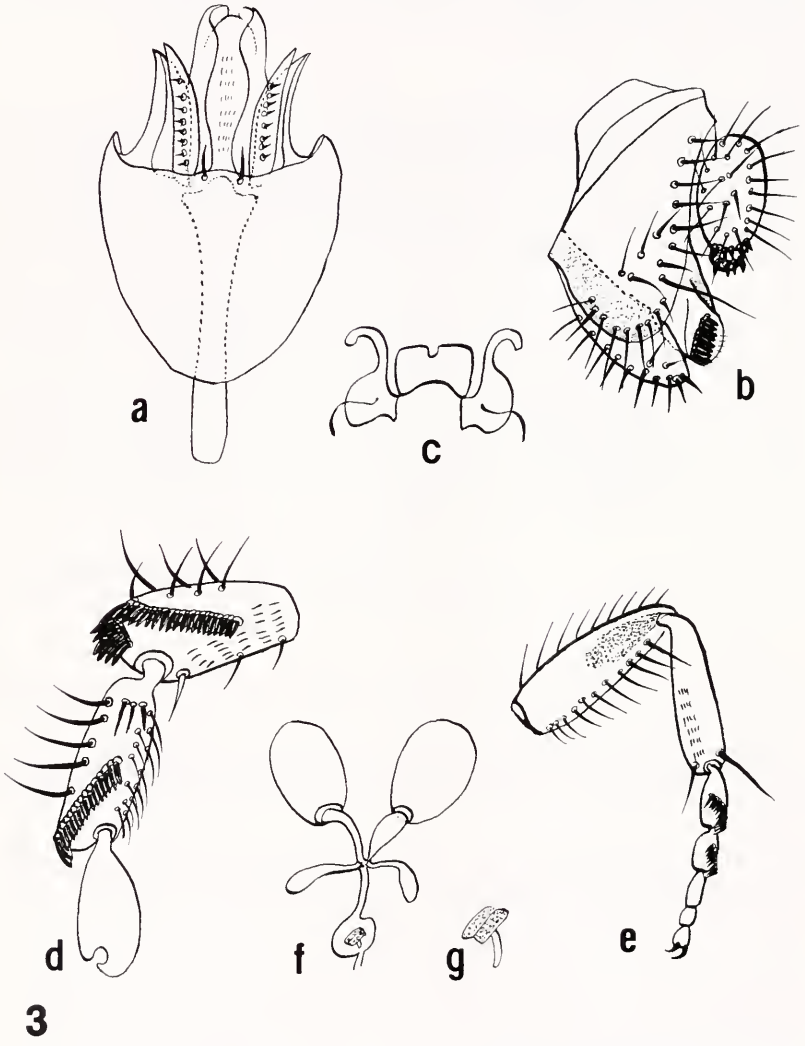

Fig. 3 *Drosophila canaryana* n. sp. A. ventral aspect of phallic organs B. left half of external male genitalia C. the bridge connected claspers D. fore basal tarsus and 2nd tarsus of male E. fore leg of male F. internal genitalia of male G. sperm pump.

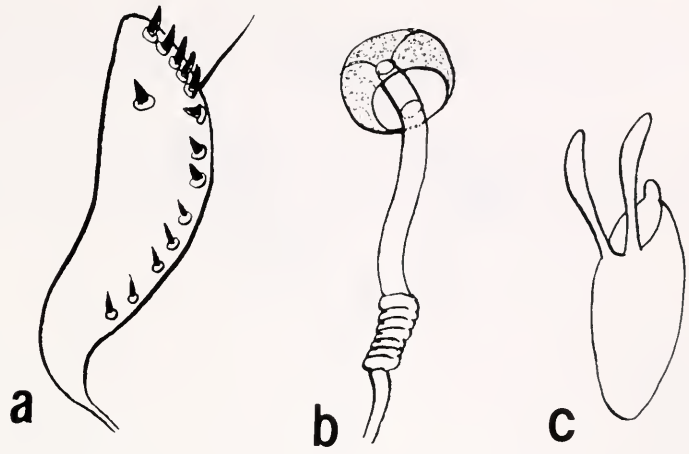

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Fig. 4. *Drosophila canaryana* n. sp. A. egg-guide B. spermatheca C. egg.

Drosophila soonae n. sp.

(Figs. 6-7)

Diagnosis: Distinguished from other species of Hawaiian *Drosophila* by modified mouthparts: each labellum with a series of long, curved, bristle-like processes extending from the apex.

Description:

External characteristics of adults: Male. Body tannish yellow, eyes scarlet in live specimens. Arista with 6 dorsal and 2 ventral branches in addition to the fork. Third antennal segment darker. Frons tan, orbits and ocellar triangle paler. Carina, cheeks and clypeus tan; carina flat. Ocelli tannish yellow. Proclinate orbital 5/6 length posterior reclinate; anterior reclinate thin, 1/3 length proclinate; proclinate orbital situated at middle of the front and near anterior reclinate. Oral bristles are made up of a row of short black bristles of about equal length. Palpi with a long apical bristle and with densely blackish setae around apical one third. Each labellum with a series of long, curved, bristle-like processes extending from the apex.

Mesonotum tannish yellow. Acrostichal hairs in 8 somewhat irregular rows. Posterior dorsocentral bristles long, anterior ones small and thin. Ventral surface of sternopleurite with 14 long, curved, black bristles. Haltere yellow. Lateral surface of second tergite with numerous upright bristles on the posterior margin, each tergite with an apical brownish band and widely interrupted at middle on sixth tergite. Fourth, fifth and sixth sternites with marginal bristles. Middle sternopleural small. Sterno-index 0.6.

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Fig. 5. *Drosophila. canaryana* n. sp. karyotype from male brain ganglion of the third instar larvae.

Legs yellow; only fifth tarsal segments dark brown. The tarsi with two rows of long hairs; one outside, the other one inside on the anterior surface.

Wing hyaline, veins pale brown; costal index 5.0; 4V index about 1.2; 4C index 0.5; 5x index 1.0. Third costal section with small black bristles on its basal 2/3.

Length of body about 4 mm in male, wings 4 mm.

Female. Labellum without bristle-like process. Palpi not as shaggy as in male. Tarsus without long hairs. Seventh sternite with marginal bristles. Second oral bristle half the length of first one, prominent. Anterior dorsocentral bristles present, 3/4 of length of posterior dorsocentral bristles. Length body about 3.5-4.0 mm in female, wings, 3.5-4 mm.

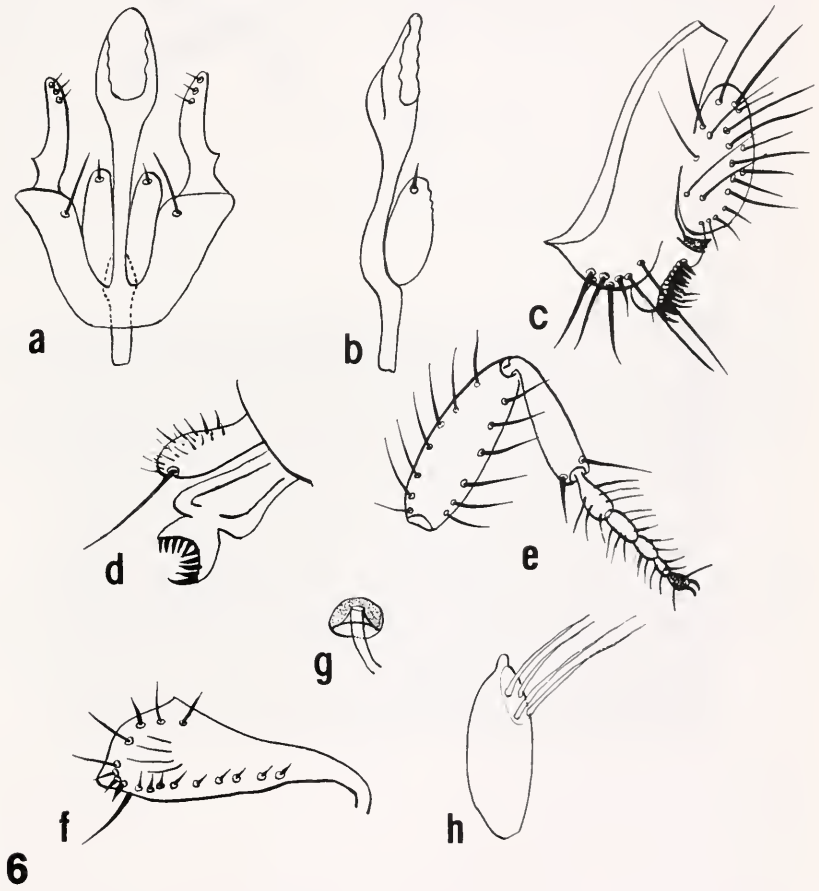
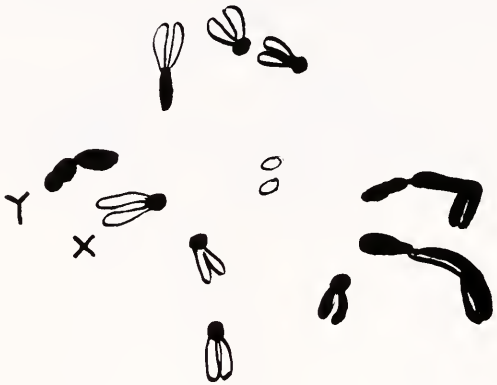


Fig. 6. *Drosophila soonae* n. sp. A. ventral aspect of phallic organs B. lateral aspect of phallic organs without hypandrium C. left half of external male genitalia D. proboscis of male (lateral aspect) E. fore leg of male F. egg-guide G. spermatheca H. egg.



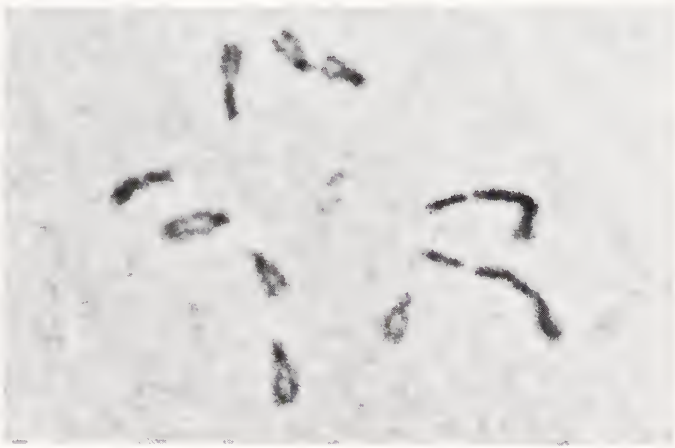


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Fig. 7. *Drosophila soonae* n. sp. karyotype from male brain ganglion of the third instar larvae.

Male genitalia: Periphallic organs. Genital arch with about 10 bristles including two long bristles on lower portioin; toe rounded. Clasper with about 11 black primary teeth. The genitalia resemble that of *Drosophila mimica* Hardy as mentioned by Takada (1966).

Phallic organs. Aedeagus apically swollen. Anterior parameters long-elliptical in shape, the apices at slightly above level as the level of insertion of the paramedian spines of hypandrium. Phallosomal index about 3.0.

Egg: Four filaments, apical two rather shorter than posterior two.

Sexual behavior: The male goes to the rear of the female and assumes head-under-wing posture. The male then extends his proboscis and licks the female's egg-guide area. The aggressor positions himself so that the longitudinal axis of his body is at right angles to the other individual. Sometimes the abdomen is bent laterally. The aggressor then rushes sideways with a crab-like motion.

Chromosomes: 2n=12, 5R1D. One pair of autosomes were double length. Karyotype observed in brain ganglion of third instar larvae of male.

Types: Holotype male. Original specimen collected July 13, 1965, at Kealakekua Ranch, Pawaina (3,000 ft.), Kona, Island of Hawaii, by Dr. H.L. Carson, University of Hawaii, on banana baits. Stock No. 15290-2591 (C129.2) of the National *Drosophila* Species Resource Center. Allotype and paratypes are the same as the above. Type specimens have been deposited at the AMNH.

Remarks: This species is closely related to *Drosophila mimica* Hardy, 1965. It belongs to the *mimica* subgroup, subgenus *Drosophila,* Genus *Drosophila,* the so-called modified mouthparts species group (Spieth, 1966). Our stock of this species was originally kept by Mrs. Kyung Soon A. Yoon, during her twenty years as a curator of the National *Drosophila* Species Resource Center. We are naming this species in her honor.

ACKNOWLEDGMENTS

We are grateful to Professor Robert C. Graves and Mr. G. Kent Vermilion of Bowling Green State University for their helpful comments on the study and for critically reviewing this manuscript. Also, the authors thank Mrs. Kyung-Soon Ahn Yoon for her careful maintenance of these stocks for 20 years as a curator of the National *Drosophila* Species Resource Center.

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PALAEODIPTERON WALKERI (DIPTERA: NYMPHOMYIIDAE) IN THE ADIRONDACK MOUNTAINS, NEW YORK[1]

Michael E. Smith[2], Barbara J. Wyskowski[3], Charles T. Driscoll[3], Carol M. Brooks[3], Christina C. Cosentini[3]

ABSTRACT: The nymphomyiid *Palaeodipteron walkeri* (Diptera) is reported for the first time from New York State. Larvae were collected from two second-order streams, one of which was acidic (Acid Neutralizing Capacity ≤ 0) with coincident low pH and basic cation concentrations, and high aluminum concentrations. Collection of *P. walkeri* in an acidic stream suggests that this species may be relatively insensitive to potential anthropogenic stream acidification.

The Nymphomyiidae is a small, archaic dipteran family consisting of only four species. One of these species, *Palaeodipteron walkeri* Ide, has a Nearctic distribution; specimens have been collected from New Brunswick (Ide 1965; Kevan and Cutten-Ali-Kahn 1975), southwestern Quebec (Cutten and Kevan 1970), northern Quebec (Back and Woods 1979) and in the United States from Maine (Mingo and Gibbs 1976) and Pennsylvania (Adler *et al.* 1985). As part of a study to determine relationships between benthic invertebrate communities and stream acidity, we collected several larval *P. walkeri* from two low-order woodland streams in the western Adirondack Mountains, New York.

During routine monthly sampling of stream benthic invertebrates using a modified Hess sampler (250 μm mesh size), two larvae were collected in Pancake-Hall Creek Tributary (43° 50'N 74° 52'W) and five larvae were collected in Beaver Brook (43° 43'N 74° 22'W) on 13 January 1986. These samples were collected in second-order riffle areas of both streams. Substrate at each site was similar, consisting of cobbles overlying gravel and sand. Both streams were well shaded. Vegetation along Beaver Brook and Pancake-Hall Creek Tributary was primarily deciduous stands (*Acer saccharum, Fagus grandifolia, Betula alleghaniensis*) with small coniferous stands (*Picea rubens, Abies balsamea, Tsuga canadensis*) interspersed. The understory consisted of sparse forbs and grasses. All specimens of *P. walkeri* are currently housed in the invertebrate collection at Valdosta State College.

Physical and chemical characteristics differed between the two streams (Table 1). Beaver Brook was 2-4 m wide, 15-30 cm deep and non-

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acidic (ANC > 0) with coincident higher pH, C_B (basic cation) concentrations and lower metal concentrations than those found in Pancake-Hall Creek Tributary. Pancake-Hall Creek Tributary was 1-1.5 m wide, 2-20 cm deep and was acidic (ANC $\leq$ 0) with low pH and C_B concentrations. Metal concentrations were elevated at Pancake-Hall Creek Tributary, especially labile monomeric Al that is toxic to fish (Driscoll *et*

TABLE 1. Yearly means (ranges) of physical and chemical stream parameters in Pancake-Hall Creek Tributary (PAT) and Beaver Brook (BE) from January 1985 - January 1986. Samples were collected monthly, n = 13.

PARAMETER	PAT	BE
Temperature (°C)	5.7 (0.0 - 14.0)	6.5 (0.0 - 18.0)
Velocity (m/sec)	0.21 (0.13 - 0.29)	0.37 (0.23 - 0.51)
Dissolved Oxygen (mg/1)	10.7 (10.0 - 12.0)	11.2 (10.0 - 13.2)
pH	4.88 (4.53 - 5.80)	6.22 (5.45 - 6.95)
Acid Neutralizing Capacity (ANC) (μeq/1)	-5.9 (-18.3 - 21.5)	56.8 (6.2 - 113.7)
Basic Cations (C_B) (μeq/1)	149.1 (99.0 - 201.9)	228.3 (152.9 - 286.9)
Dissolved Organic Carbon (DOC) (mg C/1)	3.6 (2.4 - 4.7)	2.1 (1.5 - 2.9)
Total Monomeric Al (mg/1)	0.52 (0.09 - 0.91)	0.04 (0.01 - 0.18)
Labile Monomeric Al (mg/1)	0.38 (0.04 - 0.63)	0.01 (0.0 - 0.16)
Non-labile Momomeric Al (mg/1)	0.14 (0.05 - 0.28)	0.05 (0.01 - 0.34)
Fe (mg/1)	0.14 (0.03 - 0.71)	0.03 (0.0 - 0.15)
Mn (mg/1)	0.08 (0.06 - 0.19)	0.01 (0.0 - 0.03)
Zn (mg/1)	0.05 (0.0 - 0.09)	0.01 (0.0 - 0.03)

al. 1980) and presumably other aquatic fauna. Additionally, high H^+ concentrations can be toxic to aquatic insects or affect various life history parameters (e.g. emergence) (Haines 1981). Collection of the nymphomyiid *P. walkeri* in Pancake-Hall Creek Tributary demonstrates that this species can live in acidic conditions and is probably less vulnerable than many other insects (e.g. Ephemeroptera) to potential anthropogenic stream acidification which is a major problem in the northeastern United States.

ACKNOWLEDGMENTS

Funding was provided by the Electric Power Research Institute as part of the aluminum stream study (ALSS). We thank J. Kaster and J. Whitesell for reviewing the manuscript. We also thank Dr. and Mrs. Steinhauser and the Big Moose Lake Association for their cooperation, and J. Elwood and D. Porcella for their encouragement.

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SOCIETY MEETING-FEBRUARY 15, 1989

Dragonflies and Damselflies of Acadia National Park

Dr. Harold B. White

Hal White, Professor of Biochemistry at the University of Delaware and Corresponding Secretary of our Society, is an Odonata enthusiast. After seeing his slides of the two islands that make up this large park, the attractive insects that are his quarry, and the beautiful scenery, it was easy for our 23 members and guests to understand his enthusiasm. Especially on a dark, cool, rainy February evening. Hal's statement that nearly 100 species of Odonata have so far been collected in this 100 square mile park seemed too large at first, but it soon became obvious that the surprisingly large number of ecosystems present on

(Continued on page 126)

ANTS (HYMENOPTERA: FORMICIDAE) NESTING IN SEROTINOUS CONES OF TABLE MOUNTAIN PINE, *PINUS PUNGENS*[1]

Charles E. Williams[2]

ABSTRACT: The ants *Leptothorax curvispinosus* and *Aphaenogaster carolinensis* are recorded as nesting in serotinous cones of table mountain pine, *Pinus pungens,* in southwestern Virginia. Pine cones are previously undescribed nesting habitat for both species. Ants occupied cones previously infested by the pyralid moth, *Dioryctria yatesi.*

Plant structures, such as stems, thorns and leaves, are often used as nesting sites by ants, particularly in the tropics (e.g., Janzen 1966; Rathet and Bronstein 1987). Vegetative structures and fruits of temperate zone angiosperms are also occasionally used as nesting sites (Wheeler 1910; Winston 1956) but records of ants nesting in structures associated with gymnosperms of this region (other than decaying wood) are rare. Wheeler (1910) listed one instance in which *Camponotus nearcticus* Emery nested in cones of pitch pine, *Pinus rigida* Mill., from the New Jersey pine barrens.

On 15 July 1986, I collected cones of table mountain pine, *Pinus pungens* Lambert, from the floor of a pine-oak forest located on Brush Mountain, Montgomery County, Virginia. All collected cones had previously been infested by larvae of the mountain pine coneworm, *Dioryctria yatesi* Mutuura and Munroe (Lepidoptera: Pyralidae). I found that two of these cones were each occupied by one of two species of ants. Workers, brood, and queen inhabited each of the cones. These ants were subsequently identified as *Leptothorax curvispinosus* Mayr and *Aphaenogaster carolinensis* Wheeler. *L. curvispinosus* commonly nests in galls and hollow stems of plants but *Aphaenogaster* species usually maintain subterranean nests under stones, logs or boards (Wheeler 1910). This collection represents the first record of either of these two ants nesting in pine cones. Voucher specimens have been deposited in the VPI & SU insect museum.

Cones of table mountain pine formerly infested by larvae of *D. yatesi* offer excellent shelters for ants and probably other arthropods. The random tunneling of *D. yatesi* larvae through the cone creates ample internal cavities for nesting or overwintering insects, and emergence holes pro-

[1]Received December 8, 1988. Accepted January 3, 1989.

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vide entrances into the cone interior. Moreover, the cones of table mountain pine are often serotinous and typically remain closed at maturity [an adaptation for colonizing burned sites; high temperatures associated with forest fires usually open cones (Zobel 1969)], even after infestation by larvae of *D. yatesi.* Previously infested, serotinous cones of table mountain pine thus provide a sheltered, accessible habitat for nesting ants.

The few records of ants nesting in pine cones may reflect in general the limited suitability of cones as ant habitations. The cones of most conifers open at maturity and provide little or no sheltered space for ants to raise brood. The closed cones of serotinous conifers are an exception however, and when modified by seed predators can provide high quality nesting sites for ants. Interestingly, cones of pitch pine [from which *C. nearcticus* has been collected (Wheeler 1910)] are also serotinous in parts of the New Jersey pine barrens (Givnish 1981).

ACKNOWLEDGMENTS

I thank George and Jeanette Wheeler for identifying ants, Kim Williams, H.P. Boyd, and an anonymous reviewer for providing useful comments on the manuscript, and the Virginia Tech Graduate Research Development Project and Sigma Xi for supporting studies of table mountain pine.

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these islands on the Maine coast made this diversity possible. Glacially-formed lakes and potholes, beaver ponds, streams, fresh and saltwater marshes, bogs, a great range in elevations, and the modifying effects of the surrounding bay and ocean combine to provide habitats for many species that would ordinarily not be found so far south or north. Hal also mentioned an early connection to our Society — the first list of Odonates found on the largest island, Mt. Desert, was published in the second volume of ENTOMOLOGICAL NEWS nearly a century ago. A summary of Dr. White's collecting efforts is being published in this issue of the NEWS.

The biennial elections were also held on this date. The present officers (President, R.W. Fuester; Vice-President, J. Sheldon; Recording Secretary, V. Ventre; Treasurer, J.J. Freese; and Corresponding Secretary, H.B. White) were re-elected to 2-year terms.

(Continued on page 128)

A COLLECTION TECHNIQUE FOR MOUND-BUILDING ANTS (HYMENOPTERA: FORMICIDAE)[1,2]

William H. Clark[3], Paul E. Blom[4]

ABSTRACT: We present a simple, fast, and inexpensive method for collecting relatively clean samples of mound-building ants. The method consists of creating a miniature pitfall trap in the mound with a collecting tube.

Over years of collecting mound-building ants, mainly of the genera *Pogonomyrmex, Solenopsis,* and *Formica* in North America, we have used a simple, fast, inexpensive method for making relatively clean collections of workers. Since we have found many collectors unaware of this extremely useful technique, it is described below.

The collection method described is as simple and useful as many other ant collection techniques (Clark and Blom 1979; Greenslade 1973; Wheeler 1910; Wheeler and Wheeler 1963). Melander (1902) described a similar method for use with the non mound-building ant, *Pogonomyrmex barbatus* (F. Smith). Our procedure involves pushing an open collecting vial partly filled with alcohol into the earth, gravel, or thatch ant mound and letting the container act as a pitfall trap for the ants. We insert a vial, flag the nest for easy relocation, continue collecting in the area, and return to the mound to recover the vial of ants. Forceps are sometimes needed to retrieve the vial to avoid stings and bites. The nest may be partly opened with a small trowel or other instrument if the ants are not active outside the nest. The ants usually react to the disturbance by increased activity and in the process fall into the open vial of alcohol. Greenslade (1973) described "digging-in effects" and showed that the highest catches of ants occured immediately after pitfall traps were established. Brood may be collected in this manner as workers carrying immatures to safety frequently fall into the collecting vial.

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[4]Department of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow 83843.

If care is taken in placing the vial into the mound, a relatively clean sample is usually obtained. This is a sharp contrast to the cleaning necessary to remove unwanted debris if the ants are collected by aspirator.

This method has apparently been overlooked by myrmecologists and was not mentioned in references for methods of ant study (Donisthorpe 1927; Gregg 1963; Greenslade 1973; Melander 1902; Wheeler 1910, 1932; Wheeler and Wheeler 1963). The Wheelers listed the following methods of collection from an ant colony in a mound of earth or thatch: 1) ants can be scooped up with a trowel and dumped onto a surface to be aspirated; 2) chloroform is poured into the mound and the motionless ants then collected; 3) a portion of the mound is placed into a cloth bag for later sorting; and 4) the ants may be aspirated directly from the mound. These methods require more time and effort than our suggested technique. It may be necessary to dig through a mound to obtain sexual forms, brood, and inquilines though this can be done selectively after a series of workers has been obtained.

ACKNOWLEDGMENTS

P.L. Comanor gave logistical support in the early portion of this work. O.D. Markham, T.D. Reynolds, and J.B. Johnson assisted with work at the Idaho National Environmental Research Park. R.D. Akre, J.B. Johnson, O.D. Markham, and F.W. Merickel reviewed an earlier draft and provided valuable comments.

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Some of the entomological "notes" discussed prior to the meeting included color photos of the zebra caterpillar shown by Bill Ettinger, mention by Dave Funk that the winter cranefly was observed during unusually mild periods this winter (despite the name, it is rarely seen in this area in winter), and display of a Wall Street Journal article on butterfly "ranches", and brochures advertising a successful Lepidoptera artist in Tennessee, by Dr. Ken and Sue Frank. The refreshments by Mildred Morgan were very good, as usual.

W.H. Day

THE MONARCH BUTTERFLY (LEPIDOPTERA: DANAIDAE) AS PREY FOR THE DRAGONFLY *HAGENIUS BREVISTYLUS* (ODONATA: GOMPHIDAE)

David S. White[2], Owen J. Sexton[3]

ABSTRACT: *Hagenius brevistylus* (Gomphidae) was shown to prey on an aposematic model, the monarch (*Danaus plexippus*) when the butterfly's densities were high. The mode of prey capture and feeding, where the butterfly's thorax and abdomen are eaten first, avoids the highest concentrations of cardenolide poisons stored in the wings and exoskeleton. The feeding mode is virtually identical to that of the known vertebrate predators of *Danaus*.

The monarch butterfly *Danaus plexippus* L. has been firmly established as an aposematic model (Brower *et al.* 1968). The presence of cardenolides accumulated by certain populations (Brower *et al.* 1968) renders the butterfly unpalatable to a variety of potential predators. Cardenolides are sequestered as larvae feed on milkweeds of the family Asclepiadaceae. Secondary cardenolide compounds are transmitted to the adult butterfly but are not uniformly distributed throughout the body. Cardenolides tend to be incorporated into the exoskeletal materials in levels decreasing from the wings to abdomen to thorax (Brower and Glazier 1975).

There are few records of predators regularly feeding on monarch butterflies in nature. Marshall (1902) studied predators on an Old World species closely related to the monarch (*D. chrysippus*) and concluded that most predators did not attack this distasteful species more than once. Calvert *et al.* (1979) observed three species of birds feeding on *D. plexippus* at the butterflies' wintering grounds in Mexico. They found that birds ingested muscle and tissue from the thorax and occasionally from the abdomen. The wings and most of the exoskeleton usually were discarded. Calvert *et al.* (1979) also summarized data on other known vertebrate predators of the monarch.

Adult dragonflies feed upon a diversity of prey (Beatty 1951, Corbet 1962) including occasional butterflies (Poulton 1906, Champion 1914, Hobby 1933, Wright 1944). Marshall (1902) observed one unidentified dragonfly to be holding a wing of *D. chrysippus* apparently preparing to devour it. We know of no other records of invertebrate predators on adult monarchs. Marshall (1902) does mention observing a large wasp carrying a *D. chrysippus* larva.

This study describes predation upon monarchs (*D. plexippus*) by adults of a large gomphid dragonfly (*Hagenius brevistylus* Selys) along the

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shore of Douglas Lake at the University of Michigan Biological Station, Pellston, Michigan, U.S.A., from 1979 through 1987. In 1979, both monarchs and *Hagenius* were extremely abundant at the Biological Station, and most direct and indirect observations discussed below were made in that year. In subsequent years, monarchs have been present but not abundant, while the *Hagenius* population does not appear to have fluctuated greatly. No density estimates have been made nor records kept on either species.

Monarch larvae feed on large patches of the milkweed *Asclepias syriaca* L. along the shores of Douglas Lake, pupating and emerging from late June through early August. *Hagenius* naiads live for at least two years in Douglas Lake, emerging from late June through mid-July. *Hagenius* adults establish and defend territories which include many of the milkweed patches. Adults are known to consume a wide variety of larger insects including butterflies, e.g., *Papilio turnus* L. (=*Papilio glaucus* L.) (Daecke 1915), but previously have not been reported feeding on monarchs.

Evidence for predation was both direct and indirect. Observations of attacks and feeding by several *Hagenius* on monarchs were made initially during the first two weeks in July 1979. No attacks were observed from 1980 to 1987. Indirect evidence in 1979 came from finding numerous monarch corpses scattered along the shoreline area. The butterfly remains in both direct and indirect observations consisted of: abdomen and wings; thorax, abdomen and wings; and part of the thorax and wings. In addition, single or paired wings alone were found. Between 1980 and 1987 only a few single or paired wings have been found.

Following initial observations, interactions between monarchs and *Hagenius* were monitored for about one month in a 30 x 30 m plot which at any one time was patrolled by 3 or 4 dragonflies and which contained a large patch of milkweed and emerging monarchs. Similar to most dragonflies (Westfall 1984), *Hagenius* were active only in direct sunshine; however, monarch adults were active and would feed at the milkweed flowers only on overcast days or when the sun was obscured by a cloud. If monarchs were disturbed when the sun was out, they normally would fly to the nearest shady spot. This behavior was not observed in monarch populations away from the patrolling range of *Hagenius* where butterflies seemed equally active in sunlight. Monarchs disturbed in the study site during periods of sunshine usually were attacked by one or more *Hagenius.*

In a successful capture, the dragonfly quickly alighted and incapacitated the prey by biting through the head then manipulating the monarch into a feeding position using its forelegs to press the wings together. The musculature of the monarch's thorax, and less frequently that of the abdomen was stripped over a 10-15 min period. On occasion,

the butterfly's wings were broken off but never did they show any signs of being chewed. Once the corpse was discarded, the dragonfly resumed patrolling behaviors. Only once during the one month of observations in the study plot was an *Hagenius* seen capturing prey other than monarchs even though a wide variety of large and small insects was actively visiting milkweed and other flowers in the study plot.

One *Hagenius* was observed to capture and consume two monarchs within an hour. This specimen was captured and placed in a large flight cage but could not be induced to eat more monarchs. It died after a week in captivity. During that time, the dragonfly did not show any obvious signs of toxic stress from having eaten the monarchs.

One possible explanation for the regular capture of *Danaus* by *Hagenius* is that the local *Asclepias syriaca* population lacks a sufficient level of cardenolides to supply the monarchs with a taste obnoxious to predators (Brower and Glazier 1975), so there is no deterrent. To test this possibility, we fed local monarchs to three species of potential predators. A large toad, *Bufo americanus* Holbrook, was offered a monarch in a terrarium. The toad oriented towards the butterfly, captured it, but did not ingest it; the toad did not attack again. Two days later, another monarch was offered to the same toad, but there was no attack. Five days later, the toad did attack a monarch, rejected it, then attacked again and swallowed the butterfly. The second potential predator was a duckling mallard, *Anas platyrhynchos* (L.), which had been reared on poultry mash and live grasshoppers. At the first presentation, the duckling pecked at the butterfly, shook its head several times, then ceased attacking. Two days later, a second butterfly was offered with the same results. A monarch presented on the fifth day was eaten but only after having been in range of the duckling for some time. The third predator, a large green frog *Rana clamitans* Latreille, caught a monarch flying within its terrarium, ingested the body and half the wings, and eventually swallowed it after wiping at the prey with its forelimbs.

The above observations suggest at least some degree of unpalatability in the local monarch population. None of the three above predators possessed the ability to ingest only selected parts of the monarch, i.e., separating the wings and exoskeleton from the musculature of the abdomen and thorax. The observation that *Hagenius* was selectively feeding on distinct parts of the monarch bodies further supports the view that this monarch population was sequestering some level of cardenolides.

The most salient observation here is that an invertebrate predator has been shown to feed on an aposematic model and that its mode of feeding (avoidance of the more toxic portions of the prey) is virtually identical to the mode of the known vertebrate predators of the monarch. Calvert *et al.* (1979) rejected Rothschild and Kellet's (1972) hypothesis

that certain bird species may be insensitive to moderately high levels of cardenolides, proposing instead that those birds feeding on overwintering monarchs have learned to reject unpalatable parts of the butterfly. It is hard to accept a learned taste rejection pattern for *Hagenius* or that *Hagenius* is insensitive to cardenolides. It seems most likely that the manner of prey capture in *Hagenius* and other species of dragonflies, i.e., use of a feeding basket, tends to insure that the first portion consumed will be the sections of the body with the lowest cardenolide concentrations. As body parts with higher concentrations are reached, the corpse is rejected. Thus, there is no selectivity against monarchs by *Hagenius.* Other predators which would capture monarchs in a random manner or by the wings would encounter the highest levels of cardenolides first and would reject the prey. Our study is not meant to suggest that *Danaus* is the sole prey of *Hagenius;* however, in 1979 when monarchs were extremely abundant, *Hagenius* were not observed to seek other prey. In following years when these butterflies were not common, monarchs appear to have been consumed when encountered but probably not with the selectivity seen in 1979.

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We wish to thank the faculty and students of the University of Michigan Biological Station, particularly M.J. Catterall, for help in making observations and gathering specimens. L.K. Gloyd, M.J. Westfall, Jr., and L.P. Brower have reviewed the manuscript and made many helpful suggestions.

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PICROMERUS BIDENS (HETEROPTERA: PENTATOMIDAE) IN NORTH AMERICA, WITH A WORLD REVIEW OF DISTRIBUTION AND BIONOMICS[1]

M.-C. Larivière[2], A. Larochelle[3]

ABSTRACT: The Palearctic, predatory pentatomid *Picromerus bidens* was introduced into North America about 50 years ago. Only recently, however, was this species recorded in the North American literature (1967). The introduction of the species on this continent is of particular interest since it has been shown, in Europe, to prey upon the larvae of many agricultural and forest insect pests. The species has been studied by the authors in 10 states or provinces of northeastern North America from 1978 to 1988. The establishment of the species in North America is discussed, and a world review of its distribution and bionomics (including habitat, associated plants, life cycle, seasonal activity, food, predators, and parasites) is given.

The introduction of the Palearctic, predatory pentatomid *Picromerus bidens* (L.) in North America occurred about 50 years ago. Cooper (1967) first reported the species in the North American literature. Since then, only a few papers have been published that dealt with the distribution, biology, and ecology of *P. bidens* in North America (Lattin and Donahue 1969; Oliveira and Juillet 1971; Kelton 1972; Larochelle 1979; Larochelle and Larivière 1980; McPherson 1982; Larochelle 1984; Javahery 1986; Froeschner 1988).

The European literature, on the other hand, has dealt extensively with this species since 1911. Many studies such as those of Schumacher (1911), Butler (1923), Strawinski (1927), Mayné and Breny (1947a,b; 1948a,b), Dupuis (1949), Southwood and Leston (1959), and Javahery (1967, 1968) have covered the morphology, biology, and ecology of *P. bidens,* and its potential use in biological control. The introduction of this species on this continent is of particular interest since European studies have shown this pentatomid preys upon the larvae of many agricultural and forest insect pests.

Until 1986, *P. bidens* was known in North America only from a few localities in Québec, New York, and northern New England. We have studied and collected this species from 1978 to 1988 in more than 10

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states or provinces in northeastern North America. The following account provides details of its habitat, biology, geographic distribution, and colonization speed in northeastern North America, and reports on the current state of knowledge of this species in Europe as well as in North America, as a reference for those wishing to study this pentatomid.

Picromerus bidens (L.)

Picromerus bidens belongs to the subfamily Asopinae and can be separated from all other North American asopines as follows: humeri prominent, ending in a spine; humeri, lateral margins of pronotum, and the head often shining deep-blue; inner apical third of anterior femora with a short spine and inner apical third of anterior tibia with a short, acute spur; dorsal and ventral surfaces of the body with fine or deep, dark punctures; length 11.0-14.0 mm.

A detailed description of the adult is found in Mayné and Breny (1948b), Dupuis (1949), and Kelton (1972); the latter also includes a color photo of the adult. The egg was described by Butler (1923), Mayné and Breny (1948b), Cooper (1967), and Southwood and Leston (1959). First to third instar nymphs were described by Mayné and Breny (1948b), the fourth instar by Butler (1923) and Mayne and Breny (1948b), and the fifth instar has been described in detail by Butler (1923), Mayné and Breny (1948b) and Dupuis (1949).

Geographic distribution

Palearctic distribution. In the Old World, *P. bidens* is widely distributed in the western Palearctic Region and throughout Europe, from 64°N latitude south to North Africa in the west and China in the east; it occurs as far west as Ireland, and as far east as Siberia and China (Mayné and Breny 1948b; Dupuis 1949; Puchkov 1961; Southwood and Leston 1959; Zheng 1980).

Nearctic distribution. Until now, the known North American distribution of *P. bidens* has been limited to Maine, Massachusetts, New Hampshire, New York, Vermont, and the Province of Québec (Froeschner 1988). The first North American specimens were collected on 22.VII.1932 in Lincoln Co., Maine, and on 28.VII.1945 at Ile-au-Haut (so called "Peaks Island") near Rockland, Maine (Javahery 1986). There seems to be no record of the voluntary importation of *P. bidens* for use as a biological control agent. Javahery (1986) suggests, and it is also our opinion, that the species may have been accidentally introduced from Europe, probably in the egg stage, with the importation of nursery stock or other horticultural plants.

The species has subsequently been collected at Union Village, Vermont, from 1962 to 1967 (Cooper 1967), at Durham, New Hampshire, in 1956 and 1967 (Lattin and Donahue 1969), and at Lennoxville and Ascot Corner in southern Québec in 1970 (Oliveira and Juillet 1971; Kelton 1972). In a previous paper (Larochelle and Larivière 1980), we reported *P. bidens* in Berkshire Co., Massachusetts and Franklin Co., New York as well as in about 40 localities in Québec.

We now have collected over 1,500 adults and 300 nymphs in more than 180 localities from 10 northeastern states or provinces from 1978 to 1988 (states, provinces, and counties in bold face):

MAINE: Franklin: Weld, Wilton. **Oxford:** Sumner.
MASSACHUSETTS: Worcester: W. Brookfield
NEW BRUNSWICK: Kent: Cap-Lumiere, Pointe-Sapin. **Restigouche:** White Brook. **Westmorland:** Jolicure.
NEW YORK: Franklin: Duane, Fort Covington.
NOVA SCOTIA: Annapolis: Annapolis Royal. **Cumberland:** Middleboro. **Lunenberg:** Canaan. **Queens:** W. Caledonia.
ONTARIO: Glengarry: Alexandria. **Prescott:** Carillon Prov. Park.
PRINCE EDWARD ISLAND: Kings: Brudenell River Prov. Park, East Baltic, Fortune. **Prince:** Ellerslie, Norboro. **Queens:** Surrey, Wood Islands Prov. Park.
QUEBEC: 136 localities; north to Etangs-des-Caps (Ile-de-la-Madeleine), in the following counties: **Abitibi, Bagot, Beauce, Beauharnois, Berthier, Bonaventure, Brome, Champlain, Charlevoix-Est, Charlevoix-Ouest, Châcfateauguay, Chicoutimi, Compton, Dorchester, Drummond, Frontenac, Gaspé-Est, Gaspé-Ouest, Gatineau, Huntingdon, Ile-de-Montréal, Iles-de-la-Madeleine, Kamouraska, Lac-Saint-Jean-Est, Lac-Saint-Jean-Ouest, L'Assomption, Lévis, Lotbinière, Maskinongé, Matane, Matapédia, Missisquoi, Montcalm, Montmorency No. 2, Nicolet, Papineau, Pontiac, Richmond, Rimouski, Rivière-du-Loup, Rouville, Saguenay, Saint-Jean, Saint-Maurice, Shefford, Sherbrooke, Soulanges, Stanstead, Témiscouata, Terrebonne, Vaudreuil, Verchères Wolfe.**
RHODE ISLAND: Providence: Chepachet.
VERMONT: Bennington: Mt. Equinox, Woodford. **Essex:** Bloomfield, E. Brighton. **Grand Isle:** E. Alburg, N. Hero. **Lamoille:** Belvidere Center, Belvidere Corners, Eden, Jeffersonville, Lake Elmore, N. Wolcott, Wolcott, Wolcott Pond. **Orleans:** Albany, Hazens Notch, Jay. **Washington:** E. Montpelier, Maple Corner Montpelier, Worcester. **Windham:** Townshend St. Park, Wilmington. **Windsor:** Mt. Ascutney.

The northern limit of distribution (Fig. 1) is now Iles-de-la-Madeleine (47'14" N latitude), Québec, and the southern limit, Chepachet, Rhode Island. The species is recorded for the first time from Prince Edward Island, Nova Scotia, New Brunswick, Ontario, and Rhode Island.

Observations made in Québec indicate a rapid colonization of the territory. It is possible that Québec populations are the result of successive colonizations by Maine populations. We have noticed, however, while collecting in Maine (June, July and September 1985, and August

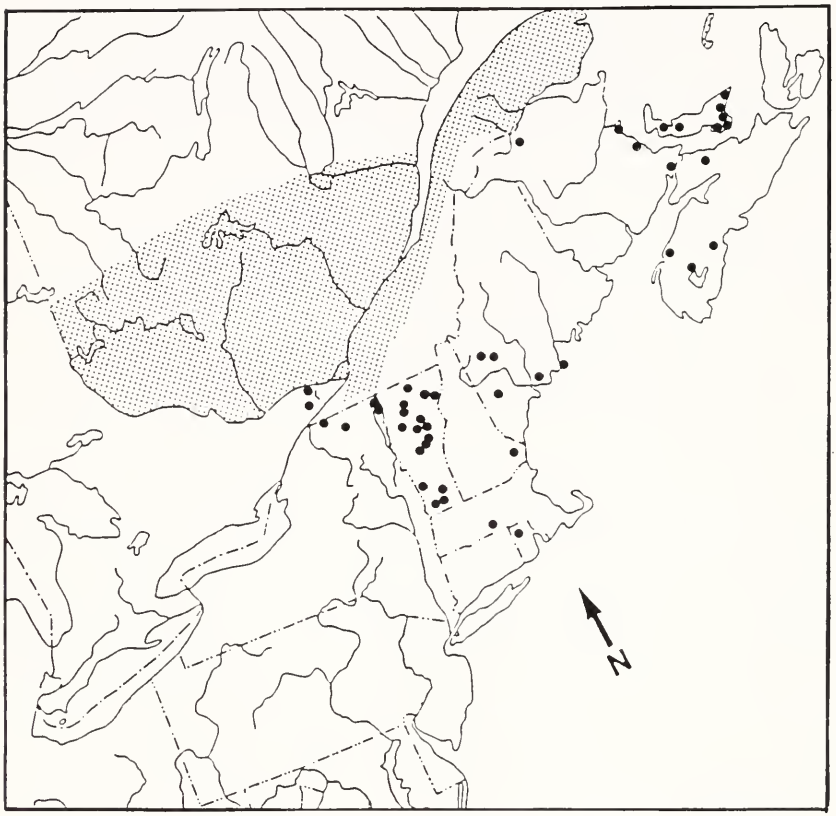

Fig. 1. Distribution of *Picromerus bidens* in northeastern North America.

1986) that the species is less abundant in fields and in general more difficult to find there than in Québec, where it was common to find 10 to 15 individuals in 3 to 4 sweeps from the third week of July to mid-September in almost any of the fields surveyed. It seems likely that the species has been more recently introduced directly into Québec (i.e., possible multiple introductions in North America), as is probably the case of certain Palearctic coccinellids (Coleoptera) such as *Propylea quatuordecimpunctata* (L.) (Gordon 1985) and *Hippodamia variegata* (Goeze) (Gordon 1987).

In 1975, *P. bidens* was known in Québec from only three localities in the southern part of the province. An intensive survey of the St. Lawrence Valley south of Tadoussac (Saguenay Co.) in 1978 showed that it occurred

in another three localities, which extended the known range more than 300 km north of Lennoxville (Sherbrooke Co.), the first record for the province. In 1979, a survey of the same region revealed its presence in more than 40 localities.

During July and August of 1980 to 1984, we surveyed the region from the southern part of the St. Lawrence Valley, north to Miquelon (Abitibi Co.), west to Abitibi-ouest and east around the Gaspé Peninsula; and from Sherbrooke (southeastern Québec) west through Montréal and the Ottawa Valley to Témiscamingue. *Picromerus bidens* has been collected in 87 localities, north to Miquelon (Abitibi Co.), western limit of its range in Québec at that time. A rapid survey of the same region in 1985 confirmed its presence in another three localities of Abitibi County. The known western limit of the range is now Manneville (Abitibi-Ouest Co.), about 30 km from the Ontario border. *Picromerus bidens* is now known from 136 localities in Québec.

Bionomics

Habitat

Europe. Fresh, humid, even marshy areas, although sometimes in drier places where a certain freshness persists; among abundant vegetation in sunny places; in areas in flower, in humid copses and bushes; especially near woods and waters; more rarely in orchards, gardens, or coniferous forests (Schumacher 1911; Strawinski 1927; Mayné and Breny 1948b; Dupuis 1949; Southwood and Leston 1959). In western Europe, the species is linked more to forests (Southwood and Leston 1959). It is found on the vegetation within two meters above the ground (Mayné and Breny 1948b).

North America. In Québec and also in the other states and provinces visited, *P. bidens* is found in wet and dry areas, but always in clear, sunny places; along hedges, in fields along the forest edge, along wooded roadsides, in openings of mixed, deciduous or coniferous forests, where it prefers shrubby areas rich in woody plants (trees or bushes, e.g., raspberry plants), but also on weeds such as goldenrods. The species is found on plants at a height of 1 to 2 m above the ground. It is found in flat open country as well as at altitudes of 1,000 to 1,200 m. We have found the species in Vermont on 7, 11, and 16.VIII.1987 at the summits of Mounts Jay Peak (1,251 m), Ascutney (1,019 m), and Equinox (1,236 m) respectively. Javahery (1986) reports that the species is rarely found in orchards.

Associated plants

The local distribution of *P. bidens* seems to be dictated by plant diver-

sity and the resulting variety of prey used for its feeding. The following is a list of plants on which various stages of the species can be found. These are not necessarily the hosts used for reproduction.

Europe: *Alnus glutinosa* (L.) Gaert., *Betula verrucosa* Ehrh., *B. pubescens* Ehrh., *Calluna* sp., *Carex* sp., *Corylus* sp., *Dipsacus* sp., *Fagus sylvestris* L., *Galeopsis* sp., *Galium* sp., *Genista* sp., *Juniperus* sp., *Myrica gale* L., *Pinus sylvestris* L., *Polygonum* sp., *Populus alba* L., *Primula elatior* (L.) Hill, *Prunus avium* L., *P. cerosus* L., *Pyrus malus* L., *Quercus* sp., *Q. pedunculata* Ehrh., *Ranunculus acris* L., *Rhamnus cathartica* L., *Ribes nigrum* L., *Rubus* sp., *R. idaeus* L., *Rumex sp., Salix nigricans* Sm., *S. repens* L., *S. caprea* L., *S. aurita* L., *Spiraea ulmaria* (L.), *Tilia* sp., and *Urtica* sp. (Butler 1923; Mayné and Breny 1948b; Dupuis 1949; Thomas 1954). According to Schumacher (1911), the following plants are visited less frequently: *Calluna* sp., *Genista* sp., *Polygonum* sp., *Salvia* sp., and *Urtica* sp.

North America. In Quebec and Ontario, *P. bidens* has been collected on *Ambrosia* sp., *Rubus idaeus, Malus* sp., *Polygonum* sp., *Rubus* sp., *Solidago* sp., *Vaccinium* sp., weeds, and forage legumes (Larochelle and Lariviere 1980; Javahery 1986).

We have also found *P. bidens* on 46 additional associated plants in Quebec, Ontario, New York, and New England: *Abies balsamea* (L.), *Alnus* sp., *A. rugosa* (DuRoi) Spreng, *Amelanchier* sp., *Betula alleghaniensis* Britton, *B. glandulosa* Michx., *B. papyrifera* Marsh. *Clematis virginiana* L., *Comptonia peregrina* (L.), *Cornus stolonifera* Michx., *Corylus cornuta* Marsh., *Crataegus* sp., graminaceous plants, *Impatiens capensis* Meerb., *Juniperus communis* L., *Larix laricina* (DuRoi) Koch., *Osmunda claytoniana* L., *Ostrya virginiana* (Mill.) K. Koch., *Parthenocissus quinquefolia* (L.), *Picea* sp., *P. glauca* (Moench) Voss, *Pinus banksiana* Lamb., *P. resinosa* Art., *P. sylvestris* L., *Populus tremuloides* Michx., *Prunus serotina* Ehrh., *P. virginiana* L., *Quercus alba* L., *Q. macrocarpa* Michx., *Q. rubra* L., *Ribes* sp., *R. cynosbati* L., *Rubus idaeus* L., *Salix* sp., *S. fragilis* L., *Sambucus pubens* Michx., *Solidago* sp., *Spiraea latifolia* (Ait.), *Thuja occidentalis* L., *Tilia americana* L., *Urtica procera* Muhl., *Vaccinium* sp., *Viburnum lentago* L., *Vitis riparia* Michx., and various undetermined species of weeds.

Although it appears that *P. bidens* does not favor any particular plant species, we have observed that the density of individuals was higher on and around raspberry plants when these were present in the habitat. In Québec, the occurrence of raspberries almost always assured the collection of *P. bidens.* We have observed the same phenomenon on goldenrods, which are blooming in August. This is probably related to the fact that both plants, at certain times in the season, are inhabited by larvae and adults of species fed on by *P. bidens.* The presence of all nymphal

instars as well as adults was noted on goldenrods and raspberries.

Life cycle

The developmental cycle is regulated by ecological conditions and their influence on nymphal development and reproductive activity. Two cycles are thought to be possible: a primary cycle in which the species overwinters in the egg stage, and, less frequently, a secondary cycle in which some adults overwinter. Our observations on North American populations seem to indicate that the species follows the primary cycle described in the European literature.

Primary cycle. Adults oviposit from August into the fall. They die late in the season, after they have mated several times, and eggs overwinter (Strawinski 1927; Mayné and Breny 1948b; Dupuis 1949). Females may oviposit as many as 5 times (Strawinski 1927; Mayné and Breny 1948b). Adults that do not participate in reproductive activity do not seem to overwinter (Gulde 1919; Dupuis 1949). Eggs hatch in May and 40 to 60 days are required for the five nymphal instars to complete development; the first adults can be found in June (Strawinski 1927; Dupuis 1949; Southwood and Leston 1959). The first instar nymph takes about 5 days to develop, nymphs of instars II to IV take 12 to 14 days, and a little longer may be required by the fifth instar nymph (Dupuis 1948, Mayné and Breny 1948b; Thomas 1954; Groves 1956; Southwood and Leston 1959). The duration of the various stages varies according to ecological and meteorological conditions; it is not rare to find fifth instar nymphs in July and newly emerged adults in August (Strawinski 1927; Mayné and Breny 1948b).

Secondary cycle. This cycle is less common and probably involves adults that have not been reproductively active and that had sufficient energy to survive winter. These individuals overwinter, mate in May and June, lay eggs in July, and new adults emerge from mid-August to early September (Schumacher 1911; Dupuis 1949).

The species is generally recognized as univoltine. Schumacher (1911) indicated that when some authors have recognized two generations per year, it is probable that the two cycles have been cofounded.

Our observations and those of Cooper (1967) and Javahery (1986) indicate that *P. bidens* is univoltine and overwinters in the egg stage in eastern Canada, New York, and New England.

Seasonal activity

Eggs and oviposition. Mayné and Breny (1948b) observed that the number of eggs laid is often inversely proportional to the number of ovipositions per female, and suggested that an increased frequency of

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mating favors the activity of the genital system. Egg-batch size varies from only 2 to 3 or as many as 70 to 75, and oviposition frequency is dependent on temperature (no oviposition under 14.5° C). Observed maximum fecundity is 300 eggs (Schumacher 1911; Mayné and Breny 1928b); mean fecundity is around 129 to 154 eggs (Javahery 1986). In Québec, we have seen gravid females from the end of August to the 15th of September in Charlevoix-Est County, and until October in the Montréal area.

Nymphs. First instars are gregarious and do not feed other than by occasionally sucking plant sap to obtain water; they remain sheltered in dark places, often on lower leaf surfaces near the ground (Mayné and Breny 1948b; Southwood and Leston 1959). Second instars are still quite gregarious, but start to disperse from time to time to find food; they become more carnivorous soon after the first molt (Mayné and Breny 1948b; Southwood and Leston 1959). Javahery (1986) observed that the two first instars in Québec populations last about 8 days, and the second instars do not feed during the first 3 or 4 days; they are gregarious at this time, forming groups of 3 to 56 individuals. Activity and mobility increase in instars III to V; the duration of each of these instars in Québec is 9 to 10 days (Javahery 1986). This author reported, from laboratory experiments, that fecundity decreases at 27°C and 28°C, suggesting that *P. bidens* is a species of cooler climates. Eggs are deposited on woody plants, in rows on stems and twigs or in batches on the lower surface of leaves (Strawinski 1927; Mayné and Breny 1948b). Javahery (1986) reported that the oviposition period in Québec is from mid-August to mid-October and that up to 4 eggs develop in the ovarioles prior to oviposition. He also observed that egg-batch size varies from 2 to 73 and that the eggs need to be subjected to low temperature (0-2°C) for about 30 days for embryonic development to be initiated; without this chilling period, 92% of the eggs did not hatch. Javahery (1986) also studied in detail the maturation of the reproductive organs, diapause, and egg and ovariole development in Québec populations.

Adults. Adults of the new generation can be found in June. According to Mayné and Breny (1948b), peak adult activity is from mid-July to the first week of October. In the Lac-Saint-Jean region of Québec, we have seen teneral individuals from 5.VIII. to 22.IX, and about 15 days earlier in the Montréal area. Individuals can be found at the bases of plants in the morning, and climb upwards with increasing sunlight; they are active during daylight hours and return to the bases of the plants as soon as the temperature cools at sunset (Mayné and Breny 1948b; Dupuis 1949).

Mating. In the field, mating usually occurs from mid-August to October, with frequency varying according to temperature (no mating

under 14.5°C) (Strawinski 1927; Mayné and Breny 1948b). After the last molt, 15 days to a month is necessary for the reproductive organs to mature before mating (Mayné and Breny 1948b). We have observed mating pairs in mid-August in southern Québec on wild grape and red oak in the middle of the afternoon and at sunset.

Longevity. Observed maximum longevity in the laboratory was 114 days; it has been estimated to be 4 months in nature (Mayné and Breny 1948b). In the laboratory, longevity decreased at 27°C and 28°C, suggesting again that *P. bidens* is a species of cooler climates (Javahery 1986).

Flight. Javahery (1986) observed higher food consumption and greater mobility during the period of sexual maturation in Québec populations and reported that no flight tendencies were observed in either sex at that time. He also suggested that flight may not be necessary to initiate sexual maturation and dispersal, whereas feeding and walking are. Mayné and Breny's (1948b), and our observations seem to indicate that flight plays a role in dispersal. Mayné and Breny (1948b) reported that the species usually travels little and at very short distances except in the following cases: "After the last molt and after having eaten, the insect has an instinctive need for dispersal. The nymphal population was without any other traveling means than walking and when the winged adults emerge, these are crowded on the restricted area previously occupied by the nymphs. These new adults often fly long distances, probably to escape surpopulation but also by instinct of species propagation. In Belgium, such flights have been observed in July and August."

We have observed many individuals flying on sunny afternoons in July and August. We feel that this means of dispersal should not be overlooked, at least in relation to the rapid range expansion in Québec.

Food

Picromerus bidens is almost entirely carnivorous. It is a polyphagous species that preys on larvae of many Lepidoptera, Chrysomelidae (Coleoptera), Tenthredinidae and other leaf-eating Hymenoptera, and more rarely on pupae and adults of soft-bodied insects. It also sucks plant juices to satisfy its needs for water. Mayné and Breny (1948b) suggested that the proximity of fresh vegetation is indispensable to the successful development of nymphs and adults.

Ethology of food gathering. Prey are generally medium-sized, glabrous, soft-bodied, and slow-moving; *P. bidens* often goes from one prey to another, slightly piercing it without actually eating it, especially in cases in which the prey does not exactly suit its requirements. In any case, larvae pierced in such a manner will die, which makes *P. bidens* such a useful predator (Mayné and Breny 1948b).

Food in Europe. Coleoptera: larvae and adults of *Cassida viridis* L. (Manolache *et al.* 1939), larvae of *Melasoma populi* L. and *M. tremulae* F. (Vuillet 1919; Gabler 1937; Mayné and Breny 1948b), *Pyrrhalta viburni* (Payk.) and *Phyllobrotica quadrimaculata* L. (Schumacher 1911) (Chrysomelidae). Diptera: larvae (Gabler 1937). Heteroptera: *Cimex lectularius* L. (Dahlbom 1837; Clausen 1940)(Cimicidae). Hymenoptera: *Diprion (Microdiprion) pallipes* (Fall.) (Mallach 1974) (Diprionidae); larvae of Tenthredinidae (Schumacher 1911; Mayné and Breny 1948b); larvae, pupae and adults of Tenthredinidae (Gäbler 1937); *Cimbex connata* Schrank (Strawinski 1927), *Lophyrus pini* L. (Gabler 1937), *Lygaeonematus wesmaeli* Tischb. (Hsin 1935), *Phymatocera aterrima* Klug. (Butler 1923) (Tenthredinidae). Orthoptera: nymphs of *Leptophyes thelessine* (L.) (Javahery 1967) (Tettigoniidae). Lepidoptera: larvae and adults (Schumacher 1911; Mayné and Breny 1948b); *Euchelia jacobeae* L. (Butler 1923), *Spilosoma lubricipeda* (L.) (Schumacher 1911) (Arctiidae); *Macrothylacia* (=*Bombyx*) *rubi* L. (Butler 1923; Mayné and Breny 1948b) (Bombycidae); *Ectropis (Boarmia) bistortata* Goeze (Schwenke 1976) (Geometridae); *Lymantria dispar* (L.) (Schaefer *et al* 1984), *L. monacha* L. (Strawinski 1927; Mayné and Breny 1948b), *Orgyia antiqua* (L.) (Skatulla 1974) (Lymantriidae); *Acronicta psi* (L.) (Schumacher 1911), *A. rumicis* (L.) (Butler 1923; Mayné and Breny 1948b), *Bupalus pinaria* L. (Friederichs *et al* 1941), *Dianthoecia capsincola* (W.V.) (Schumacher 1911), *Phytomera gamma* L. (Kanervo 1947), *Polia chi* (L.) (Schumacher 1911) (Noctuidae); *Phalera bucephala* (L.) (Schumacher 1911), *Ptilodon capucina* (L.) (Gninenko 1974) (Notodontidae); *Melitaea* sp., (Schumacher 1911) (Nymphalidae); *Aporia crataegi* L. (Krasnyuk 1928), *Pieris brassicae* L. (Schumacher 1911, Butler 1923), *P. rapae* L. (Butler 1923; Mayné and Breny 1948b) (Pieridae); *Laspeyresia (Cydia) funebrana* (Tr.) (Golubenko 1969) (Tortricidae). Neuroptera: larvae of Hemerobiidae (Butler 1923).

Food in North America. Coleoptera: larvae of Chrysomelidae (Javahery 1986). Diptera: larvae of Calliphoridae (Javahery 1986). Hymenoptera: *Diprion similis* (Hartig) (Lattin and Donahue 1969), *Gilpinia frutetorum* (Fab.) (Oliveira and Juillet 1971; Kelton 1972), two species of European sawflies (Diprionidae) noxious to Scotch pine (*Pinus sylvestris*) and white pine (*Pinus strobus*). Lepidoptera: specifically *Pyrrharctia isabella* (J.E. Smith) (Lattin and Donahue 1969), and also larvae of various Pieridae, Geometridae, and Noctuidae (Javahery 1986).

Cannibalism

Cannibalism has been observed among populations of *P. bidens*, especially when the food supply was low, or in periods of overpopulation (Mayné and Breny 1948b; Javahery 1967, 1986).

Predators and parasites

Nymphs and adults of *P. bidens* are sometimes preyed upon by *Podisus maculiventris* Say and *P. modestus* Dallas (Pentatomidae) (Javahery 1986), as well as by the sphecid wasp *Astata boops* (Schrank) (Butler 1923). Javahery (1986) reported that eggs in southern England and Québec were parasitized by scelionid wasps. Moreover, he found that the eggs are suitable for culturing several Scelionidae, especially species of *Telenomus* and *Trissolcus.*

Karyotype

2N = 12A + X + Y (Southwood and Leston 1959).

Rearing

Methods and materials used for rearing *P. bidens* have been described by Mayné and Breny (1948b) and Javahery (1986). Mayné and Breny (1948b) have successfully maintained laboratory cultures on larvae of *Melasoma populi* L. (Chrysomelidae), *Mamestra brassicae* L. (Noctuidae) and *Anagasta kuehniella* (Zell.) (Pyralidae), larvae of potato beetles, house flies, and pierids. Javahery (1986) used larvae of the pyralids *Galleria mellonella* (L.) and *Anagasta kuehniella* (Zell.). In the laboratory, the species seems to develop well on plants such as potato, cabbage, black nightshade, *Ligustrum* sp., *Weigelia* sp., birch, basswood, hornbeam, etc. (Mayné and Breny 1948b).

Biological control

Biological and ethological data suggest that *P. bidens* could be considered a useful predator against certain leaf-eating insects. The species seems to be able to establish itself well in the North American environment, it has a varied diet, occurs in diverse habitats, and has a relatively good egg-laying capacity. Oliveira and Juillet (1971) reported *P. bidens* as a biological control agent against larvae of *Diprion frutetorum* (Fab.) (Diprionidae) in pine forests in Québec.

Many authors have already pointed out the important role of this species in reducing insect pest populations in Europe. In Germany, Gäbler (1937) reported efficient control of the larvae of various sawfly species; Pschorn-Walcher and Zinnert (1971) observed the destruction of 5% of the larvae of *Pristiphora erichsonii* Htg. (Tenthredinidae) in Bavaria; and Mallach (1974) reported that the insect has been important in controlling the hymenopteran *Microdiprion pallipes* (Fall.) (Diprionidae). According to Clausen (1940), the use of *P. bidens* to control the hemipteran *Cimex lectularius* L. was recommended as early as 1776. The

method consisted of confining a few individuals of *P. bidens* in an infested room. In Sweden, *P. bidens* was found to be useful against mass appearance of the hymenopteran *Neodiprion sertifer* Geoffr. (Diprionidae) (Forsslund 1946). In Belgium, Mayné and Breny (1948b) described its action against the potato beetle. They concluded however, that even under optimal conditions (i.e., fields adjacent to its natural habitat or artificial dispersal of its eggs in spring), *P. bidens* does not effectively protect the plants. Two main factors mitigate against its systematic use in biological control: *P. bidens* is not a great traveller, traveling being mainly made by walking, and does not disperse easily in the field; it also seems far too general in the choice of its prey items.

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INCIDENCE OF ANDROCHROMOTYPIC FEMALE *ISCHNURA RAMBURI* (ODONATA: COENAGRIONIDAE) IN THE HAWAIIAN ISLANDS[1]

Donald F.J. Hilton[2]

ABSTRACT: Of 549 female *Ischnura ramburi* collected (or observed) from 17 localities on the islands of Hawaii and Oahu in the state of Hawaii, only 3 androchromotypic females were seen. These occupied a small pond on the University of Hawaii (Manoa) campus. *I. ramburi* is not native to Hawaii and the results suggest more than one introduction, perhaps via discarded aquarium contents.

Ischnura ramburi Selys-Longchamps is a North American damselfly (Davies and Tobin, 1984) first collected from Hawaii in 1973 by Harwood (1976). He recorded it at three localities on the island of Hawaii and at two on Oahu. Harwood states of *I. ramburi:* "habits are such that impregnated females may seek shelter in aircraft" and suggested that this may have been the species' mode of entry into the Hawaiian Islands. Since *I. ramburi* occurred on two widely separated islands at the time of Harwood's collections (Feb. 21-Mar. 21 in both 1973 & 1974), he did not consider it possible "to state with assurance where the species first became established". It is also possible that *I. ramburi* could have been introduced into the Hawaiian Islands via eggs or larvae associated with aquatic vegetation accompanying imported tropical fishes for the home aquarium market. The fact that tropical fishes, with their aquarium vegetation, are sometimes released into external environments has been documented by McAllister (1969) and Pritchard (1971) for the exotic flora and fauna inhabiting hot spring outflows in the Canadian Rocky Mountains near Banff, Alberta.

Robertson (1986) reported collecting *I. ramburi* on the islands of Hawaii, Kauai and Oahu. He "collected large series" (numbers not stated), though only from one locality on each of Kauai and Oahu and two localities on Hawaii, without obtaining any "andromorph" (=androchromotypic*) females. He implied that such female polymorphisms might not occur on islands.

I spent one year (July 1, 1985-June 30, 1986) collecting Odonata at various localities throughout Oahu. My collections and observations of *I. ramburi* contain information that directly relates to some of Robertson's (1985, 1986) ideas.

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METHODS

Ischnura ramburi females were either: a) collected by netting, soaked in acetone for 24 hrs and then stored in clear cellophane envelopes, or b) individuals engaged in various reproductive activities were closely observed among emergent vegetation. In addition, I examined all specimens at the University of Hawaii (Manoa campus) and the B.P. Bishop Museum.

RESULTS

I collected 168 female *I. ramburi* from the following Oahu loalities: Kawainui Swamp near Kailua (a total of 10 collected over four occasions during July 29-Sept. 25, 1985); Salt Lake (a total of 52 collected over six occasions during Jan. 10-Mar. 3, 1986); University of Hawaii, Manoa campus (a total of 43 collected over nine occasions during Oct. 30, 1985-Jan. 7, 1986); Waimanolo (a total of 63 collected over 20 occasions during Oct. 25, 1985-Jan. 21, 1986). I also closely observed reproductive behaviors of 296 solitary females and 65 tandem pairs at Salt Lake over 13 occasions during Jan. 10-Mar. 12, 1986. In addition, there were 10 females from six different Oahu localities in the University of Hawaii collection, and another 10 females from four Oahu and two Hawaii sites in the B.P. Bishop Museum. A total of 549 females were thus examined, all but three of which were gynochromotypic*. The only locality where androchromotypic females occurred was a small pond adjacent to the tennis courts on the University of Hawaii (Manoa) campus where three of 43 (7.0%) were androchromotypic.

DISCUSSION

Obviously androchromotypic females of *I. ramburi* do occur in Hawaii, although so far detected at only one site. This suggests that there may have been more than one introduction of *I. ramburi* into the islands since the androchromotypic trait is not widespread, as it would have to be if *I. ramburi* dispersed over the islands from an initial entry point. Furthermore, the presence of the androchromotypic population at the Manoa campus pond strongly points to its source being discarded aquarium contents. This is particularly likely with the thousands of college students occupying dormitories nearby. Many undoubtedly keep pets which might be disposed of when the academic year ends and students vacate their residence rooms. This seems a more likely scenario than an introduction by aircraft since the Honolulu airport is many miles away from

the Manoa campus site and yet there are populations of *I. ramburi* (e.g. Salt Lake) much closer to the airport, but in these the females are all gynochromotypic.

After I detected androchromotypic females at the Manoa campus, I initiated a study of this population. During the brief time I had to observe living individuals, 2/17 (11.8%) solitary females were androchromotypic and 1/9 (11.1%) tandem pairs contained an androchromotypic female. Although these data are very small, they do not indicate that androchromotypic females are any less likely than gynochromotypic ones to be grasped in tandem by males. Such results are at variance with Robertson's (1985) more extensive data obtained from a population of *I. ramburi* near Lake Placid, Florida, in which 31.1% (28/90) of the females were androchromotypic. He presented data which showed that copulations involving androchromotypic females occurred about half as often (17.1% (28/164)) as would be expected based upon the proportion of androchromotypic to "heteromorph" (=gynochromotypic) females in the population, apparently because males do not readily recognize the former as females. He suggested that this gave androchromotypic females an advantage in that they didn't have to waste time on unnecessary multiple matings and, since they spent less time mating, were not as likely to be seen by predators.

ACKNOWLEDGMENTS

I would like to thank R. Gambles and B. Kiauta for pointing out that rules governing combining forms of Greek roots require that "chroma" terminate in an "o", not an "a". Therefore the correct spellings are androchromotypic and gynochromotypic rather than the spellings I originally employed when I (1987) introduced these terms to differentiate between females with male-like or female-like color patterns, respectively.

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NEW STATE RECORDS FOR TWO TIGER BEETLES (COLEOPTERA: CICINDELIDAE) IN SOUTHERN NEW ENGLAND[1]

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ABSTRACT: *Cicindela rufiventris rufiventris* was collected at two sites near New Haven, Connecticut, constituting the first state records of this species. *Cicindela trifasciata ascendens* was collected from Nantucket Island, Massachusetts, representing the first record of this species from New England.

Cicindela rufiventris Dejean and *Cicindela trifasciata ascendens* LeConte are two tiger beetles that commonly are collected in the southeastern United States. In the New England states, isolated populations of *C. rufiventris* are known only from Massachusetts (Murray, 1980, Dunn, 1986) and Rhode Island (Davis, 1903). *C. trifasciata* previously has not been recorded north of Atlantic Co., New Jersey (Boyd, 1978). We report here recent collections of both species from southern New England.

Cicindela rufiventris Dejean

Two specimens of *Cicindela rufiventris* Dejean were collected on June 28 and July 18, 1986 at West Rock Ridge State Park (New Haven Co., CT) by D. Comboni. Both beetles were taken within 15 m of the Judges Cave Memorial on bare basaltic rock. The Park preserves a large escarpment of Tertiary basalt west of New Haven. Conditions on each day were sunny with temperatures near 30°C, but neither individual attempted to escape by flying. Later visits to this site in August of 1986, and in July and August of 1987 and 1988, failed to yield additional specimens. One of the two specimens was vouchered to the Peabody Museum of Natural History, Yale University. One additional specimen of *C. rufiventris* was collected from West Rock Ridge State Park in June 1986 by G. Bernard.

On August 21, 1988, T. Schultz collected six adult *C. rufiventris* .2 miles north of the Northford Post Office, New Haven Co., CT. Seven additional specimens were collected one week later on August 28. All the adults were collected along a sloping gravel track on the east bank of Farm River. The bare substrate consisted of reddish cobbles and gravelly sand

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with some exposed basalt and granite. Four voucher specimens were placed in the Peabody Museum collection.

All the specimens from New Haven County were representative of the nominate form and lacked the bold maculation pattern that characterizes *C. rufiventris hentzii* Dejean (Wilson, 1971). The nominate form has been recorded from Berkshire and Worcester Counties in western Massachusetts (J. Shetterly, personal communication) while *C. rufiventris hentzii* is endemic to a narrow, arc-like belt in eastern Massachusetts approximately 10-25 miles north, west and south of Boston, including the Middlesex Fels and Blue Hills Reservations. The next closest sites for *C. rufiventris* that have been published are in northern New Jersey (Boyd, 1978).

This species prefers rocky ledges, outcrops and substrates of crushed rock. It seems likely that its current distribution in southern New England is restricted to isolated, undisturbed exposures of bedrock or glacial deposits of gravel. Additional populations might be found between New Haven and Massachusetts if similar geologic areas are investigated.

Cicindela trifasciata ascendens LeConte

On July 25, 1988, D. Comboni collected one specimen of *Cicindela trifasciata ascendens* LeConte at Maxcy's Pond on Nantucket Island, Nantucket Co., Massachusetts. The specimen was discovered on bare sand along an unvegetated edge of the pond, although 80% of the pond's perimeter was vegetated. It was taken at 4:15 pm on an overcast day with the temperature around 28°C. A few *C. repanda* also were taken at the same place and time. Unfortunately, the lateness of the day and other commitments precluded a search for additional specimens on the island.

C. trifasciata is a coastal species that is widely distributed in the southeastern U.S., Mexico, and the Carribean islands. It prefers fresh or saltwater mudflats and shows remarkable vagility in dispersing up coastal river systems (Graves & Pearson, 1973) or between islands (Leng & Mutchler, 1916). *C. trifasciata* is attracted to lights and has been recorded from off-shore oil platforms in the Gulf of Mexico (Graves, 1981; 1982).

The subspecies *C. trifasciata ascendens* is common along the Gulf and south Atlantic Coasts of the U.S., but very rare in the northeast. Boyd (1978) reported that records of this species in southern New Jersey indicate the northern extent of its range but probably do not represent permanent, breeding populations. Nantucket Island is located 30 miles off the southern coast of Cape Cod and is well north and east of these localities. However, other vagrant animal species occasionally land on

Nantucket Island as a result of storms or accident. Given the well documented ability of *C. trifasciata* to disperse long distances over water, its occurrence on Nantucket Island is surprising but not totally unexpected.

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Offers nature enthusiasts and students a general overview of Lepidoptera of world. Subjects covered include: origins, evolution, classification, anatomy, metamorphosis, adult behavior, and ecology.

MICROCTONUS PACHYLOBII (HYMENOPTERA: BRACONIDAE) PARASITIZES *HYLOBIUS* WEEVILS IN WISCONSIN: NEW HOST GENUS AND GEOGRAPHIC RECORDS[1]

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ABSTRACT: *Microctonus pachylobii* adults emerged in the laboratory from field-collected pine root tip weevils, *Hylobius rhizophagus* and pales weevils, *Hylobius pales*. This is the first report of *M. pachylobii* parasitizing a species of *Hylobius*, and the first known hymenopteran parasite of *H. rhizophagus*. *Microctonus pachylobii* is also reported from Wisconsin for the first time.

The genus *Microctonus* (Hymenoptera: Braconidae) is widespread, and some species have been used successfully against adult Coleoptera in biological control programs (Loan 1967, Clausen 1978). One of these species, *M. pachylobii* Muesebeck, has been recorded exclusively from the pitch-eating weevil, *Pachylobius picivorus* (Germar), in the southeastern United States (Muesebeck 1961, Krombein *et al.* 1979). Although related parasites greatly reduce host fecundity (Clausen 1978), the effects of *M. pachylobii* development on host weevils are unknown.

Recently we discovered *M. pachylobii* parasitizing two additional hosts, the pine root tip weevil, *Hylobius rhizophagus* Millers, Benjamin, and Warner, and the pales weevil, *Hylobius pales* (Herbst). Adults were collected in central and northwestern Wisconsin during September and October, 1988. The weevils were collected from screen traps (Raffa & Hall 1988) in pine plantations. They appeared healthy during routine feeding and host-finding bioassays.

Twenty-eight *M. pachylobii* (15 females, 13 males) emerged from adult males and females of *H. rhizophagus* between November 9 and December 8. In addition, four *M. pachylobii* (3 females, 1 male) emerged from adult *H. pales*. The wasps are endoparasitic. We observed up to 5 final instar wasp larvae emerging from a single host, and then burrowing into the substrate to pupate. Adult wasps emerged approximately six days later, and lived for several days. Larval wasp emergence had no externally visible effects on the weevils, except a slight tearing of host tissue at the abdominal apex. Internal reproductive structures were greatly reduced. Parasitized adult weevils lived for two days after wasp emergence. The cause of death could not be directly attributed to parasitism by *M. pachylobii*.

The distribution of *H. rhizophagus* is limited to the Great Lakes region, where it is part of a weevil complex causing extensive damage to

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plantation pines (Kearby & Benjamin 1969). Larval feeding destroys the roots and may serve as an infection court for secondary pathogens (Kearby & Benjamin 1969). *Hylobius pales* is widely distributed throughout eastern North America (Clark, 1975). While a few natural enemies have been associated with *Hylobius radicis* Buchanan and *Hylobius pales* (Shenefelt & Millers 1960, Finnegan 1962, Clark 1975), there are no previous records of hymenopterans parasitizing *H. rhizophagus.*

This is the first record of *M. pachylobii* on a host other than *P. picivorus,* and the first record of this parasite in the northern United States. Additional biological studies will help determine if this parasite can aid in biological control of damaging *Hylobius* species.

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AGGREGATION BEHAVIOR IN A NEOTROPICAL OWLFLY, *CORDULECERUS MACLACHLANI* (NEUROPTERA: ASCALAPHIDAE)[1]

Charles V. Covell Jr. [2]

ABSTRACT: A cluster of the owlfly species *Cordulecerus maclachlani* Selys was observed on a branch overhanging a tributary of the Comté River in French Guiana on March 30, 1986.

On March 30, 1986, I was travelling by motorized canoe up a narrow tributary of the Comté River in French Guiana, approximately 7 kilometers north of the village of Cacao. While the purpose of the ride was to reach a good spot for collecting the butterfly, *Morpho menelaus,* I observed a tightly-packed cluster of insects on the under side of leaves on a branch of a broad-leafed tree overhanging the stream. It was approximately 7 feet above water level in a heavily shaded area. The insects appeared to be owlflies (Ascalaphidae); but we passed the site before I had a chance to collect any. The time was about 10:00 AM. At about noon, we returned downstream, and the aggregation was still intact. I swung my insect net as our canoe passed beneath it, and secured 8 specimens. The insects were indeed owlflies. Some of them had entirely clear wings, while others had a hindwing pattern of large dark spots. While the number of owlflies comprising the aggregation is unknown, the group covered an irregular area roughly 30 cm^2.

Later, Ellis G. MacLeod of the University of Illinois tentatively identified some of the series as *Cordulecerus maclachlani* Selys, and John D. Oswald of Cornell University later verified this determination. The species is polymorphic; but whether spotted and non-spotted morphs represent sexual dimorphism has not yet been established.

The present account is the first report of aggregation behavior in this species. However, Penny ([1982] 1981: 405) refers to a Dr. Engleman's report of an aggregation of *Cordulecerus elegans* at the tip of a branch at dusk in central Amazonia. Further, Philip J. DeVries (personal communication) has observed aggregation behavior in owlflies in Panama and Costa Rica. Among the 5 species in 3 genera he has recorded are 2 *Cordulecerus* species. He is investigating owlfly aggregation phenomena in greater depth.

While no such aggregation behavior has yet been described in North American species of Ascalaphidae, it appears that it may be widespread

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in neotropical species, particularly those in the genus *Cordulecerus.*

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SOCIETY MEETING OF MARCH 15, 1989

NATURAL CONTROL OF THE GRAPE LEAFHOPPER IN CALIFORNIA VINEYARDS

By Dr. David W. Williams

The grape leafhopper, *Erythroneura elegantula,* is a native species that evolved on wild grape which grows on moist flood plains. It adapted quickly to introduced commercial grape varieties and soon became a pest in California vineyards. While it does not appear to diminish crop yields, its sheer abundance at times causes considerable damage to leaves and it can be a nuisance to grape harvesters. Insecticide spraying in the 1940's resulted in resistance and the appearance of secondary pests due to the elimination of natural controls. The mymarid wasp, *Anagrus epos,* is a parasite of leafhopper eggs and effectively controls the grape leafhopper in its normal riparian environment, but not always in the drier vineyard habitats. Dr. Williams of the USDA Beneficial Insects Laboratory in Newark, DE described a control strategy whereby an imported blackberry, a food plant of the native Blackberry leafhopper, was planted near vineyards. While grape is deciduous, blackberry is evergreen and thus can sustain year-round populations of leafhoppers and their parasites including *Anagrus.* Consequently, the population of *Anagrus* is higher earlier in the year and can parasitize grape leafhoppers in their first generation before they get out of control. The complex interplay of native and introduced plants, their pest, parasites of pests, and humans emphasized to the audience that there are few simple solutions to insect control problems.

In the general discussion preceding Dr. Williams' talk several members described recent lepidopteran experiences. Dr. Charles Mason attended a meeting in Mexico on the European corn borer. As a side trip, he and several other participants visited one of the overwintering sites of the monarch butterfly. He showed slides of the dense congregations that weigh down the limbs of spruce forests at an altitude above 10,000 feet. He expressed concern that local forestry practices threaten these overwintering sites. Howard Boyd visited and was quite impressed with the Day Butterfly Center at Calloway Gardens in Pine Mountain, GA. President Roger Fuester reported that during 1988 fewer than one million acres of forest were defoliated by gypsy moth caterpillars. This is the lowest level since the mid 1970's, and is considerably below the approximately 13 million acres defoliated in 1981.

Harold B. White
Corresponding Secretary

FEEDING PREFERENCE AND ADULT SURVIVAL OF *HADRAULE BLAISDELLI* (COLEOPTERA: CIIDAE) ON DIFFERENT HOST FUNGI (POLYPORACEAE)[1]

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ABSTRACT: The mycetophagous ciid beetle *Hadraule blaisdelli* was reared on the sporocarps of four species of polyporoid fungi. There was a pronounced correlation among preference, amount consumed, and adult survival rates on these fungi in this order: *Bjerkandera fumosa, Coriolus versicolor, Ganoderma applanatum,* and *Phellinus everhartii.* Feeding, preference, and survival rates generaly correlate with the hardness of the sporocarp, although other factors may be involved. Adult beetles fed on powdered sporocarps were able to consume more and had better survival rates.

Hadraule blaisdelli (Casey) is one of the smallest species of Ciidae with an average adult length of only 1.5 mm. It inhabits the sporocarps of long-lasting woody shelf fungi (mostly Polyporaceae). Both larvae and adults bore into the spore-fruits and feed on hyphae and spores. Larger aggregations are frequent and 1000 or more adult beetles may exist within a single sporocarp.

The Ciidae in general are obligate mycetophages which will completely riddle a large sporocarp, leaving only a hollow shell, or small broken pieces, which become part of the forest floor debris. Ciids constitute a major force in the eventual destruction of wood-rotting fungus conks (Rehfous 1955, Graves 1960, Matthewman and Pielou 1971, Ackerman and Shenefelt 1973). Rehfous (1955) cited ciids as pioneer species which invade fresh sporocarps. Graves (1960) found Ciidae in all successional stages in fruiting-bodies, and that the abundance of individuals increased with the aging of the sporocarps (Graves 1960). These beetles may constitute a major portion of the consumer biomass of fungus conks (Matthewman and Pielou 1971).

Hadraule blaisdelli was originally described in the genus *Maphoca* by Casey in 1900, later transferred to *Diphyllocis,* and placed in *Hadraule* by Lawrence (1971). This species is distributed in western North America, and, in California, is found in Lower and Upper Sonoran, Transitional, and Boreal Life Zones (Lawrence 1974). *Hadraule blaisdelli* has been collected from more than a dozen species of host fungi; also, it is the only North American ciid known to infest fungus specimens in herbarium

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collections (Lawrence 1971).

Host preference in Ciidae was discussed by Paviour-Smith (1960), Lawrence (1967a, 1967b, 1971, 1973, 1974), and Ackerman and Shenefelt (1973). Feeding preferences have also been studied in other mycetophagous Coleoptera such as *Bolitotherus cornutus* (Panzer) (Liles 1956, Heatwole and Heatwole 1968) and *Tetratoma fungorum* F. (Paviour-Smith 1964, 1965). Paviour-Smith (1960) used the term "headquarters" for the fungus host(s) in which a particular beetle species most commonly breeds and successfully completes its life cycle. Lawrence (1973) discussed these "headquarters" or "host-preference groups" in great detail. *Hadraule blaisdelli* has a broad host range and it is difficult to determine from existing records any preference for a particular group of host fungi (Lawrence 1973).

Lawrence (1973) stated that the old Friesian "form genera" of polyporoid fungi, e.g., *Polyporus, Fomes,* etc., as defined by Overholts (1953) and modified by Lowe and Gilbertson (1961) and others, are too broad to be of great use in insect feeding preference studies. We follow Lawrence (1973) in using a classification based on Donk (1971), Bondarzew and Singer (1941) and others. The names of each fungus species used in this study are listed below followed by the former names in parentheses:

Bjerkandera fumosa (Persoon ex Fries) Karsten (=*Polyporus fumosus*)
Coriolus versicolor (L. ex Fries) Quelet (=*Polyporus versicolor*)
Daedaleopsis confragosa (Bolton ex Fries) Schroeter (=*Daedalea confragosa*)
Ganoderma applanatum (Persoon ex Wallroth) Patouillard (=*Fomes applanatus)*
Phellinus everhartii (Ellis and Galloway) Ames (=*Fomes everhartii)*

MATERIALS AND METHODS

The *H. blaisdelli* used in this study originated with a colony found in a dry specimen of *Daedaleopsis confragosa* which had been collected in Saugatuck, Allegan County, Michigan in March, 1957, by Robert and Anne Graves. There were no obvious signs of insect infestation at the time the fungus specimen was collected, placed in an envelope and sealed. When opened in July, 1970, there were 900-975 *H. blaisdelli* adults and numerous larvae present. We assumed that a few individuals had been in the specimen when collected and had multiplied since. The possibility of a herbarium infestation (Lawrence 1973, 1974) seems highly unlikely but cannot be ruled out, and, if this were the case, the original source of the beetles is unknown. Additional fungi were provided and a stock culture was then developed from the original group. Specimens

from this culture were used in all experiments.

Hadraule blaisdelli colonies can survive indefinitely on dry fungi without the addition of water. Apparently they are able to use metabolic water, a prerequisite for a successful herbarium pest. A well-developed cryptonephridial association of the Malpighian tubules with the rectum is present (Klopfenstein 1972).

In feeding preference and survival studies we tried to eliminate certain variables such as differences in texture, shape, size, and compactness of the sporocarp. Fungus samples were first cut into pieces (*P. everhartii* had to be sawed), and then ground by passing through a grinder several times. The remaining powder was placed in plastic boxes (12.7 mm square by 3.175 mm deep), tamped, and moistened with 2-3 drops of water. This dried into compact pellets which could be placed into the culture dishes. Pellets allowed easier viewing of the beetles which are difficult to find in entire sporocarps. Entire pieces were also used in some experiments.

In each experiment the same number of beetles was added to a small vial along with a sample of fungus. Beetles were removed from the stock culture with a fine brush, examined to make sure they were alive (they play dead when disturbed), and placed in the vials. The sexes can only be distinguished on dead, slide-mounted specimens so an equal number of each sex in each vial could not be guaranteed.

A small piece of filter paper was placed in each vial and a drop of water was added every three days. Experiments were done in the dark except for counting and addition of water. The room temperature averaged 23°C with only minor fluctuations.

It should be stressed that these studies were done with adult beetles. Larvae are small (a fraction of a mm in early stages), fragile and difficult to handle. They burrow into the fungus samples and it is impossible to find and count them without damage.

RESULTS AND DISCUSSION

In order to determine which fungus species were more conducive to survival of *H. blaisdelli,* 1 g of each species (ground and formed into pellets) was placed in separate Stender dishes. Fifty adult beetles were added to each dish and the survivors were counted after 20 and 30 days. This experiment was done three times, and the average number of survivors is shown in Table 1. Figure 1 shows the average percentage of survivors on each host species. After 20 days, survival was 92% on *B. fumosa,* 83% on *C. versicolor,* and 64% on *G. applanatum* and *P. everhartii.* But after 30 days, the survival on *B. fumosa* was 89.3%, while the beetles survived about half as well on *C. versicolor* (38.6%), and less well on *G. applanatum*

(25.3%) and *P. everhartii* (9.3%). By use of the Kolmogorov-Smirnov goodness of fit test (Zar 1984) it was shown that the differences in survival on these four species were significant beyond 0.001.

As the fungi had been powdered, one might assume that variations in hardness had been eliminated. However, the difficulty in chewing very hard fungi such as *P. everhartii,* even when powdered, may still be a problem for such small beetles. Another important factor is the nutritional value of the fungi (Gilbertson 1984, Martin 1979). *H. blaisdelli* has a relatively enormous gut which fills most of the body cavity and is normally packed with hyphae and spores (Klopfenstein 1972). This indicates that a large volume of food must be consumed in order to obtain adequate nutrition. At room temperature (23°C) 50 adults ate 0.01 g of *B. fumosa* in an 8-day period, or 0.025 mg per beetle per day. The average weight of an adult beetle is 0.134 mg. Therefore the average adult *H. blaisdelli* will consume 18.7% of its weight in *B. fumosa* per day. The beetles survived best on *B. fumosa.* The differences in the quantity of different fungus species eaten by the beetles is statistically significant beyond 0.001 according to ANOVA (analysis of variance) (Zar 1984). While the beetles consumed a greater quantity of all fungus species when the sporocarps were ground, there is still a statistically significant difference (beyond 0.001, ANOVA) between the amounts eaten of each species. On harder and/or less nutritious host species, the beetles may be unable to consume enough and their survival is reduced.

In order to discover if there were differences in the feeding rate with different species of fungi, 50 adult beetles were placed in each of four vials with 1 g of fungus (powdered and formed into pellets) and allowed to remain for 20 days. This experiment was repeated three times. The beetles ingested greatest amounts of *B. fumosa* followed by *C. versicolor, G. applanatum,* and *P. everhartii* (Table 1).

A similar experiment using fungi in the natural state correlated well with the preceding (Table 1). Figure 2 shows the weight of natural fungus consumed compared with that which had been ground. Grinding enabled the beetles to eat more of each species, but the difference is most noticeable in the relatively hard species, *G. applanatum* and *P. everhartii,* in which double or triple the weight was consumed when the fungus was ground. *P. everhartii* has the heaviest and hardest sporocarp of any which were available to us, and, after sawing it, we estimated it to be harder than oak wood. Lawrence (1973) cited only one ciid, *Malacocis brevicollis* (Casey), known to breed in this fungus species. It is apparent that hardness of the sporocarp is at least one factor which may inhibit survival of Ciidae.

In the host preference studies, four small vials (6 mm in diameter) were placed on their sides like spokes of a wheel within a covered petri

dish. To each vial the same amount of one of the four fungus species was added. One hundred beetles were placed in the center of the dish. After four days the number of beetles in each vial were counted. This experiment was repeated three times. The numbers of beetles present in each vial were as follows: *B. fumosa* (69, 57, 64), *C. versicolor* (4, 11, 8), *G. applanatum* (2, 5, 3) and *P. everhartii* (1, 0, 3). The average percent of those beetles showing a preference for *B. fumosa* was 84%, *C. versicolor* 10%, *G. applanatum* 4%, and *P. everhartii* 2%. It is obvious that, of the four species of fungi used in these experiments, *H. blaisdelli* preferred these in the order listed above and shown in Figs. 1 and 3. These data are statistically significant beyond 0.05.

From these experiments we can draw the following conclusions. A colony of *Hadraule blaisdelli* survived for years on dry specimens of *Daedaleopsis confragosa.* When given a choice among four other species of fungi, the adult beetles preferred *B. fumosa, C. versicolor, G. applanatum* and *P. everhartii* in the order named, and also ate more of and survived best on these fungi in the same order. The strong correlation among preference, weight of food consumed, and survival is shown by Figs. 1, 3 and 4. It is also obvious that, of the four experimental fungi, *B. fumosa* is far superior to the others as a host. It appears doubtful that *H. blaisdelli* could survive on *P. everhartii* in nature.

Lawrence (1973) discussed the structural characteristics of polyporoid fungi in detail. He divided the North American species into four "host preference groups" with respect to Ciidae. Most ciid species are associated with one of these preference groups, but some, such as *H. blaisdelli* are polyphagous, and no preference group is apparent (Lawrence 1973). The fungi used in our experiments included representatives of three of these four groups: 1) *Coriolus* Group *(Coriolus),* 2) *Hirshioporus* Group (not represented), 3) *Phellinus* Group *(Phellinus),* and 4) *Ganoderma* Group (*Bjerkandera, Daedaleopsis,* and *Ganoderma).*

Our results indicate that, although *H. blaisdelli* is a polyphagous species, there are still pronounced differences in host preferences as well as the ability to feed and survive on the experimental fungi. Hardness of the sporocarp is at least one factor that appears to correlate with these differences. *H. blaisdelli* has not been reported from *Bjerkandera fumosa* in nature but Lawrence (1973, 1974) recorded it from the closely related *B. adusta* (Willd. ex Fries) Karsten (= *Polyporus adustus*). Both *B. adusta* and *B. fumosa* are monomitic and remain relatively soft. Ten other ciid species are known to breed in *B. adusta* (Lawrence 1973). *Coriolus versicolor* is one of the tremetoid group of fungi and is leathery in texture; Lawrence (1973) recorded 16 species of Ciidae breeding in this species. *Daedaleopsis confragosa* has a firm fruiting body with large irregular openings; Lawrence (1973) reported 3 species of ciids breeding in it (one

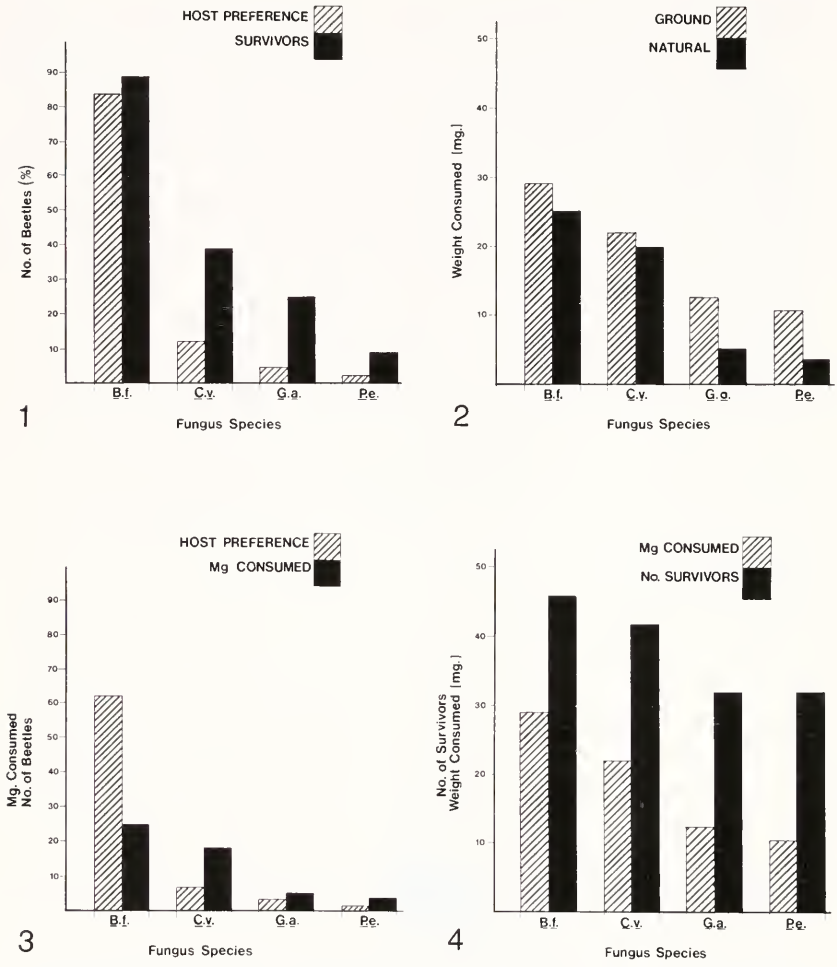

Fig. 1. Host preference (average percent of beetles showing a preference) compared with survivors (average percent of beetles surviving after 30 days.).

Fig. 2. Average amounts of fungi consumed (mg) by 50 beetles in 20 days. Comparison of amounts eaten using ground fungus and natural fungus.

Fig. 3. Preference (average number of beetles out of 100 found on each fungus species after four days) compared with the average amount (mg) of natural fungus consumed by 50 beetles in 20 days.

Fig. 4. Average amount of ground fungus consumed by 50 beetles in 20 days compared with the average number of survivors (out of 50 beetles) after 20 days.

B.f. - *Bjerkandera fumosa*; C.v. - *Coriolus versicolor*; G.a. - *Ganoderma applanatum;* P.e. - *Phellinus everhartii.*

of which was our *H. blaisdelli* record). It is interesting that Paviour-Smith (1960) noted that "a type of structure appears to be reached in the really tough trimitic fungi (*Daedalea quercina*) where no species even tries to live." *Ganoderma applanatum* is trimitic, hard and tough, and yet 10 species of North American Ciidae are known to breed in this species (Lawrence 1973). *Phellinus everhartii* is dimitic and extremely dense and hard with only one breeding ciid known.

In the polyphagous *H. blaisdelli,* hardness of the sporocarp is an important limiting factor. Hardness correlates generally with preference, feeding, and survival in experiments with four diverse and unrelated genera of fungi. It is interesting that *P. everhartii*, when ground, is consumed in much greater amounts (Fig. 2) and that survival is then comparable to the softer *G. applanatum* (Fig. 4). As these beetles may eat nearly a fifth of their body weight in dry fungus per day, the nutritional value of the host must also play an important part in survival.

Table 1. Survival of and amount of fungus consumed by *Hadraule blaisdelli* on four species of fungi (averages of three experiments using 50 individuals each).

Fungus species	Average number of adults surviving (out of 50)		Average amount of fungus consumed (mg) by 50 adults after 20 days	
	after 20 days	after 30 days	natural	ground
B. fumosa	46.0	44.7	25	29
C. versicolor	41.5	19.3	18	22
G. applanatum	32.0	12.7	5	12.5
P. everhartii	32.0	4.7	3.5	10.5

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We are grateful to John F. Lawrence for his determination of *H. blaisdelli* and for his helpful comments. Josiah L. Lowe determined all species of fungi used in our experiments. Patrick J. Dailey prepared the figures. Anne C. Graves and Anita E. Graves performed the statistical tests. Their aid is greatly appreciated.

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EREMOCORIS BOREALIS AND *E. FERUS* (HETEROPTERA: LYGAEIDAE) AS HOUSEHOLD PESTS IN PENNSYLVANIA AND CONNECTICUT[1]

A.G. Wheeler, Jr. [2]

ABSTRACT: An unusual infestation of the rhyparochromine lygaeid *Eremocoris borealis* is reported, the bugs congregating on the siding of a mountain home in Pennsylvania and causing a nuisance indoors. During hot, dry weather in August 1988, this seldom-collected species, a feeder on fallen birch and conifer seeds, apparently had migrated from the litter layer of the surrounding birch-hemlock forest. The related *E. ferus* is noted as creating a similar problem in Connecticut from late July to late August 1988. These appear to be the first records of North American rhyparochromines as household pests.

Excluding temporary ectoparasites of warmblooded animals (Cimicidae) and obligate hematophagous reduviids of medical importance (Triatominae), few North American Heteroptera are consistent household pests. Among phytophagous heteropterans, only the boxelder bug, *Boisea trivittata* (Say), is a recurrent nuisance in and around homes. Various true bugs, however, cause occasional problems indoors. Wheeler (1982) reviewed the scattered literature on these periodic invaders, noting that lygaeids of the genera *Blissus* (subfamily Blissinae) and *Nysius* (Orsillinae) have been mentioned most often among Lygaeidae that enter houses. Unusual infestations of the blissine *Ischnodemus falicus* (Say) and the lygaeine *Melacoryphus lateralis* (Dallas) also have been reported (Wheeler, 1982 and references therein). The so-called birch catkin bug, *Kleidocerys resedae* (Panzer), develops on mature seeds of birches, ericaceous shrubs, and other common landscape plants (Wheeler, 1976), and this ischnorhynchine lygaeid may congregate on sidewalks and enter houses (Wheeler, 1975).

During the hot, dry summer of 1988, a species of the largest lygaeid subfamily, Rhyparochrominae, created a problem for one Pennsylvania family. Herein, an outbreak of *Eremocoris borealis* (Dallas) is recorded, and a similar infestation of the related *E. ferus* (Say) in Connecticut during summer 1988 is noted.

Eremocoris borealis (Dallas)

Sweet (1977) raised this rhyparochromine of the tribe Drymini from

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synonymy under *E. ferus* (Say), stating that these cryptic species are behaviorally and reproductively isolated. The principal morphological character used to separate the two is tibial pilosity: *E. borealis* with hind tibia sparsely pilose, appearing nude; tibia with long, erect hairs in *E. ferus* (Sweet, 1977).

A seed bug of cool coniferous forests, *E. borealis* ranges in the East from Newfoundland south through New England and into Tennessee and North Carolina along the Appalachians; it occurs in Michigan and Wisconsin and in western North America is known from Alberta, British Columbia, Montana, and Oregon. Adults of this bivoltine lygaeid overwinter, and the bugs feed on fallen seeds of birch, *Betula* spp.; eastern hemlock, *Tsuga canadensis* (L.) Carr.; and red spruce, *Picea rubens* Sarg. (Sweet, 1964, 1977).

As characteristic inhabitants of the litter layer, rhyparochromine lygaeids are infrequently collected; many species are poorly represented in collections. It was somewhat surprising, then, that a pest control operator submitted rhyparochromine nymphs (on 15 September 1988) for identification, noting that the bugs were causing a severe problem in and around a house near Tower City (Schuylkill Co.), Pennsylvania. The nymphs had been collected dry and were in poor condition. To provide a more complete determination, additional specimens were requested. On 19 September one *E. borealis* adult (deposited in the Pennsylvania Department of Agriculture insect collection) was submitted with fourth and fifth instars of this species.

Two days later I visited the property to obtain details about the infestation and to see what plants were present on the grounds and in the surrounding area. No landscape plants in the small yard seemed likely to have favored an invasion by *E. borealis,* but the property was situated at the base of a mountain (elevation about 300m) and surrounded by a birch-hemlock forest. Trees present, in addition to sweet birch, *Betula lenta* L., and eastern hemlock, were American beech, *Fagus grandifolia* Ehrh.; black gum, *Nyssa sylvatica* Marsh.; and oaks, *Quercus* spp. Dominant understory plants were blueberries, *Vaccinium* spp.; hayscented-fern, *Dennstaedtia punctilobula* (Michx.) Moore; mountain laurel, *Kalmia latifolia* L.; and sweetfern, *Comptonia peregrina* (L.) J.M. Coult. The habitat was thus similar to that described for this species in New England (Sweet, 1964).

On 21 September, only one adult was collected by processing hemlock leaf litter in a Berlese funnel, but large numbers of *E. borealis* must have been present in the litter layer 4 to 6 weeks earlier. During August, the homeowner related that the bugs had amassed on siding, about 2 m from the ground, on the west side of the house. If such aggregation behavior

had been described by telephone, a boxelder bug problem would have been suspected.

While bugs were present on siding, other individuals (mostly nymphs, judging from the samples submitted for identification) invaded the house. They were observed crawling on the walls and carpet and were particularly annoying in the kitchen, where they infested cupboards, and the bathroom. A pest control specialist asked to alleviate the problem applied insecticide granules around the foundation of the house. Whether this treatment was responsible for the small numbers of *E. borealis* observed in late September is not known.

Eremocoris ferus (Say)

During summer 1988, *E. ferus* created a similar problem for a homeowner in Naugatuck, Connecticut. The bugs, first noticed about late July, congregated on the porch, especially under a rug. They were swept up each day, but more individuals would appear the following day, usually in mid-to late afternoon. After contending with the infestation for nearly a month, the homeowner decided to have the porch sprayed with insecticide (D. Comstock and K.A. Welch, personal communication).

DISCUSSION

Eremocoris borealis and *E. ferus* can be added to the list of Lygaeidae recorded as household pests and to the unusual or miscellaneous problems that occasionally confront pest control specialists. Although some might dismiss such infestations as insignificant, Mallis (1982) emphasized that what a pest control operator or entomologist might consider minor can well be a major problem to the homeowner or tenant involved.

To my knowledge, these are the first records of North American members of the large lygaeid subfamily Rhyparochrominae creating a household nuisance. The distribution of *E. borealis* is not well known, owing to its long confusion with *E. ferus*. Because Sweet (1977) and Ashlock and Slater (1988) did not cite a Pennsylvania record for *E. borealis*, the present report represents the first for that state.

ACKNOWLEDGMENTS

I thank D. Myers (Terminix International) for making a repeat collection of *E. borealis*, J.F. Stimmel and K. Valley (PDA-BPI) for reviewing the manuscript, D. Comstock (Naugatuck, CT) for providing details of the *E. ferus* infestation, and K.A. Welch (Connecticut Agric. Exp. Stn., New Haven) for allowing me to report information on *E. ferus* in Connecticut.

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THE GENETICS OF SOCIAL EVOLUTION. M.D. Breed and R.E. Page, Jr. 1989. Westview Press, Boulder & San Francisco. 213 pp. $36.50 sc.

Purpose of book is to initiate a synthesis of thought on how genetics structures the behavior of individual animals that live within complex social systems.

THE BUTTERFLY GARDEN. M. Tekulsky. 1985. Harvard Common Press, Boston. 144 pp. $8.95 pbk.

Guide to gardening for butterflies and attracting them by the growing of common plants and flowers which they use for food and nectar.

SUPPLEMENT TO: A CATALOGUE CHECKLIST OF THE BUTTERFLIES OF AMERICA NORTH OF MEXICO. C.D. Ferris, ed. 1989. The Lepiodopterists' Society, Memoir No. 3. 103 pp. $6.00 for members of Lepidop. Soc., $10 for non-members. Order from Dr., Charles V. Covell, Jr., Dep't. Biology, Univ. of Louisville, Louisville, KY 40292

This volume reflects nomenclatural changes published since Memoir No. 2, plus some corrections of errors in that work.

AN ANNOTATED CHECKLIST OF THE SPIDERS OF WASHINGTON. R.L. Crawford. 1988. Burk Museum, Univ. of Washington. 48 pp. $4.00.

A checklist is presented of 760 spider species currently known from Washington State. Each entry includes reference to the best illustrated description and a list of coded Washington localities.

A LABORATORY AERATION SYSTEM FOR REARING AQUATIC INVERTEBRATES[1]

Lynda D. Corkum, Elizabeth C. Hanes[2]

ABSTRACT: A dependable aeration system that can simultaneously provide a consistent, continuous air supply to several hundred small (500 mL) containers is described for rearing aquatic invertebrates. A laboratory air line or aquarium pump provides sufficient pressure to force air through main lines of clear plastic tubing that branch into shorter stoppered lengths. Air is fed into individual tanks by plastic capillary tubing, both ends of which are fitted with hypodermic needles. One needle is inserted into the main air line; the second needle is attached to the inner tank wall to project beneath the water surface.

A reliable aeration system is often essential when rearing aquatic invertebrates or when using a large number of aquatic chambers in laboratory experiments. A consistent, continuous air supply can be difficult to maintain. Here, we describe a simple, dependable system suitable for simultaneously providing air to many small (500 mL) units.

The aeration system consists of a main line of clear plastic tubing (inner diameter (I.D.), 4.8 mm; outer diameter (O.D.), 8 mm) that leads from an air outlet source through a filter tube (Balston DFU Grade BK) to a five-gang valve splitter. The filter removes particulate matter that may pass through the air line. Lines of tubing extend from each valve of the splitter. Branch lines, 0.5 m long, can be added with three-way valves or T-connectors. All tubes are stoppered at their distal end (neoprene plugs that cap insect genitalia vials work well and fit snugly into the tubing). Commercial aquarium clamps also may be used to stopper tubes. Short sections of blind tubes connected by cross tubes are preferable to one long tube to insure a continuous even supply of air throughout the network (Fig. 1).

Smaller (capillary) tubes (I.D., 0.8 mm; O.D., 2.4 mm) are connected to the network of lines using hypodermic needles. We use Yale 21G 1.5 (38.1 mm) bevelled, disposable hypodermic needles (Becton-Dickinson & Co.). Alternatively, surgical tubing and needles, available in a variety of sizes, may be substituted. The needles are prepackaged with plastic syringe connectors. To expose the open, cross-sectional end of the metal needle for air passage, we use two pairs of pliers to remove the plastic connector from each needle. It is advisable to wear safety glasses during this procedure.

The blunt end of a needle can be pushed into the capillary tubing. We

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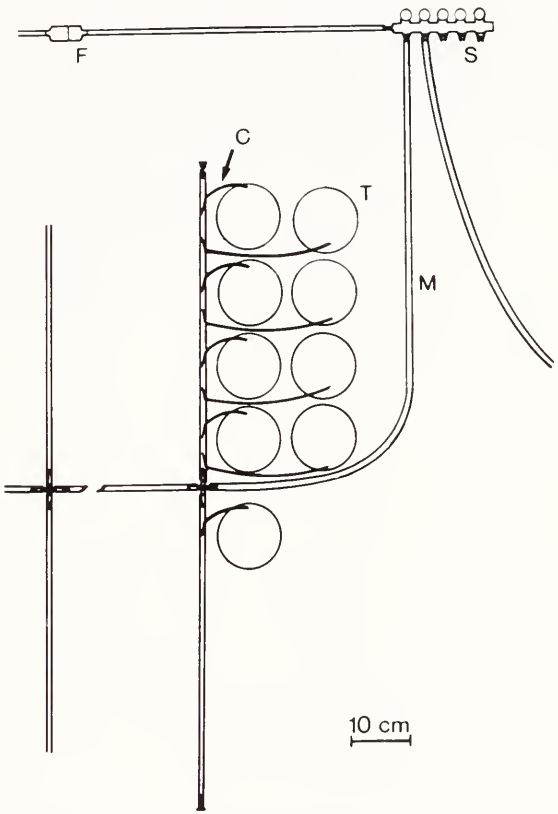

Fig. 1. Schematic of aeration system. A main air line leads through a filter (F) to a five-valve gang splitter (S). Capillary tubing (C) from main air line (M) is attached to each rearing tank (T).

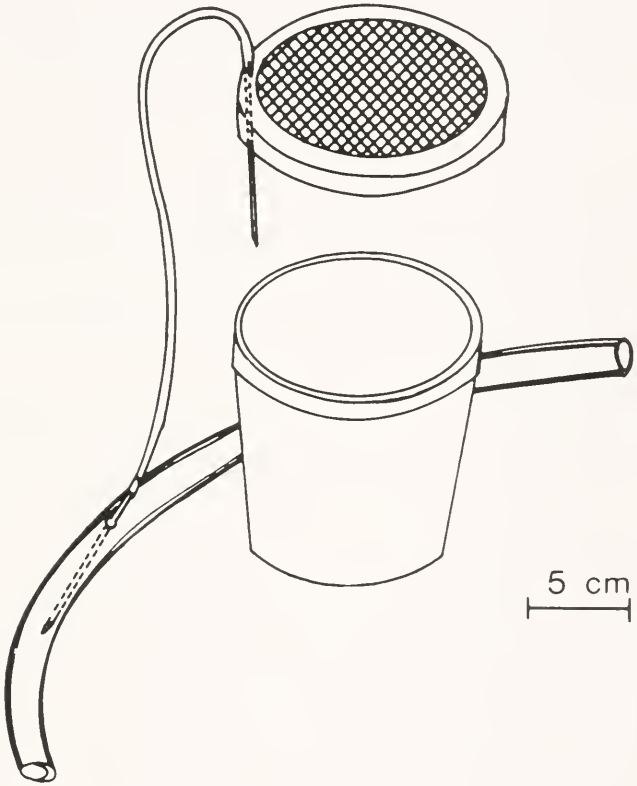

Fig. 2. Rearing tank, emergence lid, aeration tubing and syringes. Hatched area of lid represents nylon hardware cloth.

fit lengths (15 to 25 cm) of capillary tubes with needles at each end. We use one needle to puncture the outer wall of the main tubing and push the point in so that the needle rests in the air space of the tubing; the capillary tube trails away from the main line. Typically, we have inserted up to 15 capillary leads along one 0.5 m tube length.

The distal needle of each capillary tube is rigid and relatively easy to secure to the inner wall of a rearing tank with its tip below the water surface. We have found 500 mL Styrofoam containers to be especially suitable for rearing because the needle can be driven through the lip of the container (or lid) to project beneath the water surface (Fig. 2). The containers may be set up in pairs along either side of the main aeration lines.

Our containers (opening, 10.8 cm; depth, 6.8 cm) and lids were purchased from a restaurant supply company for a nominal fee ($50/500 containers and lids). The containers are sturdy enough to hold several cm of sediment and are filled with dechlorinated tap water. Marking pens can be used to label treatment numbers on the side of the container. We also use a dash-dot treatment code on the upper lip. In addition, color-coded dress pins may be inserted on the upper lip to aid in distinguishing containers.

We modify the lids of the containers to retain emerging specimens. The central portion of each lid is cut out leaving a 1-cm rim to which we attach nylon hardware cloth. When larger emergence cages are required, we use 2-L plastic tubs (depth, ca. 15 cm) that stand over the entire unit. Large areas of plastic are removed and replaced with nylon hardware cloth attached to the frame.

We have successfully used this inexpensive set-up in numerous applications. Although we typically use a laboratory air line, a powerful electric aquarium pump provides sufficient pressure to power the system. Also, the aeration system can be housed in an environmental room or growth chamber whenever temperature control is necessary. In our most recent work on the effects of larval density and food limitation on growth of a mayfly (Ephemeroptera) species, we used the aeration system to maintain 250 containers. This set-up required 20 m of regular tubing, 50 m of capillary tubing and 15 T-connectors. Such dependable aeration systems can contribute to the successful rearing of aquatic invertebrates.

ACKNOWLEDGMENTS

We thank Robert L. Baker, Jan J.H. Ciborowski, John E. Havel and Zsolt E. Kovats for their comments on the paper. Funding was provided by a grant from the Natural Sciences and Engineering Research Council of Canada to LDC. Reference to trade names does not imply endorsement of commercial products.

SUPERIORITY OF *APHAENOGASTER OCCIDENTALIS* IN CONFRONTATIONS WITH *SOLENOPSIS INVICTA* (HYMENOPTERA: FORMICIDAE)[1]

Stanley R. Jones, Sherman A. Phillips, Jr.[2]

ABSTRACT: The interspecific confrontational responses of *Aphaenogaster occidentalis* and *Solenopsis invicta* were elucidated by placing individual workers of each species together in petri dishes and observing their behavior continuously for 30 min. Although *S. invicta* was the aggressor, it could not penetrate the cuticle of *A. occidentalis* with its sting. *Aphenogaster occidentalis* was able to apply its venom topically in the majority of these confrontation trials, which resulted in paralysis of *S. invicta* workers within 5 min., and subsequent death within 30 min. These observations represent only the second report in which another species has been successful in confrontational trials with *S. invicta.*

The red imported fire ant, *Solenopsis invicta* Buren, is both an urban and agricultural pest throughout much of the southeastern United States (Lofgren, 1986). This species is aggressive toward other ant species (Jones and Phillips, 1987) and has replaced much of the native ant fauna by direct interference or by competition (Wilson and Brown, 1958; Reagan *et al.,* 1972; Whitcomb *et al.,* 1972; Hung and Vinson, 1978). To date, only *Lasius neoniger* Emery has been shown to be confrontationally superior to *S. invicta* (Bhatkar *et al.,* 1972). Herein, as part of an ongoing larger project to identify potential competitors, we report the successful response of a second ant species, *Aphaenogaster occidentalis* Emery, in confrontational interactions with *S. invicta.*

A colony of *A. occidentalis* was collected from Boulder, Colorado; colonies of *S. invicta* were collected from Kerrville, Texas. The confrontational responses of these species were tested by placing a worker of each species together in 60 by 20 mm petri dishes, the sides of which were coated with Fluon to prevent ant escape. Each of the 25 replications was conducted at 28°C under fluorescent lighting at 70-75% relative humidity. Interspecific interactions of the 8 major, 7 media, and 10 minor workers of *S. invicta* when paired with the monomorphic workers of *A. occidentalis* were observed and recorded continuously for 30 min.

Of the 25 paired trials, 22 (88%) resulted in paralysis of *S. invicta* workers within 5 min. (7 major, 6 media, and 9 minor workers). Only three *S. invicta* individuals recovered within the 30 min. (2 major and 1 media worker). Those individuals not recovering after 30 min. died as a consequence of the venom of *A. occidentalis.* In two of the trials, there was

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an avoidance of contact, whereas one trial resulted in death of *A. occidentalis* as a consequence of being stung in the area of the hypopharynx by a minor *Solenopsis* worker.

In all trials, *S. invicta* was the aggressor regardless of caste, but in most cases was apparently unable to penetrate the cuticle of *A. occidentalis* with its sting. Although "gaster flagging" has been observed in *S. invicta,* whereby venom droplets are dispersed through the air by raising and vibrating the gaster (Obin and Vander Meer, 1985), this behavior was not observed in these trials. Only after considerable provocation did *A. occidentalis* extrude its sting and topically apply venom to *S. invicta.* The venom droplet was rapidly absorbed through the cuticle by *S. invicta,* causing violent convulsions and shaking in a prone position, with legs outstretched and perpendicular to the body axis. Within 15-45 seconds, the affected *S. invicta* individual curled ventrally with its head near its gaster and remained motionless, with death ensuing shortly thereafter. With one exception, the venom of *S. invicta,* which is topically active against other ants (Schmidt, 1986), had no observable effect on *A. occidentalis.*

Virtually nothing is known about the biology of *A. occidentalis.* Most species of this cosmopolitan genus nest in either the soil, dead branches of trees, or rotting logs (Smith, 1979). Although the venom of *S. invicta* is known to be composed of piperidine alkaloids (Blum *et al.,* 1958; Jouvenaz *et al.,* 1972), attempts to isolate and characterize the venom of *A. occidentalis* have thus far proven unsuccessful (J.O. Schmidt, pers. comm.). However, the poison gland product of *Aphaenogaster fulva* Roger and *A. tennesseensis* (Mayr) is a tobacco alkaloid, anabaseine, and is reported to serve only as an attractant in *A. fulva* (Wheeler *et al.,* 1981). Based on our observations, the poison gland product of *A. occidentalis* serves as a potent and effective toxin for defense and is the first such report for this species and for species in this genus. However, because of the highly efficient recruitment system employed and the relatively large number of workers that typify *S. invicta* colonies, any results obtained from one-on-one interspecific confrontations may not necessarily reflect those that might be obtained from colony-versus-colony confrontations even if the range of these two species overlapped.

ACKNOWLEDGMENTS

We thank L. Chandler, R. Sites, and H. Thorvilson, for their reviews of this manuscript, and J.O. Schmidt (Dept. of Entomology, University of Arizona) for information pertaining to ant venom. We also thank André Francoeur (Université du Québec à Chicoutimi) for identification of *Aphaenogaster occidentalis.* A voucher specimen is in his collection (accession no. 12561). This is contribution no. T-4-239, College of Agricultural Sciences, Texas Tech University.

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SPRUCE BUDWORM LITERATURE COLLECTION

An extensive collection of spruce budworm literture has been donated to the Raymond H. Folger Library, University of Maine, by the USDA Forest Service. The collection contains over 5000 items including U.S. and Canadian federal agency reports, experiment station documents, symposia proceedings, books, and journal articles. It is believed to be the largest collection in existance of material on the spruce budworm.

These materials are available for use by writing to Mary F. Casserly, Head of Collection Development, R.H. Folger Library, Univ. of Maine, Oron, MD 04469.

ITHYTRICHIA MEXICANA, (TRICHOPTERA: HYDROPTILIDAE), A NEW SPECIES OF CADDISFLY FROM MEXICO[1]

S.C. Harris, A. Contreras-Ramos[2]

ABSTRACT: The genus *Ithytrichia* is reported for the first time from Mexico and is represented by a new species, *I. mexicana*. The structural details of the male terminalia are illustrated and compared with the two closely related North American species.

The Holarctic genus *Ithytrichia* is represented by two species in North America. *Ithytrichia mazon* Ross is apparently restricted in distribution, known only from Illinois and Arkansas, while *I. clavata* Morton is widely distributed with records from Quebec to British Columbia and south to Pennsylvania, Texas and California. *Ithytrichia clavata* has also been recorded from the Palearctic region as has *I. lamellaris* Eaton (Marshall, 1979). The genus has not been previously reported south of the continental United States (Bueno-Soria and Flint, 1978). Recent blacklight collecting by the junior author in Tamaulipas, Mexico, revealed the presence of a new species in this genus.

Terminology for genitalic structures generally follows that of Marshall (1979). The holotype will be deposited at the National Museum of Natural History, Smithsonian Institution.

***Ithytrichia mexicana*,** new species

(Fig. 1)

This species is closely related to both *I. clavata* and *I. mazon* and shares several genitalic characters. As with *I. clavata* (Ross, 1944; fig. 457A), the inferior appendages of *I. mexicana* are tapered distally in ventral view. However, in lateral view the ninth segment of *I. mexicana* is wide at the posterior apex as in *I. mazon* (Ross, 1944; fig. 458B). This combination of characters and the flared apex of the subgenital plate readily distinguish *I. mexicana* from the above species.

Male. Length 3 mm. 24 antennal segments. Brown in alcohol. Segment VII with ventromesal process extending about 1/3 length of segment VIII. Segment IX in lateral view tapering distally, posteroventral apex wide with short sclerotized knob; in dorsal and ventral view, posterolateral margin acutely sclerotized at apex, internally with sinuate, sclerotized bands dorsolaterally extending into segment VIII. Segment X fused with IX, mem-

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branous dorsally. Inferior appendages rectangular in lateral view, tapering subapically; in ventral view, wide basally and nearly contiguous mesally, tapering distally to rounded apex bearing several stout setae. Subgenital plate in ventral aspect flared posteriorly with mesal incision, bearing six setae, four lateral and two mesal. Phallus tubular, wide basally, rounded at apex with ejaculatory duct protruding ventrally; paramere at midlength partially encircling shaft.

Holotype, male. Mexico: Tamaulipas, Municipio de Gómez Farias, Rio Frio at headwaters, La Poza Azul, 6 km S Gómez Farias, 7 August 1988, A. Contreras and A. Moreno, blacklight.

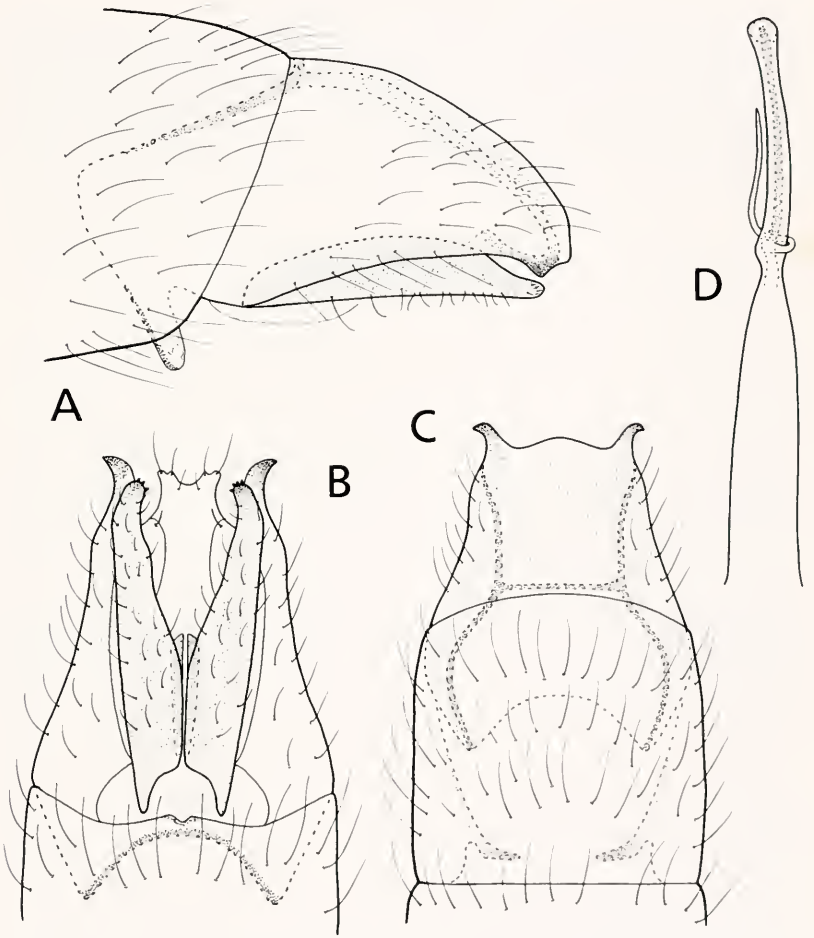

Figure 1. *Ithytrichia mexicana* n. sp., male genitalia. A, Lateral view, B. Ventral view, C. Dorsal view, D. Phallus, dorsal view.

ACKNOWLEDGMENTS

The Geological Survey of Alabama is gratefully acknowledged for providing facilities and supplies to the senior author. We thank Arnulfo Moreno and Luis Trigo for their help in collecting. Oliver S. Flint, Jr. and Patrick O'Neil were helpful in their reviews of the manuscript. Peggy Marsh typed several drafts of the manuscript and Ron Bates photographed the plate. This publication is contribution number 121 of the Aquatic Biology Program, University of Alabama.

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BOOKS RECEIVED AND BRIEFLY NOTED

THE PLANT-FEEDING GALL MIDGES OF NORTH AMERICA. R.J. Gagne. 1989. Comstock Publ., Cornell. 356 pp. $45.00

A compendium of current knowledge on biology, pest status, recognition, and literature on plant-associated cecidomyiids. Covers more than 900 species. First seven chapters cover biology, anatomy, classification, generic key to larvae associated with plants, distribution, galls, and collection, rearing and preparing gall midges for study. The bulk of the book consists of keys to plant damage by gall midges, arranged by plant families. Galls of 388 species are illustrated by 24 color photographs and 434 line drawings. Will be a classic reference for years to come.

CATALOGUE OF PALAEARCTIC DIPTERA. Vol. 6, Therevidae - Empididae and Vol 8, Syrphidae - Conopidae. A Soos and L. Papp, eds. 1988 and 1989. 435 and 363 pp. $208.00 ea.

Two more volumes in the multi-volume work that catalogues the main taxonomic, nomenclatural and distribution data of 25,000 fly species described from the Palaearctic Region.

ILLUSTRATED KEYS TO THE FAMILIES OF TERRESTRIAL ARTHROPODS OF CANADA. 1. MYRIAPODS. D.K. McE.Kevan and G.G.E. Scudder. 1989. Biological Survey of Canada, Ottawa. 88 pp. Spiral bdg.

First in a planned series of separate keys to the major groups of arthropods of Canada and northern United States. This small, well illustrated publication covers the Myriapoda, or the centipedes and millipeds.

MISSISSIPPI RECORDS OF *PLECTOPTERA PICTA* (BLATTODEA: BLATTELLIDAE) AND *ATAENIUS ROBUSTUS* (COLEOPTERA: SCARABAEIDAE)[1,2]

J.R. MacDonald, R.L. Combs, Jr.[3]

ABSTRACT: *Plectoptera picta* (Blattodea: Blattellidae) and *Ataenius robustus* (Coleoptera: Scarabaeidae) are reported for the first time from Mississippi.

One specimen of the Neotropical cockroach, *Plectoptera picta* Saussure and Zehntner, was collected 6 Aug. 1986 at the White Sands unit of the Mississippi Agriculture and Forestry Experiment Station, 15 km W of Poplarville, Pearl River Co., Mississippi. This species, not previously known from Mississippi, has been reported from Texas, Louisiana, Virginia, North Carolina, Mexico, and Costa Rica (Nickle and Gurney, 1985). The specimen was collected near the base of a ca. 75 cm. dia. oak (*Quercus* sp.) in a pasture.

Twelve specimens of *Ataenius robustus* Horn, originally reported as *Ataenius* (sp. new) (MacDonald and Combs, 1985), were collected 15 km W of Starkville, Oktibbeha Co., Mississippi as follows: 14 Sept. (1), 25 Sept. (2), 1981; 28 April (1), 17 Aug. (1), 15 Sept. (1), 13 Oct. (1), 15 Oct. (3), 29 Oct. (1), 1 Nov. (1), 1982. Specimens were collected in a pasture from cowpats of the following ages: 4 hr. (1), 24 hr. (1), 48 hr. (3), 96 hr. (6), 168 hr. (1). This species is also a new record for Mississippi and has been reported from Arkansas, Illinois, Iowa, Kansas, Missouri, Nebraska, New Mexico, Oklahoma, South Dakota, and Wisconsin (Cartwright, 1974). Voucher specimens of both species have been placed in the Mississippi Entomological Museum, Mississippi State University.

ACKNOWLEDGMENTS

The authors would like to thank D.A. Nickle, Systematic Entomology Laboratory, USDA, for determination of *P. picta* and Robert D. Gordon Systematic Entomology Laboratory, USDA, for determination of *A. robustus*. Further, the manuscript review provided by T. Schiefer, R. Brown and R. Luttrell is greatly appreciated.

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[2]Approved as assigned No.1 J-7003 by the Mississippi Agricultural and Forestry Experiment Station.

[3]Department of Entomology, Mississippi Agriculture and Forestry Experiment Station, Mississippi State University, Drawer EM, Mississippi State, MS 39762.

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SOCIETY MEETING OF APRIL 19, 1989

PHOTOGRAPHIC ESSAY ON SOME INSECT MATING SYSTEMS

By David Funk

Milkweed beetles come in pairs: they always seem to be mating. Certain stick insects have been reported to consort for three months. However, for most insects nuptual encounters are considerably shorter and less conspicuous. To observe them requires persistance and patience. To photograph them requires ingenuity as well. It was not voyeurism that attracted the largest attendance for a membership meeting in many years (19 members and 27 guests). It was primarily the expectation of seeing spectacular photographs of insects taken by David Funk, award-winning insect photographer and entomologist from the Stroud Water Research Center in Avondale, Pennsylvania. This expectation was fulfilled.

Whether by song, perfume, flashing lights or distinctive appearance, insects are able to attract and find mates. Much of this courtship activity occurs at twilight or at night when visual predators (and most entomologists and photographers) are least active. Because Dave has an interest in the nocturnal lives of insects, the audience was treated repeatedly to amazing behavior that is common but rarely observed. The song of crickets is familiar enough on late summer evenings but the encounters they initiate are not. After attracting a mate, the male tree cricket transfers a spermatophore to the female. The spermatophore not only contains sperm for fertilization but after mating it can be eaten by the female for nourishment. The size, number and sperm content of spermatophores vary in different species in relation to various male strategies to improve their mating success and to nourish females they have mated. From a pit near the base of their wings, some male tree crickets produce exudates for the female to feed upon in order to prolong mating and enhance the chances for fertilization. The bush cricket male sacrifices its wings in this endeavor.

For many insects reproduction is the primary goal of a short adulthood where little or no feeding occurs. Synchronous emergence in mayflies and cicadas is thought to saturate the appetite of available predators to insure that some individuals survive to reproduce. Sexual dimorphism reflects courtship behavior. Male mayflies, for example, have very large eyes that are used to see females at dusk. In moths where pheromones are produced, males have large antennae for detecting the attractuants. Sometimes the roles are reversed as in scorpionflies that, after capturing a meal for two, produce a pheromone to attract a female. Predators that evolve to mimic these signals have an easy meal. Mr. Funk showed a picture of a bolas spider that emits the pheromone of a noctuid moth and feasts on the males of a couple of species.

(Continued on page 182)

FURTHER NOTES ON PREPARATION OF EXUVIAE OF PARASITIC HYMENOPTERA[1]

David B. Wahl[2]

ABSTRACT: Modifications of previous methods for preparing cast exuviae of larval parasitic Hymenoptera are: 1) use of Euparal rather than Hoyer's as a mounting medium, 2) careful removal of the exuviae with forceps to minimize ultrasonification, and 3) use of cold concentrated KOH or NaOH in cases where cocoon contents are cemented together and refractory to ultrasonification.

Since publication of an earlier paper on preparation of cast larval exuviae (Wahl, 1984), additional experience has led me to suggest some alternative methods.

I do not advocate the use of Hoyer's as a mounting medium. Conversations with curators have cast doubts upon the longevity of such slides, even when "properly" rung. Euparal is very satisfactory, both for its undoubted permanence and ease of use. After clearing, the final manipulation of the exuviae is done in 70% ethanol, after which it is transferred to 95% ethanol for several minutes, and then mounted directly in Euparal. A week (approximately) of curing the slide at 40-50°C is necessary. If small bubbles of air are trapped under the cover slip, this heating period will cause either their migration to the outer edge of the cover slip or their resorption.

The typical contents of an ichneumonoid cocoon consist of the meconium (a large yellowish or brownish body of feces within the peritrophic membrane), the pupal exuviae (appearing as tighly wadded translucent cuticle with associated white fecal pellets), and the larval exuviae (light to dark brown in color). The latter are usually extended to some extent and attached (or wound about) the other contents. Careful manipulation with fine forceps will often suffice to remove the larval skin without resorting to ultrasonification of the cocoon contents. This reduces both the preparation time and the chances of tearing or otherwise damaging the fragile larval exuviae. When the cocoon contents are tightly bound together in a homogeneous mass, however, ultrasonification should be used to both loosen the components and get rid of fecal matter.

Occasional specimens will be found that have the cocoon contents firmly cemented together into a dark brown object that is resistant even to ultrasonification. Judicious use of cold concentrated KOH or NaOH

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gives excellent results in these cases. One pellet of KOH or NaOH is dissolved in two milliliters of water and the cocoon contents are placed in this solution for 15-20 minutes. This is usually sufficient to loosen the cocoon contents and allow the larval exuviae to be removed. The exuviae are then placed in a weak acidic solution (I use one drop of glacial acetic acid in two milliliters of water) to neutralize the previous basic solution, and then transferred to Nesbitt's for clearing.

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SOCIETY MEETING OF APRIL 19, 1989

(Continued from page 180)

The other main attraction of the evening was the presentation of the Calvert Prize to David Zonies, a ninth grade student at North East High School in Philadelphia. He displayed his project concerning the life-shortening effects of ultraviolet radiation on *Drosophila melanogaster.* The first runner-up, Danielle Anctil a ninth grade student at Upper Dublin High School in Fort Washington, Pennsylvania, displayed her project on the wood preferences of termites.

Harold B. White
Corresponding Secretary

SOCIETY'S INSECT FIELD DAY

The third annual Insect Field Day of The American Entomological Society was held for members and friends of the society on Saturday, June 17, 1989, at Lebanon State Forest in the New Jersey pine barrens. The primary purpose of these field days is to conduct an activity that may help to stimulate interest in insects among amateurs and students, some of whom may be budding entomologists. A total of 76 persons, including 64 adults and 12 children, attended the event which featured insect displays, field trips, and informational programs. -H.P.B.

ACID-FREE PAPER

Effective with this current, September - October, 1989 issue, ENTOMOLOGICAL NEWS is now being printed on acid-free paper. -H.P.B.

DAMAGE TO WOODY PLANTS BY THE LOCUST LEAFMINER, *ODONTOTA DORSALIS* (COLEOPTERA: CHRYSOMELIDAE), DURING A LOCAL OUTBREAK IN AN APPALACHIAN OAK FOREST[1]

Charles E. Williams[2]

ABSTRACT: Estimates of feeding damage to woody plants by adult locust leafminer, *Odontota dorsalis,* were made during a local outbreak in an Appalachian oak forest. Thirteen woody plant species were recorded from the outbreak area in southwestern Virginia, but only six (46.2%) sustained damage from locust leafminer feeding. Black locust received the heaviest damage. Red and chestnut oaks, sugar maple, black cherry, and hawthorn sustained moderate feeding damage. Possible causes of the outbreak are discussed.

The locust leafminer, *Odontota dorsalis* (Thunberg), is the most common insect pest of black locust (*Robinia pseudoacacia* L.) in the eastern United States. Feeding by adults and larvae of this beetle causes the extensive "scorching" of black locust leaves that is often evident in late summer.

Larvae of *O. dorsalis* are oligophagous, mining the leaves of black locust and a few other leguminous plants (Dominick 1938; Poos 1940; Wheeler 1980). Adults, however, have a broad host range and primarily feed on woody species such as apple, oak, elm, beech, dogwood and hawthorn as well as black locust (Hopkins 1896; Houser 1918; Dominick 1938; Johnson and Lyon 1976). Outbreaks of locust leafminer adults in suburban and agricultural areas can cause severe damage to shade and fruit trees (Houser 1918; Dominick 1938).

Little is known about the feeding ecology of adult locust leafminer in natural plant communities compared to the abundance of information from managed systems. A recent localized outbreak of the locust leafminer in a southern Appalachian oak forest provided an opportunity to document the feeding preferences of this insect in a diverse natural system. Here I provide a list of woody plants recorded from the outbreak area and estimates of the intensity of feeding damage to each species as well as discuss possible causes of the outbreak.

MATERIALS AND METHODS

This study was conducted on Peters Mountain, near Narrows, Giles Co., Virginia, where I first noted large numbers (up to 25 per leaf) of *O.*

[1]Received January 15, 1989. Accepted April 17, 1989.

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dorsalis adults feeding on leaves of northern red oak (*Quercus rubra* L.) and chestnut oak (*Q. prinus* L.) on 12 June 1988. The outbreak was confined to an area of ca. 0.25 ha, located on an exposed, northeasterly slope at an elevation of ca. 750 m.

Woody vegetation was sampled on 28 June when the browning of damaged leaf tissue facilitated estimation of feeding damage. The majority of *O. dorsalis* adults had dispersed from the outbreak area, thus total damage for the season could be estimated. Vegetation was sampled in four 30 X 2 m belt transects, each divided into a series of contiguous 5 X 2 m quadrats, centered in the outbreak area. One transect was placed parallel to the ridge on the main body of soil before a rock outcrop, and the other three were placed perpendicular to the first transect, each separated by 10 m. Woody plants were recorded by species and diameter in each transect and classified as overstory (stems $\geq$ 10 cm dbh), understory (stems $\geq$ 2.5 but $<$ 10 cm dbh), or saplings (stems $<$ 2.5 cm dbh). Nomenclature follows that of Radford *et al.* (1968). Voucher specimens have been deposited in the VPI & SU herbarium.

Density (number of stems per hectare), basal area (m^2 per hectare), and frequency (percent occurrence in quadrats) were determined for overstory and understory trees. To describe the relative importance of woody species in the outbreak area, importance values (relative density + relative basal area + relative frequency) were calculated for overstory and understory species (Curtis and McIntosh 1951). Importance values are presented as average percentages of the total. Importance values for saplings were calculated as average percentages of relative densities and frequencies (Adams and Stephenson 1983).

The extent of feeding damage to woody plants in the outbreak area was determined visually. All leaves on the distal 1 m of five randomly selected branches of all trees in the transects (n = 112) were scrutinized for *O. dorsalis* feeding damage [e.g., the characteristic "scraping" of upper leaf surfaces (Dominick 1938)]. In sapling and understory species, scanning of leaves was done directly at eye level, but for most overstory species binoculars were used to inspect feeding damage. Damage estimates were placed into four classes: 1) no feeding by *O. dorsalis;* 2) $<$ 25% of leaf area damaged by *O. dorsalis;* 3) 25 to 50% of leaf area damaged by *O. dorsalis* and 4) $>$ 50% of leaf area damaged by *O. dorsalis.* All damage estimates were made solely by the author to minimize observer bias. Broad percent damage classes were used since the precision of visual estimation of plant damage is poor at small intervals (Ruesink and Kogan 1975).

One-way analysis of variance was used to detect mean differences in feeding damage among woody plants in the study site. Individual differences in feeding damage means were determined by Duncan's multiple range test. Because there were no significant differences in damage

estimates within species among forest strata, damage estimates for each species were pooled and pooled means were used for comparisons among species. Associations of woody plant importance and feeding damage estimates were examined with Pearson correlation coefficients. Data were log-transformed before analysis and all statistical tests were conducted at the $P \geq 0.05$ significance level.

RESULTS AND DISCUSSION

The composition and importance of woody plants in the outbreak area are presented in Table 1. Chestnut oak dominated the forest overstory and was also an important tree species in the understory and sapling strata. Northern red oak, black walnut (*Juglans nigra* L.), and mockernut hickory [*Carya tomentosa* (Poir.) Nutt.] occurred sparingly in the overstory. The understory stratum was dominated by redbud (*Cercis canadensis* L.), with chestnut oak, mockernut hickory and six other woody species [*Celtis laevigata* Willd. (sugarberry), *Acer saccharum* Marsh. (sugar maple), *Pinus virginiana* Mill. (Virginia pine), *Rhus typhina* L. (staghorn sumac), *Prunus serotina* Ehrh. (black cherry), *Q. rubra*] found in lesser amounts. Sugarberry, hawthorn (*Crataegus coccinea* L.) and redbud dominated the sapling stratum, whereas saplings of northern red oak, black cherry, black locust, and shagbark hickory [*Carya ovata* (Mill.) K. Koch] occurred at low levels. The ground layer in the outbreak area was not sampled quantitatively but was dominated by herbs, particularly Canada leaf-cup (*Polymnia canadensis* L.). No leafminer feeding was observed on this species.

Feeding damage estimates differed significantly among woody plants in the outbreak area ($P < 0.0001$; Table 1). The most heavily attacked species was black locust. Although black locust is the primary larval host of *O. dorsalis* in southwestern Virginia (Dominick 1938), none of the sampled trees were mined by larvae. Despite heavy feeding damage (> 50% of the leaf area destroyed) caused by adult beetles, black locust was of little importance in the outbreak area; it occurred only at low numbers as saplings. Red and chestnut oaks, sugar maple, black cherry and hawthorn sustained moderate levels of feeding damage by *O. dorsalis*. Feeding damage in these species ranged from substantial skeletonizing of leaves (ca. 50% of leaf area eaten in some oaks) to a few localized scrapes on the leaf surface (hawthorn). Among the moderately damaged species, northern red oak appeared particularly favored as leaves of this species were often heavily skeletonized. The remaining woody plants — black walnut, shagbark and mockernut hickories, redbud, sugarberry, Virginia pine and staghorn sumac — bore no evidence of feeding by *O. dorsalis*. Thus of a total of thirteen woody plants recorded from the outbreak area, only six species (46.2%) sustained damage from locust leafminer feeding.

A positive but nonsignificant association between feeding damage estimates and the importance of woody plants was observed for the outbreak area ($r = 0.76$, $P = 0.09$).

Outbreaks of locust leafminer are often described as patchy in distribution and short in duration (e.g., Dominick 1938). The patchiness of locust leafminer outbreaks has been ascribed to recruitment of adults from nearby overwintering sites (Dominick 1938) and localized reductions in black locust foliage that concentrate adults on patches of palatable plants (e.g., Houser 1918). Unfortunately, I can only speculate on the origin of the outbreak on Peters Mountain. Although conditions favorable for overwintering of locust leafminer adults [e.g., a dense shrub layer and heavy litter accumulation (Dominick 1938)] occurred in the outbreak area, these conditions were also common in the surrounding forest. Moreover, emergence of overwintered *O. dorsalis* adults in southwestern Virginia begins in early May and is completed before mid-June (Dominick 1938 and pers. obs.); therefore, it seems unlikely that the outbreak was the result of the emergence of adults from patchy overwintering habitat.

It is also unlikely that the abundance of black locust influenced the patchy nature of the outbreak. First, black locust comprises a small proportion of the forest vegetation on Peters Mountain (Adams and Stephenson 1983) and second, the composition of vegetation in the outbreak area, particularly the species attacked by *O. dorsalis,* did not differ from the composition of the surrounding forest matrix; thus patchwise colonization of woody plants is improbable. Recent evidence suggests that stress, particularly drought stress, may predispose plant populations to insect herbivore outbreaks (Mattson and Haack 1987). Given the dry, exposed, ridgetop location of the outbreak area, it seems feasible that the eruption of *O. dorsalis* may have been mediated by plant stress. Moreover, the dry summer of 1988 may have accentuated the droughty nature of the shallow soils in the outbreak area. Drought-stressed plants differ physically (e.g., greater infrared reflectance, leaf yellowing) and chemically (e.g., increased levels of soluble nitrogen and sugars in tissues) from non-stressed plants and so may be more attractive or acceptable to insects (Mattson and Haack 1987). Thus drought-stressed trees associated with exposed ridgetop soils, may partially explain the localized nature of the locust leafminer outbreak on Peters Mountain. Culbertson (1915) also surmised that drought was a factor in large-scale eruptions of the locust leafminer in southern Indiana.

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I thank Tom Wieboldt, Associate Curator, VPI & SU Herbarium, for identifying *Crataegus coccinea.* The Nature Conservancy, Virginia Chapter, permitted access to the Peters Mountain site. W.W. Hargrove, C.L. Staines, A.G. Wheeler, Jr., K. Williams, and several anonymous referees provided constructive reviews of the manuscript.

Table 1. Importance values and mean feeding damage estimates to woody plants caused by the locust leafminer, Peters Mountain, Virginia, 1988. Means of feeding damage classes for each tree species represent pooled estimates for overstory, understory, and sapling strata [Damage classes include: 1) no feeding by *O. dorsalis;* 2) < 25% of leaf area damaged by *O. dorsalis;* 3) 25 to 50% of leaf area damaged by *O. dorsalis* and 4) > 50% of leaf area damaged by *O. dorsalis*]. Means followed by the same letter do not differ significantly (Duncan's multiple range test, $P < 0.05$).

	$\bar{X}$ Percent Importance Value			
Species	Overstory	Understory	Saplings	$\bar{X}$ Damage Class
Quercus prinus	87.2	12.7	11.3	2.36bc
Q. rubra	6.7	2.9	7.5	2.57b
Juglans nigra	4.7	—	—	1.00d
Carya ovata	—	—	2.2	1.00d
C. tomentosa	1.4	11.9	—	1.00d
Cercis canadensis	—	51.3	17.9	1.00d
Celtis laevigata	—	7.5	27.4	1.00d
Acer saccharum	—	4.2	—	2.00bc
Pinus virginiana	—	3.6	—	1.00d
Rhus typhina	—	3.0	—	1.00d
Prunus serotina	—	2.8	7.7	2.00bc
Crataegus coccinea	—	—	21.5	1.94c
Robinia pseudoacacia	—	—	4.5	3.50a

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INCORPORATION OF SLIDE-MOUNTED MATERIAL INTO ENTOMOLOGICAL COLLECTIONS[1]

Laurent LeSage[2]

ABSTRACT: A polypropylene slide box is described and illustrated. Details are given on how to incorporate slide-mounted material into collections of pinned insects or into collections preserved in alcohol.

Slide-mounted material usually consists of genitalic structures or other parts of prime importance in the identification of specimens. Unfortunately, this critical material is usually stored separately, and consequently is often neglected or ignored, and is sometimes misplaced or even lost. This duplication in storage increases the risk of loss of either the dissected parts or the original specimens. Different codes (often changing with years) used by different scientists make the retrieval of the material more complicated, if not impossible. Another problem with the slide-mounted material is actually related to the fact that for some groups of insects this mounting technique is not used any more. For example, male aedeagi or female spermathecae of beetles are now mounted on transparent plastic plates pinned directly under the specimens instead of being mounted on slides. In the Canadian National Collection (CNC), as in other museums, there are hundreds of old slide-mounted genitalia of beetles or other insects which have to be incorporated into the main collection or stored in one way or another. On the other hand, the small plastic boxes are not recommended for large collections of insects where almost all specimens are mounted on slides (Chironomidae, Ceratopogonidae, mites, etc.).

The aim of the present paper is to describe a convenient type of microscope slide box, and to explain how some of the problems exposed above can be solved using it. As pointed out by an anonymous reviewer this type of slide box is not really "new" (since, according to his comments, these boxes have been used at the USNM for the curation of several families of Diptera for more than ten years) but it is the first time that its utilization is thoroughly discussed.

DESCRIPTION

The Marin Laboratory Supply[R] (MLS) slide box is injection-molded

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of durable polypropylene plastic with luted inner walls for insertion of slides (Fig. 1). These boxes, made by Marin Laboratory Supply (P.O. Box 4019, San Rafael, CA 94903, USA), cost only US $35.00 a gross (144).

Each box measures 83 mm (3 1/4"), 29 mm (1 1/8"), and 16 mm (5/8") deep. A single box holds five standard microscope slides. Slides are easily inserted, removed, and protected with a snap-top, positive lock.

For pinned insect collections

The following discussion refers to drawers and trays of the United States National Museum (USNM) system cabinets used at the Canadian National Collection (CNC) but applies as well to the California Academy of Sciences (CAS) or the Cornell University (CU) system cabinets which are slightly broader.

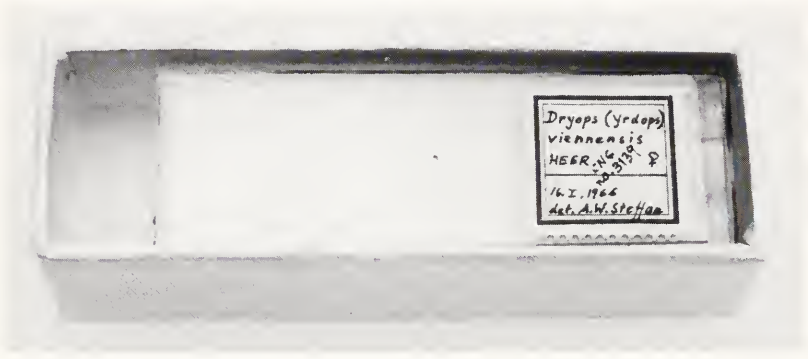
The MLS slide boxes are especially convenient for type material or other important reference specimens. For safest curation, the specimen is pinned in a separate small tray preceeding the tray with the slide-mounted material. If one wants to save space, the original specimen can be pinned on the left side of a 4x1 tray whereas the slide box containing the pertinent slide(s) is placed on the right side; it is advisable to secure the slide box with insect pins to avoid side movements of the slide box with the tray. The MLS slide boxes are transparent enough that the top slide label(s) can be read through the sides (Fig. 2). Therefore, slides can be incorporated directly without any rewriting of labels. Slides of the same taxon are stored together. Specimens with structures mounted on slides are pinned in a tray of appropriate size preceeding the tray with slide boxes. The slide holding capacity of the USNM system trays is:

4"x1" tray: 5 slides (Fig. 1)
4"x2" tray: 10-15 slides
4"x4" tray: 25-30 slides (Fig. 3)
4"x8" tray: 55-60 slides

The maximum slide holding capacity is reached when slide boxes lay on the side; in that case a general label should be attached to the side to identify the slide box contents; self-stick labels are the most convenient for this purpose. This additional work can be eliminated by removing one box and placing another horizontally for instantaneous access to the label of the slide inserted at the top of the slide box. It must be mentioned here that this method is not recommended if slides are not completely dried because cover slips and structures in the medium will eventually slide down. The easiest way to avoid these eventual problems is to place all the slide boxes horizontally inside the trays.

After all slide boxes have been properly placed in appropriate trays they are incorporated with the pinned collection and handled as regular trays filled with insects (Fig. 4).

1

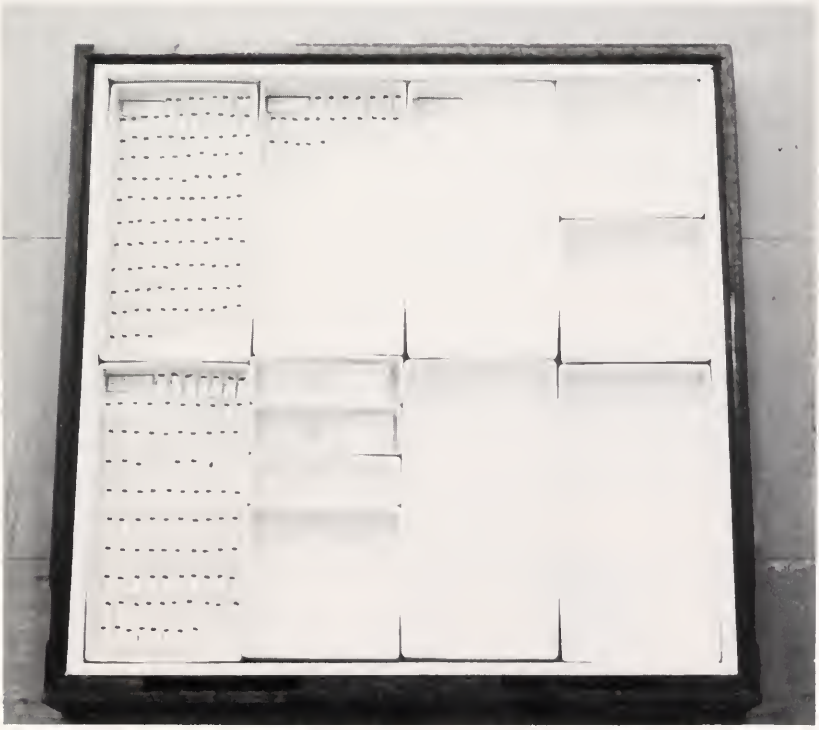


2

5

Figures 1-5. 1. Sample of a Marin Laboratory Supply microscope slide box. 2. Slide with genitalia of a beetle mounted on it and placed in small insect tray; the data of the label are readily legible through the box plastic. 3. Larger insect tray containing 25 slides (5 slides a box); one microscope slide box is placed horizontally to show the label of a slide. 4. Example of slides boxes incorporated with insect trays. 5. Example of slide boxes incorporated with insect vial rack.

3



4

Of course, there must be some sort of coding to associate original specimens and mounted parts, but since both are placed side by side in the collection, their association is very easy without searching through hundreds of slides stored in separate slide cabinets. On the other hand, the curation of slides with MLS slide boxes is no better than any other systems if slides are not properly associated, coded, or organized. If correctly used, they are, in my opinion, superior to other existing systems in the curation of slide-mounted material and their incorporation with main pinned specimens or with collections preserved in alcohol.

For material stored in alcohol

The procedures explained below apply to alcohol collections stored in vial racks as in the CNC (Fig. 5). The main advantage of this system is the possibility of retrieving single vials very quickly, much faster than when vials are stored together in large jars filled with alcohol.

The vial rack system also offers the possibility of keeping the material mounted on slides (abdomen of Ephemeroptera, Plecoptera, Chironomidae; mandibles of larvae; various appendages for compound microscope study, etc...) side by side with the associated specimens preserved in alcohol. The curation of slide-mounted material within the vial rack is less expensive than the purchase of separate slide cabinets. The MLS slide boxes prove again to be excellent for the curation of this kind of slide-mounted material, provided it is completely dried, otherwise drifting of cover slips is very likely to happen.

The slide-mounted material is properly separated, associated with the specimens preserved in alcohol and placed in slide boxes. The original specimens preserved in alcohol are placed first in the vial rack, followed by the slide box with the proper associated slide mounted parts. The slide boxes, 2 mm thinner than the diameter of 3 dram vials (18 mm) utilized in the CNC, fit perfectly in racks. Again, labels of the slides can be read directly through the sides of the slide boxes.

CONCLUSION

Not only are the new MLS slide boxes durable, safe, and inexpensive, but their use allows the incorporation of slide mounted material with main pinned or alcohol collections. At the same time, the elimination or the simplification of the code systems reduces the risk of future confusion. Finally, the side by side arrangement of original specimens and their slide mounted dissected parts provides the fastest way to retrieve both.

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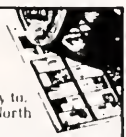

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ENTOMOLOGICAL NEWS

100TH ANNIVERSARY ISSUE

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OUR CENTENNIAL NUMBER

With this issue, *Entomological News* completes its 100th year of publishing papers of significance in the science of entomology. One has only to read the paper in this issue by Lewis P. Kelsey, a past president of this society, on taxonomic papers and descriptions of new species and other taxa published in these pages over the years, to realize the great number of important contributions this journal has made to both the science and literature of entomology.

Another paper relates some of the early history of *Entomological News* and discusses North American entomological societies and their publications in 1890, the year *Entomological News* was founded. This was prepared by William H. Day, another past president of the society.

As the current editor of *Entomological News,* I thought it might be interesting to dig back through past issues, as Lew Kelsey has done for new taxa, to look into the founding and editorial history of this journal over the past 100 years. This revealed the interesting fact that for 78 years in the 100 year history of *Entomological News*, this journal was edited by just three early and outstanding entomologists: Henry Skinner, Philip Calvert, and Rudolph Schmieder. What a tremendous contribution these three made to this journal, to our society, and, through the pages of this journal, to the science of entomology.

I commend your attention to three other papers of historic interest. One concerns a little known and short lived, but nevertheless significant, early publication of The American Entomological Society, *The Practical Entomologist*. This was the very first journal on economic entomology published in North America. The paper is a fine contribution from Carol A. Shepard.

The second paper is a report of a visit by Theodore Spilman to the New Harmony, Indiana home of Thomas Say, one of the founders of The Academy of Natural Sciences of Philadelphia. This is an amazing story of the discovery of the present location and use of the white marble slab on which Thomas Say's epitath is incised. I suggest that here is a challenge and an opportunity to rescue, preserve, and properly display a valuable artifact of early entomological and Academy memorabilia.

The third paper, contributed by Kenneth W. Cooper, recalls a determination error made by George H. Horn, an early president, for 16 years, of The American Entomological Society. Horn's initial error in determination of the world's largest bostrichid beetle, misleading information regarding its type locality, and subsequent character defamation of its discoverer, William G. Wright is an intriguing tale of error, misinformation, and pursuit, almost as good as a murder mystery.

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In conclusion, I wish to express my appreciation for the honor and priviledge of serving as the current editor of *Entomological News* over the past 15 plus years. It is a challenging and rewarding experience which I hope to be able to continue for many years to come.

- H.P.B.

LEWIS P. KELSEY

Lewis Preston Kelsey died at his home in Boyertown, PA on Oct. 8, 1989. He had been suffering from a high fever for a few days and had called a physician who advised he come in right away for an examination. Lew continued to prepare his breakfast and apparently dropped dead in the middle of this preparation. He was found by his daughter about 2 hours later.

Lew was born in Kuling, China on July 1, 1914, the son of Dean L. and Rey Preston Kelsey. His father was director of the Kuling YMCA. When Lew was 12 years old his family returned to the USA. They settled in White Plains, NY and Lew graduated from Roosevelt High School in Yonkers, NY in 1933. He obtained a B.S. degree in Agronomy from Cornell University and worked as a Soil Scientist for the USDA in New York and Vermont from 1938-41 when he entered the Army Air Corps where he rose to the rank of Staff Sergeant. He served as a weather observer in the Middle East, Africa, and Europe. While in the service he married Nancy McGilvray of Brooklyn, NY who was serving as a Sergeant in the WAC.

After the war Lew taught Pomology at the NY State College at Cobleskill. At that time he also began graduate work in Entomology at Cornell where he was awarded the M.S. and Ph.D. degrees in 1950 and 1954 respectively.

He was appointed Assistant Professor of Entomology at the University of Delaware in 1955 and had progressed to Professor by the time he retired in 1979.

Lew produced numerous scientific publications, the most notable of which were a Cornell memoir on the morphology of the dobsonfly or hellgrammite, and a Smithsonian monograph on the scenopinid flies of the world. He was the world's authority on that family of flies and continued working with them after he retired in 1979. Specimens from museums in many countries around the globe were sent to him for confirmation and/or identification. He was a gifted illustrator, a fact which clearly shows in his publications on the scenopinids.

Lew was a long time enthusiastic and dedicated member of the Lions Clubs in Newark, DE and Boyertown, PA. He served as President in the Boyertown, PA Lions Club. He assembled an impressive collection of stamps and had a remarkable series of entomological stamps from around the world. In addition, Lew was an excellent carpenter and a master gardener, especially raising chrysanthemums which won top prizes at shows in the middle Atlantic States.

He was a member of Alpha Zeta, Phi Beta Kappa, and Sigma XI, and had been an active member and past President of the American Entomological Society. He was also a member of the Entomological Society of America.

His wife died a few years before Lew. He is survived by his daughter Barbara, wife of George Gibson of Boyertown, and by a brother, a sister, and one granddaughter.

- Dale F. Bray,
Emeritus Professor of Entomology,
University of Delaware, Newark, DE

100 YEARS OF CONTRIBUTIONS TO THE SCIENCE AND LITERATURE OF ENTOMOLOGY THROUGH THE PAGES OF *ENTOMOLOGICAL NEWS*

Lewis P. Kelsey[1]

ABSTRACT: Featured contributions from the early years of *Entomological News* are reviewed. Totals of new taxa described over the past 100 years are presented and tabulated. Of 4372 new species described, the greatest number were Diptera (1230 or 28%) followed by Hymenoptera (755 or 17%), Lepidoptera (609 or 14%), and Coleoptera (483 or 11%). In addition, 362 new genera were described as well as four new families.

While discussing topics that might be included in a centennial issue of *Entomological News,* members of the (executive) council of The American Entomological Society felt it would be very interesting to know what impact *Ent. News* has had in the publications of new species over the past 100 years.

Being one of the few retired members of the council, this author agreed, with some trepidation, to undertake this review. It isn't often that one has the time, inclination, or opportunity to review 100 years of a publication!

In addition, after reading the lead editorial in Vol. I, No. 1, I became interested in seeing how well the several editors of *Ent. News* had adhered to its originally announced goals. It soon became quite evident that the editors wished to provide a service to lay persons who were interested in insects.

A careful review of the first ten years of *Entomological News* has produced a number of interesting points, especially when comparisons are made with current issues of the journal. Factually, the average number of pages per annual volume over the initial ten years was 280, or 28 pages per issue. Of these, slightly over half, or from 14 to 17 pages contained papers submitted by entomologist authors. The number of these in each issue varied from five to eight brief papers averaging two or slightly over two pages in length. Many, if not most, of these were in the form of brief notes and reports of field activities and observations rather than the result of extended research. There were a limited number of descriptions of new taxa, most of which were rather limited in scope as was the practice in those early years. Among the many well known entomologists who published rather frequently in *Ent. News* during those early years were: Philip P. Calvert, T.D.A. Cockerell, W.J. Holland, George H. Horn,

[1]Past president, The American Entomological Society; Emeritus Professor of Entomology, University of Delaware.

Henry Skinner, Annie Trumbull Slosson, J.B. Smith, and H.F. Wickham.

Some indication of the level of information offered in the earliest issues of this journal may be deduced from an interesting series of ten short and very rudimentary papers on the basics of entomology and the relationships of the orders. These were entitled "Elementary Entomology" and were signed by "P.P.C." (Philip P. Calvert). These were based on excerpts from Comstock's "Introduction to Entomology" and Packard's "Entomology for Beginners". This series first appeared in the May 1890 issue under the title. "What is an Insect". In succeeding issues, other titles which followed were "The General Structure of Insects", "Regions and Appendages of Insects: The Moveable Parts of the Head", "The Thorax, the Legs", "The Wings", "The Abdomen - Internal Anatomy", "Internal Anatomy (concluded)", "Classification of Insects", and "The Orders of Insects". The total pagination for all ten papers was only 28 pages - surely an elementary course! Following these initial papers, the series was continued under the same overall title of Elementary Entomology and was expanded to cover other subjects authored by different individuals.

Beginning in September, 1892, a new feature appeared entitled "Notes on Economic Entomology" edited by Prof. John B. Smith, Sc.D., Rutgers University, New Brunswick, NJ. This feature, which averaged between two and one half to three pages per issue and continued with some irregularity through Vol.14, 1903, discussed pertinent pest problems and suggested control measures. This, together with the early publication of the *Practical Entomologist* (Shepard, this issue), is clear evidence of the concerns of these early and forward-looking entomologists about the practical applications of their knowledge in the field of economic entomology.

In marked contrast with today's *Entomological News,* nearly one half, or from 11 to 14 pages of each issue were devoted to several continuing features, chief of which were four to five pages in each issue listing and reviewing recent entomological literature, including serial journals as well as books, from all around the world. This became so voluminous, however, that after Vol. 7, only subject matter was included, and after Vol. 13, only major works were reviewed. Beginning with Vol. 21, references were listed by source, author, and subject under general topics or orders. Beginning with Vol. 39, a numbered list of periodicals was presented once or twice a year and references carried the number rather than the title of the periodical. When this service was discontinued at the end of Vol. 69 (1958), over 160 periodicals were being reviewed. This service enabled readers without ready access to large entomological libraries to keep up on topics of interest in their particular fields of interest.

Another feature was the publication of minutes and reports of activities of entomological societies, clubs, and socials so as to acquaint readers with the activities of entomologists in other parts of the country and the world. Two to three pages were called "Notes and News" and contained "Entomological Gleanings from all quarters of the Globe". Another one and a half to two pages were titled "Doings from Societies" and carried reports of activities and events from entomological societies from around the country and the world. Societies most frequently included were The American Entomological Society, the associated Entomological Section of the Academy of Natural Sciences, the Feldman Collecting Society, the Newark (N.J.) Entomologists' Social, the Pacific Coast Entomological Society, the Chicago Entomological Club, the Entomological Society of Nova Scotia, the Florida Entomological Society, Ohio Entomologists, Kansas Entomological Society, and the Rocky Mountain Conference of Entomologists.

The country wide and even world wide coverage of these features, coupled with the name change of the society from The Entomological Society of Philadelphia to The American Entomological Society that had taken place on February 23, 1867, provides substance to the suspicion that at least some of these early entomologists had aspirations (visions?) of becoming more than just a local entomological society! This suspicion is further substantiated with knowledge of the joint meeting of the Association of Economic Entomologists, the Entomological Section of the Academy, The American Entomological Society, and the Feldman Collecting Social held at the Academy of Natural Sciences of Philadelphia on December 29, 1904, to discuss the desirability of organizing a national entomological society. The result of this and subsequent meetings was the formation, in 1906, of the present Entomological Society of America.

In general, *Entomological News,* during its first decade, seems to have served as a clearing house for correspondence and subscribers. A couple of other early but short lived features entitled "Queries and Answers" and "Identification of Insects for Subscribers" appear to have been purposeful efforts to stimulate this exchange and, of course, circulation. In both regards, Dr. Skinner and the journal achieved real success, for circulation reached 550 by 1898, not bad for a limited audience journal that started from scratch, only nine years earlier!

Just for a moment, it may be interesting to contrast some of the above figures with today's *Entomological News.* Today, each issue consists mainly of papers submitted by authors. The number of papers in each double (two month) issue averages about ten. Fifty percent of these papers range from three to five pages in length, 85% range from two to seven pages, and eight percent are eight or more pages in length. Today,

all papers are submitted to two authorities in their respective field for peer review, a policy that had not been consistently followed prior to its application in 1978 by our current editor, Howard Boyd. The only continuing features in *Ent. News* today are the excellent reports of meetings of The American Entomological Society currently written by the society's corresponding secretary, Harold B. White, and books received and briefly noted along with occasional book reviews. Current circulation is nearly 750.

Following are the results (see Table 1) of the count of the descriptions of new species, genera, and families, in ten year increments, that have been published in the pages of *Entomological News* over the past 100 years. No descriptions of subspecies, forms, varieties, or aberrations were counted although I estimate there may have been between 750 to 1000 of these. In total, 4372 new species, 362 new genera, and four new families were described. Over the past 15 to 20 years there have been fewer new species described but there have been numerous papers with redescriptions using newer descriptive techniques, genitalia studies, and electron microscope illustrations of diagnostic characters not available

Table 1. New species and new genera described in *Entomological News*, Vols. 1 - 100, 1890 - 1989.

Volumes	Odonata	Orthoptera	Hemiptera	Homoptera	Coleoptera	Lepidoptera	Diptera	Hymenoptera	Arachnida	Other orders, Diplopoda, Myriapoda	Total new species	New genera**
1- 10	4	8	4	25	20	223	60	111	8	20	483	30
11- 20	16	38	26	31	61	135	99	216	11	44	677	60
21- 30	19	29	47	62	76	136	249	198	27	56	899	86
31- 40	12	6*	82	9	74	60	198	40	34	32	547	34
41- 50	2	4	8	22	94	11	89	28	5	14	277	24
51- 60	4	0	11	35	54	15	143	20	6	80*	368	36
61- 70	9*	0	17	18	29	12	113	51	11	67	327	29
71- 80	0	7	13	18	34	13	171	64	35*	85	440	44
81- 90	0	8	19	20	21	4	90	11	19	16	208	13
91-100	0	2	13	37	20	0	18	16	2	38	146	6
Totals	66	102	240	277	483	609	1230	755	158	452	4372	362
Percent	2	2	6	6	11	14	28	17	4	10	100	

*New family described in addition to new species.
**New genera figures in addition to new species; not included in species figures.

or used by earlier authors. There have also been numerous papers dealing with reassignments to different genera, listings of synonymies, and *nomen nudum* by authors working on monographic studies, many of these by workers at the U.S. National Museum (Smithsonian Institution) and the Insect Identification section of the U.S.D.A.

It seems clear to me that over the past century the editors of *Entomological News* have generally followed the guidelines published in Vol. 1. As a result, *Entomological News* has made a significant contribution to both the science and literature of entomology and it continues to be a leading journal in which to publish short taxonomic papers.

Ed. note: The above compilation was completed and paper written a short while before the recent death of the author. Thus, it is being published posthumously. Please see the obituary for Lewis P. Kelsey on page 194.

SOCIETY MEETING OF OCTOBER 25, 1989

BIOLOGICAL CONTROL OF EUONYMUS SCALE

By Dr. Robert Hendrickson

At one time in the Delaware Valley, Euonymus was a common ornamental shrub. That changed as the plants were attacked by the Euonymus scale, *Uraspis euonymi*, an immigrant scale insect that causes discoloration, defoliation and sometimes death. Frustrated by a choice between spraying insecticides or having unsightly plants, many home owners instead removed the plants. Nurseries no longer supply susceptible species. Dr. Robert Hendrickson of the USDA Beneficial Insects Laboratory in Newark, Delaware has worked on the control of Euonymus scale and reported that the scale can be successfully controlled by a couple of coccinellid beetles, *Chilocorus kuwanae* and *Cybocephalus nipponicus*, introduced from the Orient by the USDA.

Chilocorus is about 6mm long and easy to handle in the field. *Cybocephalus*, on the other hand, is extremely difficult to work with according to Dr. Hendrickson. These scale predators are very small, only about 1mm long, and they feed and develop under the scale covers where they can't be seen. Natural dispersal of a few km per year at best has been augmented by tedious field capture and release in new areas for both species. Where they have become established, they may provide almost complete control. For example, The National Arboretum in Washington D.C. had a large collection of Euonymus that was under attack a few years ago. Now it is difficult to find a single scale there. This success story has been repeated elsewhere in the 9 states where the beetles have become established. In the future some of the more attractive but scale-prone Euonymus species may once again become common residential shrubs as a result of the work of Dr. Hendrickson and his associates.

Before Dr. Hendrickson's talk the 12 members and 3 guests at the University of Delaware meeting discussed the merits of making the Monarch Butterfly the national insect. There was considerable support for the idea. Among the points made were the Monarch's wide distribution, its familiarity to the public, its beauty and its interesting biology.

- Harold B. White,
Corresponding Secretary

NORTH AMERICAN ENTOMOLOGICAL SOCIETIES AND THEIR PUBLICATIONS IN 1890 AND THE EARLY *ENTOMOLOGICAL NEWS*

W.H. Day[1]

ABSTRACT: On the 100th anniversary of *Entomological News,* it is noteworthy that only four North American entomological journals have been published without interruption for a longer period. The *News* was intended for short papers and newsworthy items, such as reports of meetings of numerous societies, new literature citations, obituaries, reviews of basic entomology, economic entomology, and other related subjects. The new journal contained articles by most well-known entomologists of the day, and its circulation steadily increased.

Entomological News has been of service to entomologists since the first issue in 1890. Only four entomological journals in North America that have been published continuously are older. The 100th anniversary of the *News* provides an opportunity to review the state of entomology, especially its societies and journals, at the time the *News* was organized.

By 1890, the United States had experienced 40 years of unparalleled expansion. The western territories had been opened for settlement and the population had tripled (aided by 17 million immigrants) to 63 million (Hambidge, 1940), while railroads proliferated, accelerating the movement of agricultural products, manufactured items, and people. Two-thirds of the population was engaged in agricultural production (Hambidge, 1940), and crop losses caused by insects were frequent and often severe. Consequently, interest in scientific agriculture and entomology grew rapidly.

Entomological Societies

At the time *Entomological News* was initiated, there were six entomological societies in North America that produced serial journals (Table 1). Five of these were in the United States. All except the American Association of Economic Entomologists, and perhaps the Entomological Society of Canada, were organized and operated by amateur and professional entomologists who lived in the general area of their Society's headquarters. This is still the case today; only a few organizations are large enough to afford a central administrative staff for routine activities, and the travel costs for board members from distant points so they can meet regularly for policy decisions.

Most or all of the original entomological societies had some mem-

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bers from outside the immediate area, and some also had a small number of residents in other countries. Persons in these two groups were often referred to as "corresponding" members, to differentiate them from the local, "resident" members. It is interesting that at least some individuals were members of two or more societies well before the turn of the century, and that many occasionally attended meetings in distant cities. Such travel by train, for distances up to 200 or 300 miles, did not require more time than travel today does by air or car.

It is a little-known fact that the present Entomological Society of America, now the largest organization of entomologists in the hemisphere, had its beginnings in 1904, in Philadelphia. It was organized during joint meetings of the American Entomological Society, the related Feldman Collecting Social, and Entomological Section of the Academy of Natural Sciences of Philadelphia, together with the association of Economic Entomologists and the Entomological Club of the American Association for the Advancement of Science (Allen, 1960).

The importance of Pennsylvania, particularly Philadelphia, in the early development of entomology in North America was recognized by Skinner (1911), who called this state "the cradle of entomology in America". He described the pioneering work in Pennsylvania by John Bartram in the mid-1700's; Thomas Say, F.V. and J.F. Melsheimer, and Titian Peale in the early 1800's; and E.T. Cresson, G.H. Horn, J.L. LeConte, and the American Entomological Society in the mid-1800's.

One feature that each of the early entomological societies had was a unique seal or emblem (Downey and Nelson, 1968). Nearly all included an insect, and were displayed on the covers of society publications. The American Entomological Society seal featured *Dynastes tityus* (L.), the very large "Hercules beetle", and the motto "*Festina lente*" (advance prudently).

Entomological Journals

At the time the first issue of *Entomological News* was published, there had been a total of ten entomological serials in North America, and five were still being printed (Table 2). This 50% survival rate is surprisingly high, considering that most societies did not have a large number of members and thus were not likely to have significant financial reserves, that all were operated by amateur publishers, and especially that this was done in "spare" time. Moreover, E.A. Schwarz (1891) stated that most American entomologists subscribe to few, if any, journals[2]. Despite this

[2]Presumably they used society or local museum libraries. Important entomological contributions were also being made in the 19th century by the developing federal and state experiment stations, as well as by agricultural newspapers and organizations (see Barnes (1985) for additional information).

low level of support, he concluded that the six serials of the day (including *Entomological News)* compared favorably with the 19 then published in Europe, considering the much larger (4-fold) population there, and the lower printing costs on the Continent.

It is also noteworthy that of the five entomological journals extant when the *News* was begun, four are still being produced, 100 years later (Table 2). This is evidence of the continuing great importance of insects to agriculture and man, as well as the wise guidance and unselfish support by the leaders and members of the parent societies.

The Early *Entomological News*

In the first issue of *Entomological News* in 1890, E.M. Aaron outlined some of the objectives of the new journal. In addition to scientific papers, it was to include "Notes and News", "Queries and Answers", "Exchanges", "Doings of Societies", and "Entomological Literature". Many of these subjects had been missing from American entomological literature since the demise of the *Bulletin of the Brooklyn Entomological Society, Papilio,* and *Entomologica Americana*, according to Osborn (1937). The usefulness of these sections to the many subscribers who were not close to a major entomological library, and to amateur entomologists, must have been considerable.

Although these sections might be considered to be of minor importance today, I suggest that reading them (and the accompanying editorials) provides a much deeper understanding of the personalities and the atmosphere of entomology in the past than does a review of scientific papers.

Aaron (1890) also indicated that the new journal would be enlarged and modified, as the subscribers desired. An obiturary section was added the first year, and steadily grew in size and scope. Although published articles provide a partial (though often scattered) record of the professional accomplishments of entomologists, it is an unfortunate fact that the lives of most entomologists are documented only after their death. Thus, obituaries are a prime source of information for historical studies, and this is evidenced by the large number of references to *Entomological News* obituaries in Wade (1928), Essig (1931), and Mallis (1971).

In the third year, an "Economic Entomology" section was added, under the editorship of John B. Smith of Rutgers. This was the second time that the American Entomological Society contributed to the literature on economic entomology, the first having been 27 years earlier, when *The Practical Entomologist* was initiated (see the article by Sheppard in this issue). This publication was the first serial published by an

entomological society in the Western Hemisphere to deal with economic entomology.

It appears that the *News* was the first entomological periodical (Skinner, 1900) to publish a photograph by the then new "half-tone" process (January 1891). This was the first economical means of printing photographs; the cost was about 20% of reproducing line drawings by lithography. The first color *News* illustration, using the 3-color method, appeared in the April 1900 issue.

Many of the well-known entomologists of the day published in the *News*, from the first issue. Although several were local American Entomological Society members, such as Calvert, Cresson, Fox, Horn, and Skinner — most contributors were from other areas, including Ashmead, Blatchley, Beutenmuller, Blaisdell, Cockerell, Davis, Dyar, Edwards, Gillette, Holland, Jones, Lugger, Osborn, Slosson, Townsend, Weed, Van Duzee, and Williston.

The editor (Skinner, 1891) emphasized his desire to provide material of interest to all subscribers, from amateurs and students to teachers, professors, and researchers. Short discourses (based on Comstock's and Packard's texts) on morphology, biology, classification, and other basic subjects were added, as well as insect poems, jokes, anecdotes from newspapers (some of which were obvious exaggerations), an insect identification service, and even articles with a philosophical or religious slant. This broad approach evidently was effective, for the *News'* circulation reached 550 copies before its 10th anniversary (Skinner 1898), and the size of each volume increased from 168 to 500 pages before its 20th year (Allen, 1960).

Entomological News has continued to thrive, despite competition from an increasing number of entomological and natural science publications. This success is the result of several factors, the most important of which are a long series of able and enthusiastic editors, the strong financial backing by the parent society, a willingness to evolve to suit changing conditions, and bequests by several committed society members. I trust that the *News* will still be an important part of American entomology for the next 100 years!

Table 1. Chronology of Entomological Societies[a]

No.	Founded	Society	Operating in 1890[c]
1.	1859[b]	American Entomological Society ("AES") (until 1866 known as Ent. Soc. of Philadelphia)	+
2.	1863	Entomological Society of Canada (1871-1949 known as Ent. Soc. of Ontario)	+
3.	1872	Brooklyn (N.Y.) Entomological Society	+
4.	1874	Cambridge (Mass.) Entomological Club	+
5.	1880	New York Entomological Club (predecessor of no.8; ceased operations in 1885)	
6.	1884	Entomological Society of Washington (D.C.)	+
7.	1889	American Association of Economic Entomologists	+
8.	1892	New York Entomological Society	
9.	1901	Pacific Coast Entomological Society	
10.	1904	Hawaiian Entomological Society	
11.	1906	Entomological Society of America (also name of joint society formed by this society and no. 7 in 1953)	

[a]This list includes only organizations which published serial journals, and that were organized prior to 1908, fifty years after the AES was founded.

[b]Erroneously listed as "1958" in Downey & Nelson (1968).

[c]The year that *Entomological News* was first published.

Some of the above data are from Sabrosky (1956), and all entries have been checked against this excellent reference.

Table 2. Chronology of Serial Entomological Journals

No.	Date[a]	Journal	Society	Longevity ranking[c]
1.	1861-	Transactions American Entomological Society (1861-67 as Proceedings Entomol. Soc. Philadelphia)	American Entomol. Society	1
2.	1865-67	Practical Entomologist	American Entomol. Society	-
3.	1868-	Canadian Entomologist	Entomological Soc. of Canada[b]	2
4.	1874-	Psyche	Cambridge (Mass.) Entomol. Club	3
5.	1878-85	Bulletin Brooklyn Entomol. Society (reinstated in 1912)	Brooklyn Entomol. Society	-
6.	1881-85	Papilio (merged in 1885 with no. 8)	New York Entomol. Club	-
7.	1884-	Proceedings Entomol. Society Washington	Entomol. Soc. Wash.	4
8.	1885-90	Entomologica Americana (reinstated in 1926)	Brooklyn Entomol. Society	-
9.	1889-1906	Proc. Amer. Assoc. Econ. Entomol. (succeeded by no. 14)	Amer. Assoc. of Econ. Entomologists	-
10.	1890-	Entomological News	Amer. Entomol. Soc.	5
11.	1893-	J. New York Entomol. Society	New York Entomol. Society	6
12.	1901-30	Proc. Pacific Coast Entomol. Society	Pacific Coast Entomol. Society	-
13.	1906-	Proceedings Hawaiian Entomol. Society	Hawaiian Entomol. Society	7
14.	1908-	Journal of Economic Entomol.	Amer. Assoc. Econ. Entomol., to 1952; Entomol. Soc. Amer., 1953-	8
15.	1908-	Annals Entomol. Soc. America	Entomol. Soc. Amer.	8

[a]If begun by 1908.

[b]By Entomological Society of Ontario, 1871-1949.

[c]If published to present without interruption.

Some of the above data are from Sabrosky (1956), and all entries have been checked against this comprehensive reference.

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THE BIRTH OF *ENTOMOLOGICAL NEWS* AND A CENTURY OF EDITORS

Howard P. Boyd[1]

ABSTRACT: Circumstances leading to the establishment of *Entomological News* are recounted and the chronology of early editorships is traced. Three early entomologists, Drs. Skinner, Calvert, and Schmieder, combined, served as editors of *Entomological News* for 78 years of its 100 year history.

As has been previously published, most recently in the September-October 1984 issue of *Entomological News* that was devoted to the 125th anniversary of The American Entomological Society (Boyd, 1984), when The American Entomological Society reached agreement with the Academy of Natural Sciences of Philadelphia, on December 17, 1875, to meet at and occupy quarters within the academy's building, a part of that agreement was that the members of the society would form and constitute the entomological section of the academy. Thus it was at a meeting of the Entomological Section of the Academy, on October 24, 1889, that Eugene M. Aaron moved that "this section shall, beginning with January 1890, publish its proceedings, and such short notes as may be offered, at or near the first of each month, that all matters pertaining to this journal be referred to the entire publication committee, with full powers". That publication committee consisted of Ezra T. Cresson, Charles A. Blake, and Benjamin H. Smith representing The American Entomological Society, and Henry Skinner and Philip Laurent representing the Entomological Section of the Academy.

At a subsequent meeting on November 28, 1889, the publication committee further considered the matter and decided that such a publication, if properly, wisely, and economically managed, could be maintained and could become a useful and valuable adjunct to both the section and the society. It was proposed and decided that this new publication would consist of at least 160 pages annually, to be published in ten monthly parts, except July and August, to be of uniform size with the *Transactions* of the society, with the title "*Entomological News and Proceedings of the Entomological Section of the Academy of Natural Sciences of Philadelphia*". The subscription price was set at one dollar per annum but it was to be

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free to members and associates of the section. Expenses were to be met by receipts from subscriptions and advertisements plus whatever sum the section could appropriate from its funds, with the understanding that any deficit would be met by a contribution, not to exceed $100 per annum, from the funds available to the publication committee of the society. This new publication was to be under the management of the joint publication committee of the section and the society and this joint committee would elect an editor and an advisory committee of four persons to conduct the publication. At this same November 28 meeting, Aaron was elected editor of the new journal to begin publication in January, 1890, E.T. Cresson was elected treasurer, and George H. Horn, E.T. Cresson, and Henry Skinner constituted the advisory committee. Dr. Horn moved that the section be asked to allow Philip P. Calvert to associate with them. Other interesting details concerning these two meetings and a third meeting on December 9, 1889, are reviewed under the title, "In Retrospect", in the July, and continued in the November, 1943 issues of *Entomological News* by Ezra T. Cresson, Jr. (Cresson, 1943).

In the lead announcement on pages 1-3 of the initial issue, Vol. I, No. 1, mailed on January 15, 1890, editor Aaron stated that "the Entomological Section of the Academy of Natural Sciences of Philadelphia, with the cooperation and financial aid of The American Entomological Society, have decided to publish, begining with this number, a journal...." From all of the above, it is clear that, although technically, at least on paper, *Entomological News* was initiated as an academy publication, in reality it actually was a joint operation of both the academy and the society. Certainly members of The American Entomological Society, most notably Philip P. Calvert, Ezra T. Cresson, George H. Horn and Henry Skinner accepted and executed major responsibilities and the society itself guaranteed at least part of the necessary financial backing for this new journal. This arrangement continued for the first 35 years that *Ent. News* was published, until the sectional organization of the academy was abolished in 1924, following which *Ent. News* officially became a wholly society publication without any formal announcement other than cover and masthead name changes.

Aaron's tenure as the journal's initial editor was very brief. He authored the announcement on pages 1-3 of Vol. I, No. 1, but he served as editor for only the first two issues, January and February 1890. Following this, Henry Skinner (M.D.) took over as editor for the March 1890 and subsequent issues. Even though Aaron apparently edited the first two

issues, the title or cover page for Vol. I, 1890, credits Henry Skinner as editor for the entire volume year.

Starting in May of 1892, Skinner wrote a series of interesting editorials, usually one to one and a half pages in length, most of which addressed pertinent entomological matters or issues of the day. His first editorial was entitled "Entomological Rubbish" and was on the subject of the proper and improper methods of pinning and mounting specimens, and on the proper sizes of pins. Another editorial, in the April 1893 issue, reviewed publication policies of the journal, such as the fact that *Entomological News* was for papers too short to be accepted in the *Transactions*, that papers should be limited to two printed pages, and that papers would be printed in the order in which they were received, policies that, except for the two page limitation, are still in place today. In the September, 1982 issue, he editorialized humorously on the trials and tribulations of an editor processing poorly written manuscripts from authors.

Skinner continued as editor until he resigned on October 12, 1910, to become effective December 15, 1910, he thus having served, according to his own statement, a total of 21 years. His letter of resignation was published in Vol. XXI, No. 1, January, 1911 issue of *Entomological News*. He then was appointed editor emeritus and Philip P. Calvert, who had served as associate editor since January, 1893, was appointed editor and Ezra T. Cresson, Jr. associate editor. Skinner continued as editor emeritus until his death, at age 65, on May 29, 1926. Skinner justifiably believed that during his tenure as editor, *Entomological News* had weathered its "nursery period" and had come "of age". Without question, Skinner set the stage for the future success of the journal and was the first of three outstanding editors to have served *Entomological News* over its long history.

The second of the early editorial giants was Philip P. Calvert who served as editor of *Entomological News* for 33 years, much longer than any other editor in its history. Having served as associate editor from 1893 to 1910, and then as editor from 1911 to 1943, a total of 51 years, no other individual contributed so much to the long term success of *Entomological News*. When he resigned his editorship, it was stated that for 33 years he had "been seasoning the *News* with his own particular flavor which in terms of the kitchen we might describe as well salted, with a judicious use of pepper. The pepper may have caused an eye to smart now and again but we think the consensus of opinion is that the flavor has been agreeable." (*Ent. News.* 1944 LV (1) pg. 2)

It was during his tenure as editor that *Entomological News* officially became a publication of The American Entomological Society, in 1925, upon the dissolution of the sectional organization of the Academy of Natural Sciences of Philadelphia in 1924. Dr. Calvert submitted his resignation as editor on September 29, 1943 and this was accepted on October 28, 1943, at which time he was elected editor emeritus (see *Ent. News*, Vol. LV, No. 1, January 1944). He continued as editor emeritus until his death, at age 90, on August 23, 1961.

Following the resignation of Dr. Calvert as editor, it is no wonder that, apparently, no one was willing to try to step into his shoes so, beginning in January 1944, the publication committee of the society decided to continue the editorship in the hands of the editorial board and named A. Glenn Richards and Rudolph G. Schmieder as co-editors. However, the masthead for all issues of the journal for the next three years, from January 1944 through December 1946, carried the name of Dr. Calvert as editor emeritus, followed by a mere listing, in alphabetical order, of E.T. Cresson, Jr., E.J.F. Marx, J.A.G. Rehn, A.G. Richards, and R.G. Schmieder as members of the editorial staff without the designation of any individual(s) as actual editor(s) or co-editor(s). In contradiction to this, however, in a memorial biography of Dr. Schmieder, published in the March 1968 issue of *Entomological News*, Schmieder is credited with having been editor beginning in 1945. In any event, beginning with the January 1947 issue, without any textual announcement, the name of Rudolph G. Schmieder appears as editor of *Entomological News*.

Dr. Schmieder was the third and last of the three early giants in the editorship history of *Entomological News*. Between the three of them, Skinner, Calvert, and Schmieder, they covered and accounted for 78 of the current 100 year editorial history of the journal. As stated in his memorial biography, Schmieder's "greatest service to the society lay in his meticulous editing of the *News* for many years, with no return except the personal satisfaction of a somewhat onerous task well done". He continued to serve as editor right up until his sudden passing, at age 69, on August 23, 1967.

Editorship since the passing of Dr. Schmieder is modern history and needs no elaboration. Subsequent editors have been Ross H. Arnett, Jr., Robert W. Lake, and Howard P. Boyd. These are included in Table 1.

Table 1. Editors of *Entomological News*

Editor	Tenure[a]	Period[a]
Aaron	1890 (Jan. & Feb.) (#'s 1 & 2)	2 mos.
Skinner	1890 - 1910	20 yrs., 10 mos. or 21 yrs.
Calvert	1911 - 1943	33 yrs.
Editorial staff with Richards & Schmieder as co-editors	1944 only or 1944 - 1946	1 yr. or 3 yrs.
Schmieder	1945 or 1947 - 8/1967	24 yrs., 10 mos or 22 yrs., 10 mos.
Arnett	11/1967 - 8/1972	5 yrs., 2 mos.
Lake	1973 - 4/1974	1 yr., 4 mos.
Boyd	5/1974 - present	15 yrs., 8 mos. (to date)

[a]Available records often do not agree on exact dates.

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A BRIEF HISTORY OF *THE PRACTICAL ENTOMOLOGIST* AND ITS CONTRIBUTIONS TO ECONOMIC ENTOMOLOGY

Carol Anelli Sheppard[1]

In August, 1865, The Entomological Society of Philadelphia (progenitor of The American Entomological Society) passed a motion permitting its publication commitee to issue a monthly journal on "popular" entomology[1]*. Envisaged as a means to "bring two classes of men, the scientific and the practical, in closer communication," *The Practical Entomologist* would, as such, help dispel the notion that "scientific men are not sufficiently practical, and that practical men are not sufficiently scientific" (Ennis *et al.* 1865). Since the society owned and operated the printing press used to publish its *Proceedings*[2], which addressed a more scientific audience, they reasoned that publication of the new periodical would not present an undue burden. Income generated from advertisements would defray publication costs; scientific contributions would emanate from entomologists throughout the United States, who would "most cheerfully lend their gratutious aid," since "it is the happiness of this class of men to contribute their knowledge for the welfare of humanity" (Ennis *et al.* 1865).

Distinguished as the first U.S. journal devoted to economic entomology, *The Practical Entomologist* began publication October 30, 1865. Curiously, the editorial staff was not cited until the third issue, when Ezra T. Cresson, James W. McAllister and Augustus R. Grote were named as editors, with Benjamin D. Walsh serving as associate editor[3]. In an article entitled "Introductory," which appeared in the first issue, the editors denounced the majority of insecticidal "decoctions and washes," labeling them "as useless in application as they are ridiculous in composition." Whereas contemporary agricultural journals often advocated the use of such remedies, *The Practical Entomologist* offered an alternative approach to insect control:

> "The enquiring Agriculturist who reads this Bulletin must not expect to find recommended any peculiar brew... as specific for any one or all of our insect enemies. He will find, however,... that the real conditions of life and the transformations of each species... will be faithfully recorded for his information... and that he will be enabled from the information thus obtained, to determine at what period of

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*Numerical superscripts refer to annotations to the text at the end of this paper.

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the insect's life the greatest quantities can be most readily destroyed by the simplest means." (Anonymous, 1865a)

Generally written in a straightforward manner that kept scientific jargon to a minimum, *The Practical Entomologist* published brief articles related to insect pests and their identification, natural history and means of control. The journal's intended audience comprised agriculturists and horticulturists, as evidenced by the preponderance of advertisements for nurseries, seedhouses, farm implements and periodicals, *e.g., Prairie Farmer, American Bee Journal and Bee Gazette,* and the nascent *American Naturalist*[4]. However, at least some scientists gleaned information from *The Practical Entomologist,* since Walsh, who became its sole editor with Volume II, occasionally sent the journal to his correspondents, the most illustrious among them being Charles Darwin.

Walsh sent Darwin[5] the first issue of the journal, in which his article on the Colorado potato beetle appeared (Walsh 1865a, discussed below), and his subsequent article on introduced insects in the U.S. (Walsh 1866a), of which Darwin said, "[it] interested me greatly and seemed very well done."[6] In his book, *The Descent of Man,* Darwin (1896) cited Walsh's comments, published in *The Practical Entomologist,* concerning sexual dimorphism in the mandibles of corydalids and lucanids[7], the tarsi of carabids and the abdominal appendages of dragonflies[8]. Baron C. R. von Osten-Sacken also was pleased to receive the periodical from Walsh.[9]

While the majority of articles in *The Practical Entomologist* were original, excerpts from *Treatise on Injurious Insects,* written by the German naturalist Vincent Köllar, often appeared in the earlier numbers[10]. A few publications of Asa Fitch, first New York state entomologist, were likewise extracted[11]. Among the notable entomologists who published in the journal were A.R. Grote (1865, 1866), A.S. Packard (1865, 1866a-c), C.V. Riley (1866) and, as mentioned, B.D. Walsh, who published over 100 articles and essays[12] in the journal (Henshaw 1889).

Because of his prodigious contributions, Walsh's stylistic and substantive influence pervade the journal. Through his often trenchant essays, readers were disabused of entomological misnomers (*e.g.,* "The three so-called army-worms"), misconceptions ("Borers — the plum-ugly theory") and misinformation ("Entomology run mad"; "A mass of mistakes") (Walsh 1867a-d). The promotion of scientific fallacies ignited Walsh's ire, as illustrated by his reaction to a Maryland man, who proposed to sell his Hessian fly control method for $100 per county despite his patent ignorance of its natural history:

". . . one chief reason why Entomology is in bad repute with the

> generality of Farmers, is that Scientific men usually shrink back from the disagreeable task of exposing such unmitigated humbugs as this precious [*sic*] Maryland scheme. And therefore, I have thought it good not to mince matters... If the paper for which I am writing, or I myself as an individual, come to grief in consequence, the more's the pity. I have an invincible dislike for pretentiousness and charlatanism in all its forms — especially when it proposes to bleed the American public to the amount of $360,000 for a bag of moonshine — and come what will of it, I am determined to express my own honest unbiased opinion on all such subjects." (Walsh 1866b)

A regular feature of the journal was its "Answers to Correspondents," which addressed questions and/or specimens sent from readers to the editors. Initially, Walsh was to have answered only inquiries from western correspondents (Anonymous 1865b), but he assumed full responsibility for the column six months after the journal's inception until its demise in October, 1867. Acting in this capacity, Walsh encountered problems familiar to today's taxonomists who perform service identifications:

> "Your insects arrived in miserable order. Of course if you pack eight glass vials loose in a box, without even wrapping up each in a separate paper, some of them will get broken on the road. Besides, some of your numbers, being marked with pencil on the corks of the vials, I cannot read with any certainty. Here follow the names of your insects, so far as I can name them, many being out of the vials and mashed up with broken glass." (Walsh 1866c)

As editor of *The Practical Entomologist,* Walsh called upon his entomological correspondents to contribute indirectly to the journal. For example, if unable to identify Diptera or Coleoptera sent him by readers, Walsh forwarded the specimens to Baron von Osten-Sacken or John LeConte, respectively, whose comments and/or determinations would then appear in print[13]. At times, these exchanges resulted in the description of new species[14], as was the case with the grape rootworm, *Fidia viticida* Walsh, a serious economic pest that could instead have borne LeConte's name. The latter had given the name, "*Fidia* undescribed," to a specimen sent him by Walsh in 1861; in November, 1866, Walsh wrote LeConte, reminding him of the insect, which had since been infesting cultivated grapevines in Kentucky and elsewhere. Walsh continued:

> "Now you once observed that insects must be properly named, in order that Farmers may anathematize them properly. Therefore, as

> this *Fidia* still lacks a specific name . . . I thought I would recommend him to your attention. In case you accept the charge, please send the results directed to me, including the name & the description if n. sp., and I will publish the same in the P.E. I could easily, of course, take the generic name & the fact of its being undescribed from your mouth, & publish a description myself, thereby acquiring all the *kudos* of describing a n. sp. But what you have done is more than half the battle, & therefore it is but fair that you should give your name to the species."[15]

Six months later, Walsh (1867e) published a description of *Fidia viticida* in *The Practical Entomologist*. Although reference is made to the new species in one of the three intervening extant letters from Walsh to LeConte[16], it is not revealed how it came to be named by Walsh[17]. Apparently no ill will resulted from the outcome, since their correspondence continued until 1869, the year of Walsh's death.

The apple maggot, *Rhagoletis pomonella* Walsh, is yet another insect of economic importance that readers of *The Practical Entomologist* brought to Walsh's attention. Aside from the substantial monetary losses attributed to this pest, current interest in the apple maggot surrounds its differentiation into host races on its major host plants, hawthorn and apple (Deihl and Bush 1984; McPheron *et al.* 1988). The formation of host races has been proposed as a mechanism of sympatric speciation (Bush 1975); the shift to a new host provides reproductive isolation without a period of geographic isolation. It is remarkable that Walsh, in discussing the apple maggot's host plant shift from wild hawthorn to introduced apple, postulated that the new species arose in sympatry *via* what he termed "phytophagic isolation"[18].

Perhaps the most pedagogical articles published in *The Practical Entomologist* were the series of three entomological lessons written by A.S. Packard (1866a-c), in which were discussed the classification, internal and external morphology and development of insects and related taxa. Walsh commented on the lessons in a letter to Osten-Sacken:

> "I fully agree with your opinion about Packard's articles on Entomology in the P.E. I long ago objected to them in letter to Cresson; and now that I have control of the paper, there will be no more of them."[19]

In all likelihood, Walsh considered Packard's subject matter inappropriate for the journal, since Walsh himself referred readers to his *Proceedings* publications when their queries required "scientific" rather than "practical" answers[20]. Similarly, in acknowledging a taxonomic

key that LeConte had prepared[21] at Walsh's request, the latter wrote:

> "I should have liked to have printed your whole letter to Cresson; but as the Practical Entomologist is obliged to be as "practical" as possible, I have been obliged to confine myself to the Analytical Table."[22]

In keeping with the "practical" format of the journal, Walsh also refrained from discussions of evolution in *The Practical Entomologist,* although he staunchly defended Darwin and elsewhere published evidence supporting his theory of species origin (C.A. Sheppard, manuscript in preparation).

One of the most famous articles published in *The Practical Entomologist* concerned the geographic spread of the Colorado potato beetle, *Leptinotarsa decemlineata* Say. According to the article, written by Walsh (1865a), the beetle was endemic to the eastern slopes of the Rocky Mountains, where it fed on native buffalo bur, *Solanum rostratum* Dun., until settlers to the area brought with them the potato, *Solanum tuberosum* L. Finding the cultivated plant palatable, the beetles allegedly moved eastward, "from potato patch to potato patch," the first report of heavy infestations originating from eastern Nebraska in 1859, followed by outbreaks in Iowa in 1861, and Illinois in 1864.

Casagrande (1985) recently refuted this scenario, in light of evidence that the beetle had been collected from the Iowa - Nebraska border as early as 1811, by Nuttall, and again by Say in 1819-20. As Casagrande (1985) points out, Walsh apparently was unaware of earlier collections of the beetle from that area[23], and thus, incorrectly interpreted the 1859 Nebraska infestation as the recent eastward movement of the beetle from Colorado; in fact, the beetle spread as a potato pest from Nebraska both eastward and westward (Casagrande, 1985).

To Walsh's credit, in an attempt to chronicle accurately the spread of the beetle, he obtained numerous "first appearance" reports from various periodicals[24] and sought information on the beetle's distribution from coleopterists:

> "It seems to me important, before the thing is forgotten, to collect & register as far as possible places & dates regarding this matter; & I have accordingly collected a considerable amount of evidence thereanent[25], & am writing to my correspondents for more. Will you oblige me by contributing into the general stock what you know yourself on the subject? I write to Ulke[26] by this mail."[27].

Throughout its two year duration, the scope of *The Practical Entomologist* remained true to its title, but occasionally a political article or

two peppered its pages. When Townend Glover, first USDA entomologist, reported that his duties were not restricted to insects, but also included preserving and arranging "all the objects of general natural history, such as insectivorous birds, specimens of fruits, textile materials. . ."[28], Walsh exclaimed,

> "Can we wonder that, under such circumstances, Mr. Glover's Report contains scarcely any original investigations. . .? When he should have been looking after the Bugs, he was set to work on the Birds; if he attempted an attack upon the Army-worm, he was called off to unpack a basket of apples. . . Will our rulers at Washington never learn, that it is bad policy to put a square man into a round hole? And that, whether round or square, no one man can fit a hole that is as wide across as the dome of the Capitol?" (Walsh 1866d)

Because of what he viewed as their political impotence, even the farmers were castigated by Walsh:

> "Probably about nine-tenths of the Members of Congress and of our different State Legislatures are lawyers . . . and the remaining one-tenth are Physicians, Merchants and Manufacturers, with a *very* small sprinkling of Farmers . . . What do they know about Farmers, except that they have got votes? Or about Farmers' pockets, except that most of the taxes come out of them? . . . if one-hundredth part of the pecuniary damage, that is annually inflicted by Noxious Insects upon the farmers, were inflicted, instead, upon the Merchants or upon the Manufacturers, thousands of dollars would have been long ago voted by Congress to discover some remedy or some palliation of the evil. Why? Because the Merchants, as a class, act in one solid body; the Manufacturers, as a class, act in one solid body; while the Farmers of the United States are nothing but a mere rope of sand. It is the old Greek fable of the bundle of sticks, practically translated into modern English for the benefit of 'whom it may concern.'" (Walsh 1866a)

Although the minutes of The American Entomological Society are devoid of any reference to *The Practical Entomologist*, the journal's rise and fall are recounted in its pages. Initially, the journal was distributed gratuitously, the only charge being for postage at 12 cents per year. However, by the third issue, publication costs (the greatest of which was paper) were exceeding the income from advertisements, which was the sole means of support for the journal. The editors appeared openly disheartened:

> "We had, on commencing, every cause to believe, that, by reason of the large circulation of the Bulletin, those doing business of interest to the Farmer and Agriculturist would patronize the advertising columns, and thereby assist us in establishing and maintaining the only periodical in this country devoted entirely to Practical Entomology. We shall go on, now that we have began [*sic*], and crowd into the limited space all the information it will hold... It is to be regretted that a work of this kind does not receive more encouragement than it does, for there is nothing so much needed by Agriculturists as information concerning the habits of Insects that are injurious to their crops of all kinds, with reliable remedies for their destruction." (Anonymous 1865c)

An exuberant tone opened issue 5, since circulation had approached nearly 8,000 copies monthly and the advertising columns were nearly filled:

> "The encouragement we have received incites us to new energy. Three editions of our first three numbers have already been printed, and from present indication, we shall soon publish a fourth." (Anonymous 1866a).

The tremendous increase in circulation necessitated a yearly subscription fee of 50 cents beginning with issue 6, since publication expenses continued to exceed funds generated from advertisements (Anonymous 1866b). However, while people were willing to pay 12 cents postage per year to receive the paper, they were "very slow in making up their minds to send 50cts. a year."[29] The editors made no public statement concerning the paper's finances again until issue 9, when the dire situation was conveyed in an essay entitled, "Shall this paper be continued another year?":

> "Since we were obliged to stop the gratuitous distribution, and to ask the small subscription price of 50 cents a year, some appear to think that there is a screw loose somewhere, and that the Committee, growing tired of giving the paper away, want to put money into their own pockets... This is not so.... they have, on the contrary, been obliged to put their hands into their own pockets to the extent of several hundreds of dollars... Certainly this state of things cannot be expected to continue, nor will the Committee undertake the publication of the *Practical Entomologist* another year unless they have some reasonable assurance that it will be self-sustaining." (Anonymous 1866c)

The second year of publication was to have been contingent upon the guarantee of 5,000 subscribers to the periodical. As a means to this end, "club" incentives were offered, whereby those sending the names of 20 or more subscribers would receive premiums on books of reader interest.[30] With the last issue of volume I, the editors announced that although the goal of 5,000 subscribers had not been met, they believed it would be reached by the next number; thus, they embarked upon another year of publication.

Pleas for 10,000 suscribers[31] began appearing with the third issue of volume II, and continued until six issues later, when a publisher's notice announced, rather acridly, the imminent termination of the periodical:

> "It has become very evident that the time has not yet arrived, when the Agricultural community — to whom economic entomology is of the most importance — will sustain a work devoted exclusively to that subject. The devastations of injurious insects will, no doubt, continue to increase as long as the farmer, gardener and orchardist remain ignorant of the habits of these insects, and until they learn how to distinguish their friends from their enemies. They will doubtless awake from their apathy when they find that the "Hessian Fly," the "Wheat Midge," and the "Chinch-bug" have destroyed the crops of grain. . . [here follows a list of serious insect pests and associated crops]; and then, *perhaps,* they will — when too late — seek for practical knowledge. . ." (Anonymous 1867a)

Walsh's experience with *The Practical Entomologist* left him somewhat jaded, as the following passage from a letter of Walsh to Darwin reveals:

> "I have recently returned like a dog to his vomit, and again become Editor of a Monthly Periodical[32] (of which I enclose a Prospectus) devoted to Economic Entomology. I think this time we shall make it a success; at all events I hope and expect it, which is more than I ever did as regards the old 'Practical Entomologist,' from the total lack of business talent and tact in the Society that published it."[33]

Still, in an earlier letter to Darwin, Walsh acknowledged that the association served him well:

> "Editing the *Practical Entomologist* does undoubtedly take up a good deal of my time, but I also pick up a good deal of information of real scientific value from its correspondents."[34]

Indeed, in addition to the cases cited earlier, Walsh learned of and named several new species through his contact with readers of the journal.[35] Given that he acted as the journal's sole editor for the second year but remained totally removed from its business matters, it seems likely that Walsh felt his efforts had been mismanaged.

E.T. Cresson, a founding member of the society that published *The Practical Entomologist,* opined that the journal had to be abandoned because "the time had not yet come for the agricultural public to realize the importance and value of such knowledge" (Cresson 1909). Entomological historian Herbert Osborn (1937) echoed this view, stating that the number of entomologists was too small, and the agricultural public too indifferent, to provide adequate support. Another notable historian, L.O. Howard (1930), lavished praises on the journal, stating, "it seems incredible, in view of the extremely valuable articles, notes and answers to correspondents which it contained, that it should not have continued to receive the wide-spread support of farmers and fruit-growers at the ridiculously small price of 50 cents a year."

Having read through the pages of *The Practical Entomologist* more than 50 years after Howard's (1930) writing, this author shares his sentiments:

> "The two volumes abound in sound information. The contributions by Walsh, written in his vigorous style and indicating everywhere his opinion of charlatanistic recipies, lend great readability to the journal even at this date. . . The entomologist of today who does not spend an hour or so with *The Practical Entomologist*. . . loses a great deal."

FOOTNOTES

[1]Minutes of The Entomological Society of Philadelphia for August 14, 1865.

[2]The *Proceedings* were superseded by the *Transactions of the American Entomological Society*, still in publication.

[3]Presumably, at least Cresson and McAllister edited the first two numbers, since both resided in Philadelphia and were organization members of the society; Grote lived in New York, Walsh in Illinois.

[4]Although currently a scientific journal, the *American Naturalist* at the time was billed as "as Popular Illustrated Magazine of Natural History . . . without those technicalities which often render the mass of such reading tedious and difficult." In *The Practical Entomologist* (hereafter PE) *II*:86 (1867).

[5]B.D. Walsh to C. Darwin, letter dated Nov. 12, 1865, C.V. Riley Collection, Library of Field Museum of Natural History, Chicago (hereafter, LFMNH).

[6]*Ibid.* C. Darwin to B.D. Walsh, letter dated Dec. 24, 1866.

[7]PE *II*:88 (1867)

[8]PE *II*:107 (1867)

[9]B.D. Walsh to C.R. Osten-Sacken, letters dated Nov. 28, 1866 and Apr. 1, 1867, Museum of Comparative Zoology, Harvard University (hereafter, MCZ).

[10]See PE *I*:35-37; 46; 69-71; 83; 90 (1866)

[11]See PE *I*:22-23 (1865). The publications extracted were: The current month, *Abraxas? ribearia.* Trans. N.Y. State Agric. Soc. *7*:461-469 (1847); First and Third Reports, Trans. N.Y. State Agric. Soc. *14*:705-880 (1855), and *16*:315-490 (1857, but misdated and bound as 1856). Fitch himself never published in PE.

[12]The estimate is mine, whereby monthly "Answers to Correspondents" were counted as a single article rather than individually, as in Henshaw (1889).

[13]*e.g.*, see PE *II*:8; 9; 10 (1866); PE II:47 (1867).

[14]*e.g.*, see PE *II*:9; (1866).

[15]B.D. Walsh to J. L. LeConte, letter dated Nov. 6, 1866, Collection #B/L493, American Philosophical Society Library, Philadelphia (hereafter, APSL).

[16]*Ibid.* B.D. Walsh to J. .L LeConte, letter dated Nov. 30, 1866.

[17]Unfortunately, LeConte's letters to Walsh, if extant, have not been located by this writer.

[18]Although it is impossible to state unequivocally whether he was proposing a conditioned host plant preference ("Hopkins host selection principle") or a genetically determined one, Walsh has been cited as the progenitor of both theories by 20th century entomologists (C.A. Sheppard, manuscript in preparation).

[19]B.D. Walsh to C.R. Osten-Sacken, letter dated Nov. 28, 1866 (MCZ).

[20]*e.g.*, see "Answers to Correspondents" [to Willie C. Fish] PE *II*:103, and [to V.T. Chambers] PE *II*:119 (1867).

[21]Published in "Answers to Correspondents" [to Chas H. Peck] PE *II*:9 (1866).

[22]B.D. Walsh to J. L. LeConte, letter dated Sept. 30, 1866 (APSL).

[23]Walsh (1865a) did state that the beetle "was first discoved by Say in 1823 in the regions bordering on the Upper Missouri river"; perhaps he thought the "regions" were further upstream than is now known to have been the case, or he believed that adaption to potato foliage occurred in Colorado rather than at the eastern edge of the beetle's range.

[24]The reports are cited in Walsh (1865a).

[25]thereanent-*i.e.*, concerning the matter

[26]Henry Ulke, noted coleopterist. (For biographical sketch, see Proc. Entomol. Soc. Washington *12*:105-111 (1910).)

[27]B.D. Walsh to J. L. LeConte, undated letter (APSL).

[28]From Glover's Report of the entomologist, printed in Annual report of the (U.S.) Commissioner of Agriculture (1863), pp. 561-579.

[29]E.T. Cresson to J.A. Linter (Asa Fitch's successor as state entomologist of New York), letter dated May 26, 1866, printed in Calvert (1928).

[30]PE *I*:105 (1866); books are listed on p. 116 of the same number.

[31]See PE *II*:36 (1866); PE *II*:48; 60; 76; 82; 85; 88 (1867). These were terse requests set in small type: "Wanted 10,000 subscribers to the Practical Entomologist"; "We want 5,000 more subscribers to the Practical Entomologist. Will not each present subscriber try to send us another?" According to Bardolph (1948), the journal reached a circulation of 20,000, which appears to be inconsistent with the circumstances chronicled herein.

[32]*The American Entomologist,* which Walsh co-edited with C.V. Riley. Walsh died before the completion of the second volume.

[33]B.D. Walsh to C. Darwin, letter dated Aug. 29, 1868, record unit 7076, C.V. Riley papers, 1866-1895, scrapbook #9, Smithsonian Institution Archives, Washington, D.C. (hereafter, SIA).

[34]B.D. Walsh to C. Darwin, letter dated Feb. 25, 1867, printed in Darwin and Seward (1903).

[35]See PE *II*:34 (1866); PE *II*:58; 117 (1867).

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A VISIT TO THE TOMB OF THOMAS SAY IN NEW HARMONY, INDIANA

T. J. Spilman[1]

Thomas Say, often styled the Father of American Entomology, left Philadelphia near the end of 1825 to take part in a new sociological experiment. At Pittsburgh he boarded a specially made keel boat that was nicknamed the Boatload of Knowledge because of the cargo it carried — scientists, teachers, artists and other intellectuals. Down the Ohio River they went, until at the southwestern corner of Indiana they made their way up the Wabash River to settle early in 1826 at a small town called New Harmony.

This experiment or movement was the brain-child of Robert Owen, a wealthy Welsh mill owner. He planned to establish a new communal or communistic system to improve the lot of workers during the industrial revolution. Owen went to Philadelphia to gather intellectuals to his movement; it was to be a society led, not by politicians, but by intellectuals, teachers, and scientists. In Philadelphia Owen convinced William Maclure, a wealthy geologist, to invest in the movement, and it was Maclure who convinced many scientists, Say included, to join the movement. Maclure had long been Say's sponsor.

To begin his movement, Owen bought the town of New Harmony, a town that had been built in the wilderness in 1814 by a religious group led by George Rapp. After the sale, Rapp's group, called Harmonists or Rappites, moved to western Pennsylvania.

Owen attracted many people, later called Owenites, to his movement, but after only a few years the movement failed and the town returned to private ownership. Even so, many of the members, including Say, stayed in New Harmony. It was in that town that Say continued his work on insects. He became a leader in the town and eventually lived in a great house formerly used by Rapp and Maclure. In that house Say died on October 10, 1834.

Say was buried in a grave that is unknown today, according to Webster (1895:102), but in 1846 his body was moved to a brick underground vault behind the Rapp-Maclure house. Webster's account stated that the vault was "entirely covered over with earth," but he also described the interior of the vault. Perhaps the entrance to the vault was uncovered at that time. The interior had platforms of solid brickwork; on the east and west side were the remains of Alexander, Anna, and

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Margaret Maclure, the brother and sister of William Maclure. On one of the platforms on the north side of the vault were the remains of Thomas Say. Atop the north end of the earthen mound was an inscribed, white marble, memorial shaft dedicated to Say and erected in 1846. The ownership of the house and tomb and the care that was to be given to the latter was discussed by Webster (1903:94) and Howard (1903:138). All of these facts are recorded in the biography of Say by Weiss and Ziegler (1931).

Today the vault itself cannot be seen or opened; it is completely hidden under a grass-covered, elongate mound of earth. The memorial shaft is still in place. The mound and shaft can be seen on the west side of Main Street, between Church and Granary Streets. Webster's account of access to the interior of the vault was partially corroborated in a conversation I had with Anna Deischer in New Harmony in 1980. She told me that her mother often spoke of descending a few steps into the vault and touching the bones of Say and others on the platforms. The entrance to the vault was obviously still open when her mother was a little girl, about 1900. I have not been able to determine when the vault was completely sealed.

I met Anna Deischer when she was a guide in Rapp Dweling No. 2, a large building across Main Street from the vault and the Rapp-Maclure house. No. 2 was used by the Harmonists as living quarters for many people; it was called a Brüder Haus. At present, in a large room on the south end of the first floor there is an antique print shop, called the Bennett-Slater Newspaper Museum, and it was into this shop that Mrs. Deischer sent me for more information on Say. On a long, sturdy table was a large, rectangular, incised, white marble slab, the kind of slab usually seen covering graves (fig. 1). Incised into the surface of the slab were a few lines (fig. 2):

THOMAS SAY
Son of D^{r} Benjamin Say
One of the Founders of the Academy
of Natural Sciences of Philadelphia
Born in Philadelphia
June 27th 1787
Died at New Harmony
October 10th 1834

I have not been able to determine if the slab was used in the vault or on the unknown grave. Because of its smooth surface, it is being used in the print shop as a composing table. A similar slab at the print shop was incised with the names of Maclures.

Finding the Say slab in the print shop was a surprise, but finding it hidden under equipment, type, and stacks of paper was even more sur-

Figure 1. Print shop in Dwelling No. 2; Say grave slab on table.

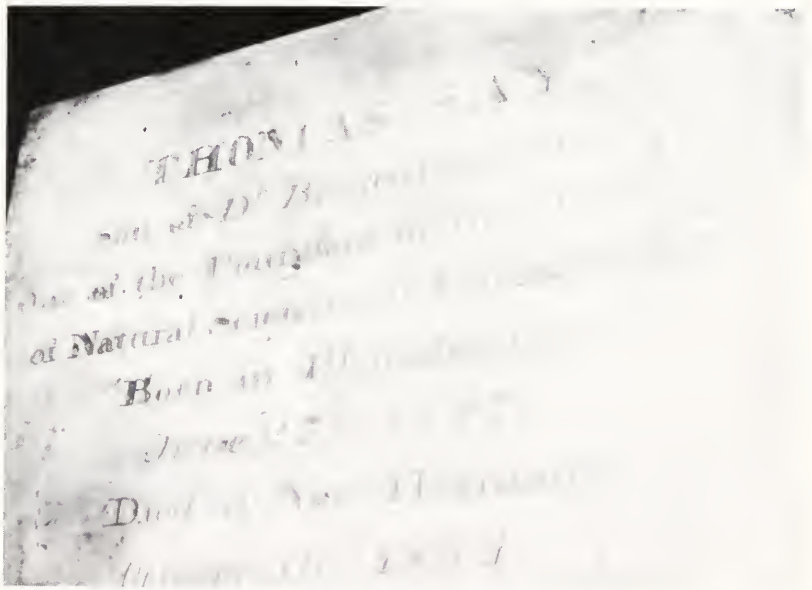

Figure 2. Part of Say grave slab with incised wording.

prising. The slab could easily be damaged. It should be protected and exhibited for all to see.

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(Continued on page 248)

GEORGE H. HORN, WILLIAM G. WRIGHT, AND THE PECULIAR PROBLEMS CREATED BY THE DISCOVERY OF THE WORLD'S LARGEST BOSTRICHID BEETLE, *DINAPATE WRIGHTII* (COLEOPTERA: BOSTRICHIDAE)

Kenneth W. Cooper[1]

ABSTRACT: When William Greenwood Wright sent George H. Horn fragmentary remains of the world's largest bostrichid beetle in 1885, he unwittingly brought about that great coleopterist's most unusual blunder - the production of a chimaera, with attendant problems for Horn. Turn about, Horn's knowing misrepresentation of certain facts before him unintentionally caused Wright's name to be linked with deceit and cupidity. Horn's error in originally stating *Dinapate wrightii* to be "the largest blind beetle known" is reviewed, variations in his subsequent accounts are discussed, and an explanation is presented. The factual background for these events is pieced together leading to the conclusion that Wright is innocent of unsupported charges against him and a victim of Horn's errors and subsequent accusations by others.

"... the last error shall be worse than the first."
Matthew XXVII, 64.

If George H. Horn, President of the American Entomological Society for sixteen years (1867-68 and 1884-97), member of the Advisory Committee for the first eight volumes (1890-1897) of *Entomological News*, and premier American coleopterist of his time, were alive today to tell us of any notable misadventure associated with any one beetle among the nearly 1600 he had described as new, I believe unhesitatingly he would devote his remarks to *Dinapate wrightii* Horn. That beetle is the only recorded borer in our native fan palm and is by far the largest bostrichid known. To those distinctions must be added that it is one of the few living beetles described from fragments only, as though from fossilized remnants. Horn's distress over his tribulations with that beetle would surely heighten were he now to learn that his deviation from the facts before him had resulted in the defamation of the accomplished naturalist William Greenwood Wright of San Bernardino, California, discover of *Dinapate*, with whom for years thereafter Horn had maintained a cordial relationship.

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Horn's first error: the four accounts of *Dinapate* and how they changed.

Horn (1886) laconically tells of his troubles with *Dinapate* as follows: "The first fragments of this genus received by me consisted of a hind body and a head without mouth parts, excepting the mandibles. Supposing the head (which I now know to be larval) to belong to the fragments of body, the genus has been characterized in verbal remarks before the Academy of Natural Sciences as eyeless, and therefore the largest blind Coleopter known. The discovery of additional material enables me now to correct an error which has unfortunately appeared in print." Horn does not say where the error appeared in print, and a search has turned up no publication of a suitable date that cites Horn's remarks.

Actually Horn had portrayed the giant bostrichid as blind before both the Academy of Natural Sciences of Philadelphia (hereafter the "Academy") on 24 November 1885, and the Entomological Section of the Academy (officially the American Entomological Society since 1867) on 14 December 1885 — an important date. Official handscript minutes of both meetings, entered in separate ledgers, are in the Academy's Archives. The relevant remarks made by Horn at the Academy are: The beetle "... is a voracious wood borer. It is two inches long in the female, and over two inches in the male, or three times the size of the largest allied species. It is totally blind and is the largest blind beetle yet known." By the time of Horn's talk on 14 December, the beetle had been baptized. The secretary's minutes state that "Dr. Horn exhibited some drawings of *Dinapate Wrightii*. From these the plates will be made that will accompany the paper upon this insect, which, Dr. Horn states, to be the largest blind insect known."

Neither Horn's remarks, nor mention of his talk, appear in the published Proceedings of the Academy. Those made in mid-December before its Entomological Section were altered before publication (see: Trans. Amer. Ent. Soc. 12, Proc. xxiv). They state: "Dr. Horn exhibited fragments of several specimens of *Dinapate Wrightii*, and drawings which he had made for the lithographic artist in preparing a plate." They omit mention of Horn's mistake and imply that the plate exhibited by Horn at the meeting is the one prepared for the wholly new manuscript accepted for publication on 28 January 1886 (see: Trans. Amer. Ent. Soc. 13, Proc. ii; signature dated June, 1886).

There is a mysterious third reference: "Note on *Dinapate Wrightii* n.g. et n.sp." listed in Henshaw (1886: see pp. 68 *and* 95) as by Horn and published in "*Science* 1885, v. 5, No. 148, p. 2 Proc." That reference would seem to suggest that here was the item which Horn stated to have "... unfortunately appeared in print." However, that proves not to be the

case. The cited note, as well as two other items attributed to Horn by Henshaw, were never published in *Science* or elsewhere. Why Henshaw did not withdraw those titles from his list of literature, the two parts of which were published in July and August of 1886, is a puzzle. First, he had every opportunity to check whether the titles had been published in *Science* in 1885[1]*; second, as documented later (see annotation 6), Henshaw had received and commented on Horn's (1886) published description of *Dinapate* some two to possibly four months before the signatures containing his own article had been set in type[2]; finally, Horn's published description of *Dinapate* had been reviewed in the issue and on the page immediately preceeding that of the first part of Henshaw's article (see: Ent. Amer. 2(3): 64 and 2(4): 65 respectively). All that can be concluded is that Henshaw's reference to the "Note on *Dinapate* . . .", though factually wrong, could not have been just a figment of his imagination. Such a note surely had been written, had been submitted for publication in *Science* sometime toward the close of 1885, but for one reason or another had not been published.

I have been unable to find any other reference to an account recording Horn's error that appears relevant, considering the time of publication of Horn (1886). Where then had Horn's premature remark ". . . appeared in print"? Note that Horn's phrase does *not* say that his remarks had been *published.*

It seems likely that Horn's remarks of 24 November 1885 had indeed "... appeared in print" in signature 26 of the Proceedings of the Academy for 1885. Signatures 26 and 27 (pp. 385-416) had been printed and were distributed to the members of the Academy at the regular meeting of 19 January 1886. They contained a number of research articles, the minutes of the Academy for the nine weekly meetings held in the period 3 November through 29 December 1885, as well as various reports, including that of the Corresponding Secretary of the Academy (namely Horn). Presumably the text was distributed to the membership for approval and at that point was still subject to revisiion and elision. Horn was not present at that meeting (as the Recording Secretary's handscript record shows) but as Corresponding Secretary he assuredly received a copy. If the embarrassing remarks were present in the *printed* minutes, Horn alone had cause to seek their removal, as painful for him as that may have proved.

The conclusion offered is a plausible conjecture, and at this time is not subject to direct test for no known copies of that "pamphlet" of 19 January 1886 is in the Academy's Archives. Apparently Horn did not disapprove of those minutes when they were read for approval at a meeting early in December, for on 14 December, before the Entomological See-

*The numerical superscripts refer to annotations to the text at the end of this paper.

tion of the Academy, he had declared *Dinapate* "... to be the largest blind insect known." The Recording Secretary of the Academy certified the date of distribution of the signatures to members of the Academy to be 19 January 1886 in a letter dated 4 February 1886 and printed on the reverse of the title page for the Proceedings of 1885. Accordingly there was adequate time remaining for revision. The final issue (Part 3) of the Proceedings for 1885 could not have been distributed to members and subscribers or sent out in exchange before early February, 1886. The American Entomological Society acknowledged receipt of a copy of Part 3 at its only February meeting, on the 25th, 1886 (Trans. Amer. Ent. Soc. 13, Proc. ii, 1886).

At that time Horn enjoyed world-wide renown. He was a member of four distinguished foreign entomological societies among others (see list in Calvert 1898, p. xxii). In addition he had recently been elected an honorary member of the Entomologisches Verein zu Stettin (1884) and an honorary member of the Société entomologique de France, Paris (1885), both prestigious honors. The international esteem in which he was held owed to his extraordinarily wide knowledge of beetles, his exceptional eye for valuable diagnostic attributes, for his clear, succinct and reliable descriptions of species and genera, for his excellent monographs, and for his attention to the works of foreign coleopterists bearing on the North American fauna. Publication of his manuscript and plate of an eyeless adult *Dinapate*, with its larval head, would have proven a monumental embarrassment to Horn once an articulated specimen or adult head of *Dinapate* had been found.

Providentially, Horn was saved from continuing his blunder sometime between 14 December 1885 and 19 January 1886, or shortly thereafter, as the foregoing dates imply. In that period he received from Wright two large larvae and a head (lacking ligula and labial palps) and at least one antenna of an adult *Dinapate*. Now aware of his mistake, happily for Horn the new specimens had come at a time when he was still able to withdraw or alter the unpublished accounts of his remarks, as he evidently did.[3] However, at least thirty individuals had heard his comments about "the largest blind beetle (or insect) known." That error certainly had its ludicrous aspects (but not for Horn) and there remained a strong likelihood that remarks or correspondence of one or more members of his audiences would carry far afield, an unpleasant possibility. Horn (1886) lessened the prospect of damage to his reputation, should revelation of his remarks occur,[4] by frankly stating his error and his view of its "cause" in the paper he finally published, as quoted in the initial paragraph of this section (q.v.). A similar but much briefer remark was recorded in the unpublished minutes for the 25 May 1886 meeting of the Academy.

Although the signature of Horn's publication on *Dinapate* is dated January, 1886 and the article occupies only the first four pages of the first number of *Transactions* 13 for 1886, the preprints ("extras" as they were then called) and the first number of volume 13 (consisting of eight signatures) were first available for distribution much later.[5] Horn mailed preprints toward the end of March[6] and the first number of the *Transactions* was mailed about a month later.[7]

Was Horn's synthetic *Dinapate* a transparent error?

Few coleopterists who have never seen adult or larval *Dinapate* would fail to be astonished, as I was, on reading Horn's bland statement of his error in conjoining the eyeless head of a larva with the hinder body of an adult. How could Horn with a quarter of a century's experience, and already distinguished author of 179 notes and papers on beetles, deceive himself thus and seemingly so egregiously? Unwarranted haste would be my answer,[8] and not the monster he had unwittingly contrived.

It may be recalled that Horn exhibited his fragments and drawing of the "blind" *Dinapate* at the 14 December 1885 meeting of the Entomological Section of the Academy. The handscript minutes of that meeting make no mention of skepticism or criticism voiced by any of the ten other entomologists present. To them it must have seemed a proper beetle, albeit blind. How would such a chimaera fare today?

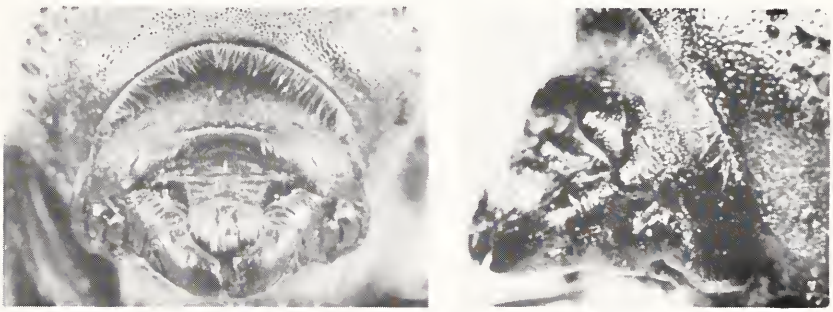

Figure 1: How the chimaera of *Dinapate wrightii* looked to Horn. The head of an adult has been replaced with that of a nearly mature larva. The result is a plausible adult beetle. Left: face view; right: oblique lateral view. Reproduced at 4.5x.

Figure 1 shows aspects of an adult *Dinapate* provided with a larval head. It differs from Horn's chimaera (which was assembled as a drawing) by retaining the larval mouthparts in addition to the mandibles and antennae. It is indeed a convincing looking adult beetle that had lost its antennae, for the general appearance of the larval and adult head is

strikingly similiar in size, shape, heavy tough integument, setation and coloration. Most to whom I showed the chimaera, after closely examining it, commented only that its antennae are missing, showing that they, like Horn and his colleagues, readily accepted the larval head as that of an adult beetle. Horn's error was not a foolish one but his haste in this case was.

What *is* the type locality of *Dinapate*?

Horn (1886) states the type locality to be the "Mojave Desert, California." However, no known record establishes when, or exactly where, Wright first found fragments of *Dinapate* or whether all of the fragments came from the same locality. Clearly they did not come from one individual and that is definitely so for the "specimens" finally described by Horn.

In the unpublished minutes of the Academy's meeting on 25 May 1886, Horn is recorded as having remarked that "The imago is as large as a man's thumb . . . yet it has not been known until within recent years."[9] At a minimum that suggests the discovery to have been made not later than sometime in 1884. Though both Horn (Trans. Amer. Ent. Soc. 13, Proc. xix, 1886) and Wright[10] had obtained intact adult specimens by rearing before the close of 1886, it was nearly eleven years later that the first find of specimens of *Dinapate* by anyone other than Wright appears to have been made. Again, no living adult beetle had been found. It is the only record before 1900 for which there is a *bona fide*, published account. However, it was not a chance discovery, and it was not made on the Mojave Desert.

On 8 February 1897 Henry G. Hubbard, an exceptional collector, wrote to his friend E. A. Schwarz, a coleopterist at the U.S. National Museum, that he had just returned from Palm Canyon, at that time about seven to eight miles south of the small village of Palm Springs. There he had found the workings of *Dinapate* in logs of the fan palm, *Washingtonia filifera*, as well as a disarticulated specimen of the beetle. He mentioned that the proprietor ("Dr." Welwood Murray) of the Palm Springs Hotel,[11] where he stayed, had told him that "Mr. Wright comes almost every year in September to this place and always goes without a word up the cañon, so that no one here has ever heard of *Dinapate*." Hubbard wrote that he ". . . could easily trace the operations of Mr. Wright . . ." and that "Several logs which Mr. Wright has laid open to the heart gave me an excellent chance of examining the old borings of the beetle . . .". In them Hubbard had found dead larvae of *Dinapate* and their remains. That letter and two others (of 27 February and 13 March 1897) of a total of six bearing on *Dinapate* were published posthumously.[12] Their very enjoyable texts (Hubbard 1899) give the first account of the biology of *Dinapate* and few of the many later publications add importantly to what Hubbard had

observed and thought. From the sections of palm trunk that Hubbard sent to Schwarz six adult *D. wrightii* were obtained. Emergence of adults occurred in Washington, D.C., in the period 29 July to 30 August 1897 (records on file at the U.S. National Museum).

A footnote by Schwarz at the close of Hubbard (1899; *v.* p. 89) holds that "While at San Diego, Cala., Mr. Hubbard ascertained that the type locality of *Dinapate wrightii* is Palm Springs, Cala. and not the Mojave desert as stated by Horn." Regrettably Hubbard's notebook in the Smithsonian Archives has no mention of this and the only record available is Hubbard's letter of 1 February 1897 (unpublished). In that letter to Schwarz, Hubbard says "I found out today where Mr. Wright got his specimens of *Dinapate*. It was at Palm Springs Cal." ... "I met today with Mr. [G. W.] Dunn, a sort of entomologist ... He knew all about *Dinapate* & where it was found. Says it occurs in Sept. & has seen the holes himself but has never taken the insect. He says Mr. Wright gave away to a dealer the only good specimen he had as he expected to get more and the dealer asks $1300 for the specimen."[13] In the very first line of the same letter Hubbard mentions "On my arrival here at noon on Saturday I found your letters of Jan. 20th, 21st, & 22nd ... ". Ironically Schwarz' letter of 21 January 1897 (see Schwarz 1929, pp. 234 - 235) advises Hubbard that "Coquillett [a government entomologist with much experience in California][14] says you would enjoy greatly a short stay at Palm Spring[s] in the Desert where there is a good hotel and where you would have an opportunity of seeing the native palm trees of California, *Washingtonia filifera*. In the dead trunk of one of these trees the giant Bostryc[h]id, *Dinapate wrightii*, has been discovered." The Coquillett Notebooks in the National Archives make no mention of *Dinapate*. Nor does Schwarz say Coquillett had told him of the occurrence of *Dinapate* at Palm Springs. But most assuredly Schwarz had heard that *Dinapate* occurs there and in the fan palm before Hubbard had spoken with Dunn. If not from Coquillett, from whom or how could Schwarz have obtained his knowledge? And if from Coquillett, from whom did Coquillett learn that fact? It seems unlikely that either learned this from Horn.

In any case, because of the foregoing, Palm Springs is now regarded to be the type locality of *Dinapate wrightii* (Lesne 1909, Fisher 1950). It must nevertheless be recognized that hotel proprietor Murray's remarks to Hubbard about Wright's activities of each September in Palm Canyon have little bearing on whether or not Palm Springs is the type locality. Murray is said to have moved to Palm Springs (then "Palm Valley") in 1886 (Gunther 1984) and his hotel did not open to receive guests until late in 1886 (Bourne 1953, Harrington 1962, Ainsworth 1973). Horn, it will be remembered, had received fragments of *Dinapate* by November 1885

and perhaps earlier.

The formally designated lectotype is a male mock-up of fragments of adult *Dinapate* (#3560) in the Horn collection at the Museum of Comparative Zoology, Harvard University (Cooper 1986). The fragments composing it came from a region or regions of the Colorado Desert. Davis' (1940) comment that "The type material probably came from Palm Canyon . . ." is the most that can be said. Palm Springs is accordingly an appropriately designated type locality.

The false type locality and the defamation of W. G. Wright

Once it became widely known that the Mojave Desert is not the type locality of *Dinapate*, it was inevitably accepted (as their relative statures assured) that Wright must have deliberately duped Horn about the source of his specimens. That was first implied by James (1906), resident at the Murray hotel during Hubbard's stay and in a muddled way familiar with Hubbard's activities. Others reached the conclusion that Wright had lied to Horn in order to conceal the source of his specimens or simply echoed that view (Martin 1917, Comstock 1922, Michelbacher and Ross 1938, Stickney *et al.* 1950, Baker 1965). It is now the firm belief of coleopterists interested in *Dinapate* or its allies. But why would Wright choose to have his wonderful new beetle described and associated with a false type locality, for sooner or later that would surely bring his name into disrepute?

Jaeger (1956) alone has given an explicit, detailed answer to that question. To summarize: customarily Wright was secretive about his collecting. If asked where he had been, his answer generally was "Oh, out on the Mojave." "It was after one of his long drawn-out 'Mojave journeys' that he returned with some very valuable beetles, so unbelievably rare and unusual in appearance that he offered them for sale and, it is said, got nearly a thousand dollars a pair for them. At least three such sales were made before the price came down: to the British Museum, to the Russian Museum at St. Petersburg, and, I believe, to a museum in Paris." Under the circumstances, as Jaeger says, *Dinapate* ". . . was worth as much as a vein of gold to Wright." During the golden period of commercialism, Jaeger says that Wright would first move out onto the Mojave, then camp until his pursuers ("Many of his friends, either anxious to collect the beetle for their own collections or for possible sale") had tired of waiting and departed. Wright would then circle to the east of the San Bernardino mountains and enter the Colorado Desert and Palm Canyon, via the Morongo Pass, from the north. Such a route would be an arduous one-way trip of 100 miles or so by horse-drawn wagon, compared with the more direct eastward route (about 55 miles or slightly more) via the San

Gorgonio Pass. Furthermore, "Wright seldom paused in the village of Palm Springs but went directly to the canyon without a word to anyone."

Wright's time-consuming and necessarily secret tactic for eluding those who would follow him is said by Jaeger to have succeeded through the years 1886 to 1897. How could Jaeger know at first hand what he describes so factually? Born in 1887, he ranged from minus one to nine years of age in that period. The only information verifiable today provided by Jaeger's account is that of Wright's sales to the three museums. Inquiries were made of entomologists at those institutions concerning purchases of *Dinapate* from Wright.

Dr. John La Salle, during his research at the Zoological Institute of the Academy of Sciences of the USSR, Leningrad (the old St. Petersburg Museum) found no specimens of *Dinapate* there or any record in its register that there ever had been specimens in the collection.

Dr. J.J. Menier, of the Muséum National d'Histoire Naturelle, Paris, very kindly sent me a photocopy of the relevant page of the Catalogue des Animaux Articulés, Série 1888. The 44th entry for that year records their sole specimen as new to the collection: "*Dinapate Wrightii*, Horn. Californie, . . . Insecte Coléoptère donné au Museum par . . . Horn."

Miss C. M. von Hayek, of the British Museum of Natural History, wrote that a male and female of *Dinapate wrightii* (with the locality labels "California," but not in Wright's hand to judge from the photocopies so thoughtfully sent me) as well as two larvae, are in fact in the collection. The Accessions Catalogue lists all four as "*Presented* by Dr. W. G. Wright, San Bernardino, California" (italics mine). They were received in 1886 and "presumably early on as the serial number [14] is low." Dr. John La Salle, now of the C.A.B. Institute of Entomology, London, has provided additional information from the accession records, as well as copies of a few letters interchanged between Wright and A. G. Butler, Assistant Keeper of the Zoological Department.[15]

So much for Jaeger's account. His primary sources seem to have included Hubbard (1899), James (1906), Martin (1917), and Schwarz (1929) but his account perhaps draws upon gossip and tales that had grown over the years among his naturalist acquaintances plus a personal excess of imagination. Few readers of Jaeger's articles would fail to be astonished on learning that he was a highly regarded naturalist and very successful author of non-fictional books of solid worth about Southern California and its plants and animals.

Who misstated the type locality, and why?

Correspondence between Wright and Horn concerning *Dinapate*, which in principle could resolve many problems of interpretation, does not appear among preserved papers of either man. Horn had died after a lengthy illness at the end of November 1897. It is not known whether news of Hubbard's recent success in finding *Dinapate* on the Colorado Desert, at what is presumed to be the type locality, had reached him, although it had been mentioned in Philadelphia as early as 9 March 1897 (Smith 1897). A statement by Horn could possibly have resolved the dilemma. Wright never answered what James (1906) had implied and Wright died (in December 1912) long before Martin's (1917) conclusions had been published. Of course Wright may not have seen James' book or had it called to his attention. Even so, no reply to such a charge would be required other than by a nagging conscience. Fortunately there is one record, reinforced by publication, that answers the question of who bears the responsibility for citing the Mojave Desert as the type locality but not the question why. It absolves Wright, who seems guileless; it is Horn who bears the responsibility.

The *unpublished* minutes of Horn's remarks at the Academy on 24 November 1885 commence: "Dr. Horn called attention to a specimen of coleoptera collected in the Colorado Desert by Mr. Wright[16] . . . it is the largest blind beetle yet known." That observation is reported in a note on that meeting published in the *American Naturalist* 20:754 for August 1886: "Dr. Horn described a large, blind, wood-boring beetle from the Colorado Desert." So it was not the Mojave Desert but the Colorado Desert (an arm of the Sonoran Desert) that Wright gave Horn as the source of the fragments which Horn assembled and described as *Dinapate Wrightii*. Had Wright, at that time, specifically designated the area in that desert which became known as Palm Springs in late 1887 (Gunther 1984), depending on the year(s) of collection, he might have stated Agua Caliente, the most widely used name in the period 1875 - 1886 or less likely, Palm City (1884 - 1885) or even Palm Valley as the home of *Dinapate*.[17] Whether he had designated a specific site is not mentioned by Horn. Oddly, Horn had not stated the Colorado Desert to be *Dinapate's* home at any meeting of the Entomological Section of the Academy.

Consider now Horn's public remarks concerning the host plant in which the larvae of *Dinapate* live. The unpublished minutes of the Academy for its meeting of 25 May 1886 record Horn as remarking that "The trunks of a species of palm, *Washingtonia filifera* are so tunnelled by the larvae of this beetle, *Dinapate Wrightii*, as to threaten destruction of the plant." Again, at the meeting of the Academy on 3 August 1886 the unpublished minutes state that "Dr. Horn exhibited a fragment of the

trunk of *Washingtonia filifera* containing a larva of *Dinapate* and showing ravages inflicted by the insect on the tree." In the *American Naturalist* 20:1000, issued 23 November 1886, it is commented that at that August meeting of the Academy "Dr. Horn showed a fragment of the palm *Washingtonia filifera* containing a larva of a beetle (*Dinapate*) recently described by him."

The above are in striking contrast to Horn's remarks before the Entomological Section of the Academy. Though the topics were much the same, the minutes *never* mentioned that the host is a palm, no less the specific palm *Washingtonia filifera*. The host is simply "a tree" and the portions of the "tree" displayed are described as a "fragment of tree trunk" or a "section of a tree" (see respectively: Trans. Amer. Ent. Soc. 13, Proc. xvii and xix; *ibid*., 14, Proc. vii, 1887).

It is now strikingly clear that Horn's remarks before the Academy were not intended for either the entomologists' ears (in Philadelphia) or eyes (anywhere). It is easily seen why.

Dinapate is a very large beetle and obviously must require a very large plant host peculiar to the appropriate desert. Potential hosts would differ if the beetle is an inhabitant of the Mojave Desert (high desert) or the Colorado Desert (low desert) of which *Washingtonia filifera* is an endemic. Sharp (1899) provides an excellent example of such direct reasoning. Because Horn (1886) had given the type locality as the Mojave Desert, Sharp quite rationally but unwisely stated in the renowned Cambridge Natural History that the larva of *Dinapate* is " . . . found in the stems of species of yucca."[18]

By similar reasoning, a determined entomologist knowing either the true type locality of *Dinapate* or its plant host but not both, without great difficulty would soon be able to narrow down the missing element. Given both the Colorado Desert as habitat and *Washingtonia filifera* as host (or just "native fan palm of California"), even without a definite desert locality such as Agua Caliente, success in finding *Dinapate*[19] (but not necessarily in obtaining an adult specimen) would virtually be assured. Horn, however, provided neither clue to the haunts of *Dinapate* in his published article; quite the reverse, he misrepresented where it occurs. Why?

The answer seems to lie in Horn's (1886) remarks immediately following his listing of the Mojave Desert as the type locality. He says:

"As the habits of this insect and its larva are now being investigated by Mr. Wright, I refrain from mentioning any matters of this character as comparatively little is known except its food plant. It is to be expected

that in the near future we will have full details from him." Horn also comments on Wright as ". . . a zealous Botanist, for whom neither the privations incident to an exploration of the Mojave Desert [Wright 1883] nor the jealous watchfulness of the Indians [Wright 1884[20]] seemed to have had any terrors."

In justice to Horn, it is likely that Wright had asked him not to reveal the locality or host from which the specimens were taken for the reasons Horn gives in his 1886 description.[21] However, naming the Mojave Desert appears to have been a deliberate deception for at that time the Mojave and Colorado Deserts were sharply distinguished by all but laymen.[22]

Though Horn's decision to cite the Mojave Desert as the type locality may be regarded by some as defensible (as Horn no doubt would contend), it was, in fact, Horn's worst and last mistake in his extraordinary affair with *Dinapate*. Not only did it cause Wright's character to be defamed, as it has remained to this day, but the gambit was foolhardy. It would inevitably be found out that the cited type locality was a deception, to Horn's discredit. It is not the only erroneous type locality on record associated with an eminent coleopterist (see Leech 1958), but it is perhaps unique in being an apparently deliberate misrepresentation by a most eminent and highly regarded entomologist. All that could have been avoided had Horn simply given California as the type locality; assuredly imprecise, as was common in those days, but not untrue.

Etymology of *Dinapate*

Horn (1886) did not discuss the meaning he attributed to the name *Dinapate*. Jaeger (1956) however does, and would have it believed that "... *Dinapate* was coined from two Greek words meaning 'clever deception,' probably in reference to Wright's wiley tactics."

However, *Apate* was already employed as the name of a genus of bostrichids of generally large size, to both larva and adult of which *Dinapate* bears resemblance.[23] The Greek *deinos* denotes terrible, fearful, etc. In the same vein that prompted *Dinichthys*, *Dinosaurus*, *Dinornis* and *Dinotherium* for fish, reptile, bird, and mammal of earlier times that were "terrible," impressive monsters of their kind, Horn very likely, in analogy, coined "*Dinapate*." By rare coincidence the Greek *apate* denotes fraud, deceit, etc. Recalling Horn's initial blind chimaera with a larval head and an adult body, or the misrepresentations of the type locality, or both, "*Dinapate*" becomes what probably was an unintended but very apt pedantic pun: Terrible fraud!

CONCLUSIONS

1) Horn's remarks on *Dinapate* and exhibition of a drawing of it as "... the largest blind coleopter known" were recorded in the handscript minutes of the meetings at which he spoke. Following his discovery that he had created a chimaera having a larval head and adult afterbody, neither those minutes nor a very likely submission on *Dinapate* to *Science* (not necessarily by Horn) were ever published.

2) The mistaken placing of a larval head on the body of an adult of *Dinapate*, as Horn had done using the first fragments of the beetle sent him by Wright, is not as incredible an error as it would seem. Such a newly reconsituted chimaera, though eyeless and a giant among bostrichids, appears otherwise unremarkable as an adult beetle that had lost its antennae.

3) Though no correspondence between Wright and Horn is known to have been preserved, it is shown that Horn *was* informed by Wright that *Dinapate's* habitat is the Colorado Desert and its host the California fan palm, *Washingtonia filifera*.

4) Neither host nor habitat were revealed by Horn (1886) in his paper on *Dinapate*, nor in published minutes though he spoke openly of both to non-entomological audiences, and was so recorded in the handscript minutes of the meetings. They were not stated in print, perhaps at Wright's request, so that Wright might continue his study of the biology of *Dinapate* at his leisure, which he did.

5) When concealing the type locality in his publication, Horn misrepresented it — his last error. He gave the Mojave Desert, which is false.

6) After publication of Hubbard's (1899) investigations which confirmed Schwarz' and Dunn's prior knowledge that *Dinapate* occurs at Palm Springs, that last error by Horn led to widespread belief that Wright had deliberately deceived Horn regarding the type locality, which he had not.

7) A brief history of the defamation of Wright is given and probed. The claim that Wright sold specimens of *Dinapate* to three Old World museums for huge sums is shown to be false.

Annotations to the Text

1. Number 148 of *Science*, a weekly periodical, is part of volume 6, not 5 as cited by Henshaw. None of the *Science* numbers contain any of the three references cited by Henshaw, nor does Henshaw's (1898) compilation of Horn's entomological publications.
2. Did Henshaw fail to check No. 148 of *Science* because he thought Horn's reference to the printing of his remark before the Academy was actually a reference to the title for which Henshaw had some reason to believe would appear as he had cited?
3. As will become clear, Horn had still another reason, very important to him, for with-

drawing his remarks made at the Academy on 24 November 1885.

4. Which in fact did happen long after Horn's article on *Dinapate* had appeared, as will be reported further on.
5. On 25 March 1886, the Publication Committee of the Entomological Section of the Academy ". . . reported that 96 pages (12 signatures) with seven plates of vol. xiii had been completed" (Trans. Amer. Ent. Soc. 13, Proc. iii, 1886).
6. Horn's preprints were probably mailed close to 29 March. In a letter to Henshaw dated 9 April 1886 (now in the Archives of the Museum of Comparative Zoology, Harvard University), Horn expressed gratification that Henshaw had been pleased by the *Dinapate* paper. Coincidentally, a presentation copy of the preprint from W. G. Wright (signed in his hand), of San Bernardino, California, to an unidentified recipient (and now in the possession of the California Academy of Sciences) is also dated 9 April 1886.
7. The first number of *Transactions* 13 (pages 1 - 64, 8 signatures) was received at Harvard on 30 April 1886 and at the British Museum of Natural History on 8 May 1886. According to R. L. Moroney, Historian in the office of the Postmaster General, the latter date is compatible with a mailing at Philadelphia ". . . in late April 1886."
8. Horn surely must have realized that complete specimens would turn up through the activities of the energetic Wright, as indeed they did in the first quarter of 1886.[15] As Quine (1987) remarks "... the more surprising a thing would be if true, the less likely it is. . ." Horn's failure to wait for an intact example is testimony to the certainty he felt, as unique as that would be, that *Dinapate* is eyeless, even though that placed it sharply apart from all above average-sized insects known.
9. It seemed odd to Horn and ohers that such a large beetle should escape notice and collection. Though often fairly common in many groves of fan palms in southern California, it emerges nocturnally and then takes to flight (Martin 1917). Thereafter it is to be found burrowed into the growing tips of palms (Wymore 1928). As to be expected from such behavior, very few adults have been hand-collected; most have been obtained by rearing or cutting them from infested logs in spring (*e.g.* Garnett 1918).
10. Wright's intact specimens will feature importantly in another context; namely did he sell specimens to the British Museum of Natural History? The evidence presented permits estimates of when he had them at hand.
11. For a relevant picture, see p. 83 of Ainsworth (1973). In it are displayed Welwood Murray and the two large, upright logs of *Washingtonia*, pocked with exit holes of *Dinapate*, that served as gateposts to the Palm Springs Hotel in Hubbard's time.
12. E. A. Schwarz saw to their publication. His footnote to p. 83 in Hubbard (1899) states "These letters are now, after the death of the author, published without any alterations." However, when the original copies of the letters (in the Smithsonian Archives) are compared with the published text, Schwarz appears to have been in a spirited editorial mood. He freely made deletions (in addition to omitting those parts of the letters not bearing on *Dinapate*), substitutions, corrections, additions, and changes in punctuation. Happily he altered only what Hubbard wrote, not Hubbard's message.
13. There appears to be no record of that dealer, or of the price of his offering (an apocryphal tale?). But to readers of Schwarz (1929), that sum of $1300 had appeared to involve an unexplained, private joke between Schwarz and Hubbard. It is the basis of an amusing remark that deserves inclusion in any history of the refinding of *Dinapate*. When Hubbard sent Schwarz the disarticulated beetle found on his trip to Palm Canyon, he remarked (13 February 1897, unpublished) "I have put it together with shellac so that it is really not a bad looking specimen. It has been gnawed a little at the hinder end, probably by a mouse, and has lost the ends of the antennae, most of its tarsi, and one or two legs . . .". To which Schwarz replied (19 February) "Of course I duly admired your *Dinapate*. It is not to be [denied] that your specimen is, to put it mildly, somewhat damaged but if a perfect specimen is worth $1300, I place the value of your

specimen at about $688.75." See also Schwarz (1929, pp. 253 - 254) for more in the same vein.

14. Coquillett was an entomological field worker of the U.S.D.A., and active in southern California during the 1880's; leaving there in 1893 for Washington, D.C. He became Custodian of Diptera at the U.S. National Museum and thus a colleague of Schwarz. While in California he is said to have had ". . . a very good knowledge of California Coleoptera" (Banks *et. al.* 1911). Very likely he had heard from Dunn, or some other, of the occurrence of *Dinapate* in the Palms at what is now Palm Springs. It is possible that Wright was the ultimate source, but not to Coquillett.
15. Dates in the Accessions ledger are given for reports on certain lots received, but not for Wright's specimens of *Dinapate* (lot 14). The report date for lot 16 is 19 April 1886. All higher numbered lots have still later report dates. It is likely Wright's *Dinapate* were received on or before 19 April, and that Wright had obtained intact adult specimens a month or more earlier.
16. This portion of Horn's remarks, which is at variance with the type locality he was recording, provided an added reason (to that of "the largest blind beetle known") for withdrawing his remarks of 24 November 1885 from publication.
17. Nevertheless, some of Wright's butterflies collected in 1884 and 1885 are labeled "Palm Springs. Either that name was a familiar one to some at that time, contrary to accounts of place name histories (e.g., Gudde 1969; Gunther 1984), or the specimens were labelled at a later date (perhaps from papered butterflies mounted after "Palm Springs" became the official name of the village).
18. Presumably Sharp had in mind *Yucca brevifolia* Engelm. in Wats., the Joshua Tree, which may reach 12+ m in height. It is distinctive of the Mojave just as *Washingtonia filifera* is of the Colorado Desert (Parish 1930).
19. There are many scattered stands and groves of palms along fault lines and in canyons rimming the Colorado Desert, nearly all with its colony of *Dinapate* (Cornett 1985). In those days only the difficulties of a desert search for palms would prove a formidable obstacle in locating the workings of *Dinapate*.
20. Clearly a trip into the Colorado Desert from San Bernardino. It included a stop in the Palm Canyons south of what is now Palm Springs, and continued south-easterly at least to the Travertine Rock west of the Salton Sink.
21. Parish (1907), a close friend and executor of Wright's estate, mentions Wright's earlier studies of *Dinapate*. He had found where oviposition occurs, larval paths into the trunk of the palm, details of the larval galleries, evidence of the length of larval life, size of populations within a single palm [on the low side], and effect of the larvae on the palm. It is a pity that his studies were not published. Parish also points out, as is clear from *Washingtonia* being the host, and probably corroborated by Wright, that Horn erroneously gave the habitat of *Dinapate* as the Mojave Desert.
22. Parish (1930) notes that the name Mohave [or Mojave] ". . . is sometimes applied to the entire Southern California Desert." But that was not the practice of the period, or later, by geologists, botanists and zoologists. Altitudinally, floristically and faunistically each desert has distinctive attributes, blurred somewhat only at a transition point, as at Twentynine Palms. Anyone innocent of California who consulted a map to find the Mojave Desert would automatically have been misdirected as to the native habitat of *Dinapate*, as Horn assuredly was aware.
23. Horn comments on the resemblances between the larvae only, but he had chosen the name for the beetle before he had received preserved larvae from Wright, namely on or before 14 December 1885 (Trans. Amer. Ent. Soc. 12, Proc. ii). The choice of the name was probably suggested by the enormously larger, but superficially similar, chimaeric adult to that of *Apate* sp. Horn may have had wry feelings about the implications of the name *Dinapate* later on, but not when he compounded it.

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