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STUDIES OF CROSS-MATING AMONG STRAINS OF THE ALFALFA WEEVIL[1] FROM THE UNITED STATES AND WESTERN EUROPE

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ABSTRACT—Cross-matings among strains of the alfalfa weevil, *Hypera postica* (Gyllenhal), from Maryland, Utah, France, and Germany, demonstrated that partial intersterility existed between Maryland weevils and the other three strains. The Maryland alfalfa weevil probably originated from other areas in the Old World. The complete compatibility demonstrated between the Utah and the western European strains indicates that the western U.S. alfalfa weevil originated in western Europe.

Because of the often vague and sometimes questionable differences in the behavior of alfalfa weevils, *Hypera postica* (Gyllenhal), from the eastern and western United States, Blickenstaff (1965) conducted cross-mating tests to determine whether any degree of reproductive isolation existed between the 2 populations. He demonstrated that E ♂ × W ♀ produced fertile eggs; the reciprocal cross produced sterile eggs. However, Armbrust *et al.* (1970), unlike Blickenstaff (1969), found no differences in sexual maturity between the eastern and western strains and also showed that E ♂ × E ♀ contributed more to the genetic pool than the W ♂ × W ♀. They therefore suggested that the partial genetic incompatibility described by Blickenstaff (1965) would probably have little effect when the 2 strains meet and mix. The true relationships between these weevils can be determined only

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[1] Coleoptera: Curculionidae.

[2] This research was conducted by the senior author while in the Applied Plant Genetics Laboratory (now Field Crops Laboratory), PGGI, ARS-NER, USDA, Beltsville, Maryland 20705.

[3] Research Entomologist, Present Address: Beneficial Insect Introduction Laboratory, IIBIII, ARS-NER, USDA, Beltsville, Maryland 20705.

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by further studies of the United States and European strains of the alfalfa weevil. The objective in the present research was therefore to determine the genetic relationship among French, German, Utah, and Maryland alfalfa weevils. The data will be of immediate importance to researchers who attempt to predict regions of probable spread within the United States, and will also serve as a possible means of delineating specific geographical areas in which to search for biological control agents.

Materials and Methods

Sources of Alfalfa Weevil Populations: Second-generation alfalfa weevils were selected from the following laboratory colonies: Wurzburg, Germany; Paris, France; Logan, Utah; and central Maryland; and were reared under quarantine conditions and utilized in the study. Procedures used in establishing colonies were described by Schroder and Steinhauer (1975).

Cross-mating Procedures: Five days after emergence, adult weevils from Germany (G), France (F), Utah (U), and Maryland (M) were sexed and stored in separate containers until they were 14 days old. They were then treated topically on the venter of the abdomen with the hormone, 10,11-epoxy farnasenic acid methyl ester (Bowers and Blickenstaff, 1966) (100 ug/ul acetone per weevil) to prevent reproductive diapause. All 16 possible crosses (10 replicates per cross) were arranged by placing 2 ♀ and 2 ♂ adult weevils in a ½ gal plastic container and holding them for 5 weeks at 22 ± 2°C and 70% R.H. Crosses were examined for eggs on Monday and Thursday of each week, and maximum of 100 eggs were extracted and incubated on each of the examination days. The extracted eggs were placed in inverted plastic petri dishes (90 mm diam) containing 2 filter paper disks moistened with 1 ml distilled water. The free space around each petri dish was packed with white rug yarn to prevent the escape of emerging larvae. Eggs were incubated at 22°C and 8-h photoperiod to determine the percentage hatch. Larvae were reared to determine percentage adult emergence and sex ratio of the progeny.

Statistical Analysis: A completely randomized block design was planned in which we initially used a 2-way analysis of variance to test the null hypothesis that hatch, adult emergence rates, and the male : female ratio were the same for all 16 cross-matings. Each of the 10 extractions of eggs was to be considered a replication, and the 16 crosses were treated as treatment effects. Then, if the F values for treatments were significant at the 1 or 5% level of probability, the least significant difference would have been the criterion used for comparisons of means. However, bias introduced by the presence of microsporidians made the analysis not feasible, so only a standard deviation for each cross was computed.

Results

Hatchability, Adult Emergence Rates, and Sex Ratio of the Progeny: At the time of the 1st egg extractions (4 days after the pairs were combined for mating), 8 of the 16 crosses had produced eggs. By the 2nd egg extraction, 14 crosses were productive, and by the 3rd extraction, all were highly productive (151 to 1000 eggs/extraction) except U ♂ × U ♀ (6 eggs) and M ♂ × U ♀ (61 eggs). The U ♂ × U ♀

Table 1. Mean % for hatch, adult emergence, and male alfalfa weevils resulting from cross-matings between German, French, Maryland, and Utah populations.

Cross	Hatch		Adult emergence		Males	
♂ × ♀	%	Std. dev.	% Adults	Std. dev.	%	Std. dev.
FM	0.0					
GM	0.0					
UM	0.0					
GG	9.6	17.8	0.7	2.2	[a]	
UU	13.5	20.1	0.0			
MU	19.2	10.7	0.0			
GU	29.9	26.4	8.8	15.1	18.4	29.3
MG	34.3	12.3	12.1	13.2	36.1	21.6
GF	34.3	13.8	15.2	18.4	60.5	17.3
MF	35.6	13.5	20.3	16.5	38.4	9.6
FU	39.4	29.8	7.7	8.0	32.6	25.3
UF	42.1	30.2	22.9	22.8	47.0	25.3
UG	45.3	22.7	14.7	11.1	49.0	12.0
MM	50.1	29.5	10.8	12.2	44.7	23.5
FF	54.3	21.3	12.3	10.0	47.1	20.8
FG	60.7	21.8	14.2	8.8	48.2	20.4

[a] The sex of the new adults could not be determined for the GG cross.

and M ♂ × U ♀ crosses eventually reached 60 and 127 eggs/extraction, respectively.

Hatch Rates: The mean percentages for larval hatch are presented in Table 1. The F ♂ × M ♀, G ♂ × M ♀, and U ♂ × M ♀ produced nonviable eggs; the reciprocal crosses produced 35.6, 34.3, and 19.2% viable eggs, respectively. The G ♂ × G ♀ and U ♂ × U ♀ had low rates of hatch compared with the M ♂ × M ♀ and F ♂ × F ♀, which were 50.1 and 54.3% viable, respectively. These hatch rates are comparable to those obtained by Blickenstaff (1969) in his previous cross-mating studies with alfalfa weevils: M ♂ × M ♀, U ♂ × U ♀, M ♂ × U ♀, and U ♂ × M ♀ crosses were 55.0, 56.6, 49.0, and 0.0% hatch, respectively. However, the 13.5 and 19.2% hatch we obtained for U ♂ × U ♀ and M ♂ × U ♀ were much lower than the percentages Blickenstaff obtained for same crosses. This result can be partially explained by the presence of a microsporidian disease in the Utah colony. This disease greatly reduces fertility in 3rd-generation laboratory-reared adult alfalfa weevils (T. U. Hsiao, personal communication).[5]

The low hatch rates for G ♂ × G ♀ may be partially explained by the suspected presence of a lethal factor that may have expressed it-

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self in a sublethal condition in the orange-colored larvae and pupae present in the German weevil population (Robert F. W. Schroder, unpublished data). Eggs, larvae, and adults from the G ♂ × G ♀ crosses did not contain any pathogens.

Adult Emergence Rates: Table 1 summarizes the data for the adult progeny reared from the crosses. The percentage of adults reared from eggs incubated was low and ranged from 0 to 22.0%. However, the 10.8% adults reared from eggs from the M ♂ × M ♀ crosses was very similar to the percentage Blickenstaff (1969) obtained for same crosses (12.1% new adults). On the other hand, no adults developed from the F ♂ × M ♀, G ♂ × M ♀, U ♂ × M ♀, M ♂ × U ♀, and U ♂ × U ♀ crosses, though Blickenstaff (1969) obtained 13.1 and 21.6% new adults from U ♂ × U ♀ and M ♂ × U ♀, respectively.

Sex Ratio: The percentages of males reared from each cross ranged from 18 to 61% for G ♂ × U ♀ and G ♂ × F ♀, respectively (Table 1). The M ♂ × M ♀ crosses produced 45% male progeny compared with 55.7% obtained by Blickenstaff (1969). The U ♂ × F ♀, F ♂ × F ♀, F ♂ × G ♀, and U ♂ × G ♀ produced between 47 to 49% male progeny.

DISCUSSION AND CONCLUSIONS

Compatibility between populations of the alfalfa weevil from Germany and Utah, France and Utah, and Germany and France was demonstrated. Cross-matings between populations from France and Maryland, Germany and Maryland, and Utah and Maryland were partially intersterile: Maryland females crossed with Utah, German, and French males produced infertile eggs, and the reciprocal crosses, though they produced fertile eggs, often produced progeny that were predominantly females. The crosses having the highest ratio of females were: G ♂ × U ♀, F ♂ × U ♀, M ♂ × G ♀, and M ♂ × F ♀. The M ♂ × M ♀ cross was considered normal and had a ratio of 45 ♂ to 55 ♀.

The population of alfalfa weevils in Utah probably originated in western Europe, since they are completely compatible with populations from France and Germany. Thus, parasites collected in western Europe may be more suitable for release in similar climatic regions in the western United States. From the partial interfertility between female weevils from Maryland and males from France, Germany, and Utah, Maryland weevils probably originated from a different area in Europe or from the Middle East. Then studies should be continued to determine the origin of the eastern United States strain. Researchers could then delineate specific geographical areas in which to search for biological control agents that could be collected and released in the eastern region of the United States.

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BOOK REVIEW

INSECT POPULATION ECOLOGY: AN ANALYTICAL APPROACH. G. C. Varley, G. R. Gradwell and M. P. Hassell. 1974. University of California Press, 212 pages. Paperback, price $7.95.

This book is a must for entomologists wishing to keep abreast of modern developments in population ecology. Although primarily intended for the beginning student, older entomologists trained in the traditions of Shelford and Andrewartha and Birch will find this text a readable and painless transition into the current approach to population ecology. The text, which can be read cover-to-cover in an evening, is one of several recently published which serve as a bridge between the treatment of basic ecological principles and the quantitative analysis and interpretation of population data. It assumes no mathematical competence on the part of the reader, but explains concepts such as life tables and how to construct them, density dependent and density independent phenomena that influence population dynamics and how to determine the relative influence of each component in constructing population models, competition theory, and the mathematical theories of various workers for parasite-host or predator-prey interactions.

Readers interested in biological control but not familiar with its principles, procedures and philosophy will find Chapter 9 an excellent capsule summary. It mentions some significant successes (and why there are failures), attributes of "good" biological control agents, recent trends in biological control, and also discusses the relative merits of multiple over single parasite or predator introduction.

GORDON GORDH, *Systematic Entomology Laboratory, IIBIII, Agr. Res. Serv., USDA, c/o U.S. National Museum, Washington, D.C. 20560.*

TWO NEW GENERA AND SOME RECORDS OF MIRIDAE (HEMIPTERA) FROM PANAMÁ

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ABSTRACT—**Englemania** new genus and **Myrmecomiris** new genus are described from Panamá. *Englemania* **bicolor** and *Myrmecomiris* **clistogaster** are described as new species. A list of 26 species of mirids occurring in Panamá is also given.

Among very interesting mirid material sent to me as a gift by Dr. D. Engleman, now living at Coco Solo, Canal Zone, there were specimens of what I am describing below as two new genera. Because there are few records of mirids from Panamá, besides what is recorded by Distant (1883) in *Biologia Centrali Americana*, I thought it convenient to include a list of some species collected by Dr. Engleman and by me.

The types of the new species are deposited in the collection of the United States National Museum (USNM) and paratypes in the collection of the Museum Nacional, Quinta da Boa Vista, Rio de Janeiro, Brazil (MN), and my collection (JMC).

In the descriptions that follow, 25 micrometer units are equivalent to 1 mm. This publication is possible thanks to NSF Grant GB-7382.

Englemania Maldonado, new genus

Bryocorinae, Bryocorini. Habitus as in fig. 1. Head horizontal (fig. 2), angularly produced between antennae, inserted to eyes; tylus arising close to level of apex of antennal sockets; vertex inconspicuously corrugate, convex; eyes moderately large, occupying sides of head, not quite reaching level of top and venter of head, separated from bucculae by distance equal to thickness of 1st antennal segment at apex. Beak straight, reaching base of genital capsule. Antennae inserted contiguous to and at midlength of height of eye (fig. 2). First antennal segment slightly shorter than interocular space, 2nd slightly over twice as long as 1st, 3rd as long as 1st, 4th slightly longer than 1st; 1st 2 much thicker than last 2, both slightly thickening toward apex; all segments thickly covered with abundant fine decumbent pubescence that is shorter than thickness of 1st 2 segments and longer than thickness of last 2.

Pronotum with moderately long collar, longer than thickness of 2nd antennal segment, densely pitted; calli well defined, moderately elevated, somewhat corrugate, well separated from each other in front; posterior lobe densely pitted; lateral margins of pronotum constricted; posterior margin straight above scutellum; without lateral carinae. Scutellum wider than long, disc depressed, margins slightly elevated. Forewing complete, smooth, opaque except membrane, embolium narrow and somewhat thickened, cuneus longer than wide, 2 cells in membrane. Legs slender, tapering to apex, 1st and 3rd thicker than 2nd; hind femur with apex reaching beyond apex of abdomen, slightly curved; covered with abundant fine decumbent pubescence that is shorter than its corresponding segment of origin; tarsi thickened toward apex; arolia absent, pseudarolia arising from ventral surface. Body covered with abundant short fine decumbent pubescence. Genitalia as in fig. 3–6.

Type-species: *Englemania bicolor*, new species.

Because the rostrum reaches beyond the fourth abdominal segment *Englemania* runs to couplet 21 in Carvalho's (1955) key to the Bryocorini genera of the world. Carvalho's key (p. 31) can be modified to include the new genus as follows:

21. Collar strongly depressed, the apical corners of pronotum tuberculate (Venezuela) .... *Pristoneura* Reuter
— Collar not depressed, the apical corners of pronotum not tuberculate 21a
21a. Head roundly produced forward and not reaching midlength of first antennal segment (Brazil) .... *Stictolophus* Bergroth
— Head sharply produced forward and slightly surpassing apex of first antennal segment (Panamá) .... *Englemania* new genus

The genus is dedicated to Dr. D. Engleman for his enthusiastic collecting and interest in the Hemiptera.

Englemania bicolor Maldonado, new species

Male: Habitus as in fig. 1. Head dorsally and laterally, 1st segment of beak and antenna, pronotum above, femora except basally, tibiae, basal ⅓ of clavus, outer longitudinal ½ of corium, embolium, and cuneus light orange brown. Second antennal segment, scutellum, apical ⅔ of clavus, inner longitudinal ½ of corium, and membrane dark brown. Head below, last 2 antennal segments, last 3 segments of beak, trochanters, base of femora, and 1st tarsal segments light stramineous. Metasternum orange. Abdomen mostly brownish, irregularly spotted with some lighter and some slightly darker areas.

Head: Length 8, width across eyes 10.5, interocular space 5. Antennal segments: 4.5 : 10 : 4.5 : 5.5, shape and pilosity as described for genus. Beak: 15 : 10 : 8 : 4, the fourth segment with the basal half overlapping the third, first reaching posterior margins of anterior coxae. Pronotum: pilosity, collar, calli, anterior and posterior lobes, and lateral and posterior margins as described for genus; length 9.5, anterior width 7, posterior width 15.5. Scutellum: width 8, length 6. Length to apex of forewing 2.0–2.1, width across forewing 0.73 mm. Genitalia as in figures 3–6.

Female unknown.

Holotype: ♂, Coco Solo Hospital, 9°21'N–79°51'W, Canal Zone, Panamá, in light trap, 14 September 1972, D. Engleman collector, USNM, Cat. No. 73272. Paratypes: 3 ♂♂, same place of collection, each on different dates, 1 in MN, 2 in JMC.

Myrmecomiris Maldonado, new genus

Mirinae, Herdoniini. Habitus as in fig. 7, ant-mimic. Head vertical, long (fig. 8–9); in dorsal aspect very slightly produced between antennae, inserted to eyes,

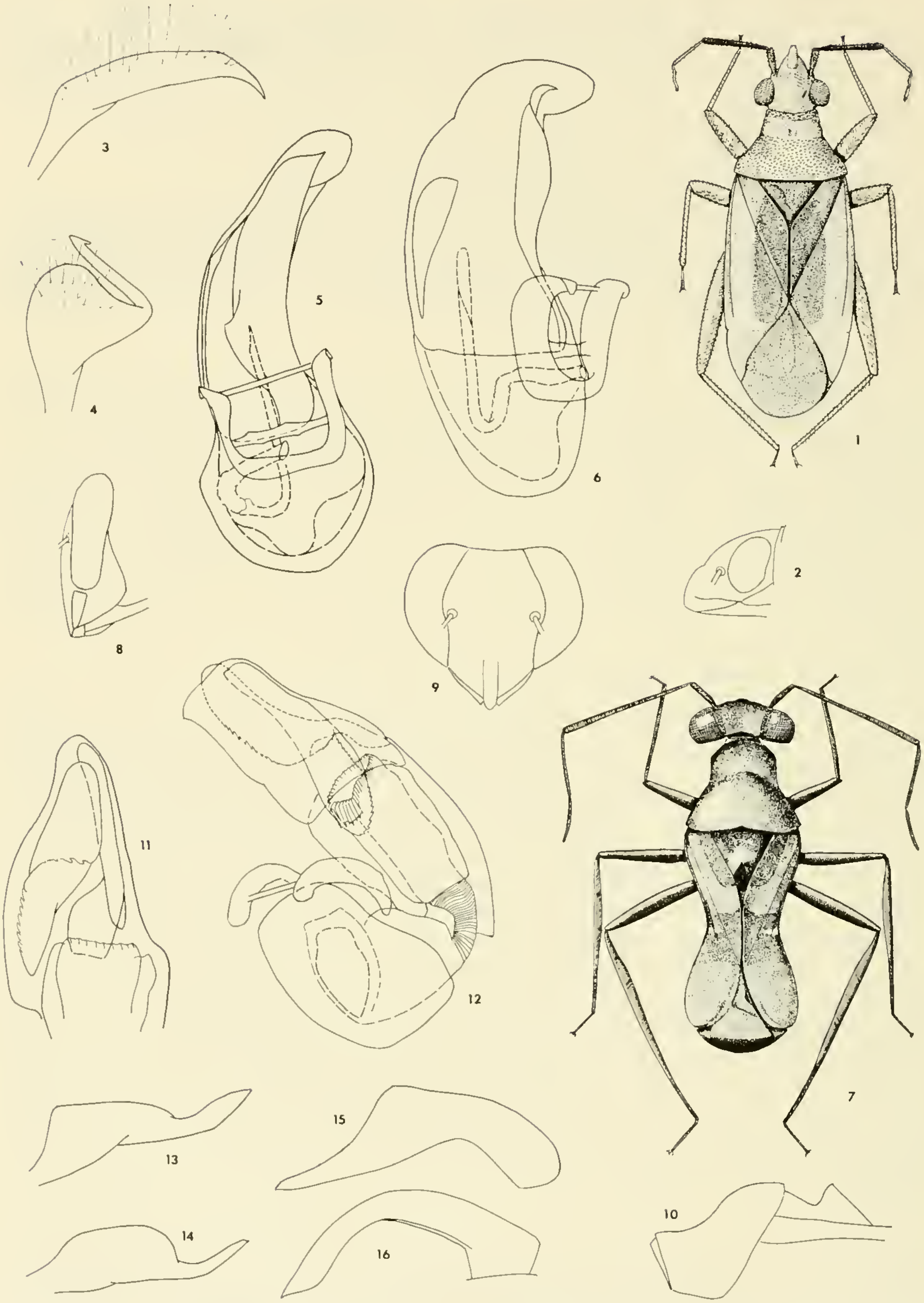

Fig. 1–6. *Englemania bicolor*, male. 1, habitus. 2, head, lateral. 3, left clasper, dorsal. 4, right clasper, ventral. 5, aedeagus, dorsal. 6, aedeagus, lateral. Fig. 7–16. *Myrmecomiris clistogaster*, male. 7, habitus. 8, head, lateral. 9, head, frontal. 10, pronotum and scutellum, lateral. 11, tip of aedeagus, ventral. 12, aedeagus, latero-dorsal. 13, right clasper, lateral. 14, right clasper, dorsal. 15, left clasper, lateral. 16, left clasper, dorsal.

very broad, almost as wide as widest part of pronotum; eyes large, from above slightly produced backward and reaching slightly beyond collar, in lateral aspect slightly over ⅔ as long as head; antennae inserted close to eyes, at about midlength of eye in shallow concavity of inner margin; vertex smooth, slightly sunken along median line. Vertex and frons smooth, with moderately long vertical hairs. Antennae with 1st 2 segments thicker than last 2; 2nd slightly incrasate, 4× as long as 1st; 3rd 2× as long as 4th and slightly over ½ as long as 2nd, covered with inconspicuous very short pilosity. Beak straight, almost reaching anterior margin of middle coxae. Pronotum smooth, strongly constricted before middle; collar sunken, well defined, short, slightly shorter than thickness of 1st segment; anterior lobe flat above (fig. 10), anterior margin slightly convex; posterior lobe globose, widening to lateral angles, posterior margin slightly bisinuate; anterior lobe and contiguous areas of posterior lobe with long silvery decumbent pubescence pointing cephalad, remaining part of hind lobe with scattered shorter vertical pilosity. Scutellum with erect, broad, conical projection (fig. 10); with scattered long vertical pilosity. Forewing strongly constricted at about midlength, area near constriction velvety, basad and caudad of this area somewhat polished, inner longitudinal ½ of clavus velvety; membrane from level of cuneus bent at 90°; cuneus 2× as long as wide at base, basally cleft from clavus. Coxae of forelegs well separated from last 2 pairs, which are contiguous; forefemora thickest at midlength, mid- and hind femora widest basally; foretibiae straight, of same thickness throughout; fore and hind tibiae flattened on basal half; legs with sparse, long, vertical, grayish pilosity; arolia divergent, 1st segment of hind tarsi shorter than 2nd and 3rd together. Abdomen strongly constricted and flattened at base; apical portion broad, thick, and bent downward so that last terga are vertical. Genitalia as in fig. 11–16.

Female unknown.

Type-species: *Myrmecomiris clistogaster*, new species.

The erect conical projection on disc of scutellum and the strongly constricted pronotum, place *Myrmecomiris* close to *Zacynthus* Distant in Carvalho's (1955) key to the genera of Herdoniini (p. 109). They differ as follows: *Zacynthus*—head subtriangular and subobliquely deflected, vertex longitudinally sulcate, first antennal segment shorter than length of head, anterior margin of pronotum subtruncate or slightly emarginate, spine of scutellum slender and with a distinct central carination to apex; *Myrmecomiris*—head very broad and vertical, vertex not sulcate, first antennal segment longer than length of head, anterior margin of pronotum slightly convex, spine of scutellum conical and without carination at apex. The very broad head and the conical spine on disc of scutellum separate *Myrmecomiris* from other Herdoniini. The generic name refers to the ant-like shape of the body.

Myrmecomiris clistogaster Maldonado, new species

Male: Mostly black, slightly polished; short white transverse fascia on corium; mid- and hind coxae whitish below. Tibiae dark gray on apical half. *Head*: Width across eyes 34, interocular space 8, length 8, length of face 29. *Antenna*: 10 : 41 : 24 : 17. *Pronotum*: Length 28, anterior width 17, posterior width 34.

Width at constriction of forewings 23. *Scutellum*: Length 18, width at base 20. Length to apex of corium 4.0 mm., width across humeral angles of pronotum 1.4 mm.

Genitalia as described for genus.

Holotype: ♂, Coco Solo Hospital, Canal Zone, Panamá, in light trap, 9°21'N–79°51'W, 13 September 1972, D. Engleman collector, USNM, Cat. No. 73273. Paratypes: 3 ♂♂, same place of collection, each on a different date, 1 in MN, 3 in JMC.

The trivial name of the species refers to the narrow waistlike abdomen.

Records of Miridae from Panamá

In the following records, if no collector is given the specimens were collected by Dr. D. Engleman. The specimens are deposited in my collection.

BRYOCORINAE: Bryocorini

Bothrophorella nigra (Stal)—Porto Bello, JMC.
Eccritotarsus embolionigrus Carv.—Cerro Campana, 850 m., Stockwell coll.
Neella carvalhoi Hsiao—Gatun Spillway, Coco Solo Hospital.
Neella floridula (Distant)—Cerro Campana
Neofurius bimaculatus Carv. & Hsiao—Coco Solo Hospital
Pachymerocerista pilosus (Carv.)—Coco Solo Hospital
Panamacoris stramineous Carv. & Penha—Coco Solo Hospital
Parafurius discifer (Stal)—Madden Dam, C. Z., Punta Vacamonte 8°52'N, 79°40'W
Pycnoderes atratus (Distant)—Coco Solo Hospital
Pycnoderes quadrimaculatus G.-M.—Boquete, Prov. Chiriquí; Panamá City, Porto Bello, JMC.

DERAEOCORINAE: Hyaliodini

Annona bimaculata (Distant)—Boquete, Prov. Chiriquí
Florus insolitus Distant—Coco Solo Hospital

MIRINAE

Mirini

Euchilocoris scutellatus (Distant)—Coco Solo Hospital, C. Z.
Horcias variegata Distant—Coco Solo Hospital
Lampetusa anatina Distant—Coco Solo Hospital; Madden Reservoir.
Mabelia pulcherrima Kirkaldy—Coco Solo Hospital.
Piasus n. sp., apparently the second species in the genus as the specimens at hand do not agree with Carvalho's (1946) description of *P. cribricollis* (Stal); Coco Solo Hospital.
Prepops frontalis Reuter—Coco Solo Hospital.
Proba sallei (Stal)—Boquete, Prov. Chiriquí.
Taedia signata Carv. & Gomez—Coco Solo Hospital.
Taylorilygus pallidulus (Blanch.)—Coco Solo Hospital; Boquete. Prov. Chiriquí.

Stenodemini

Collaria oleosa (Distant)—Darien; Boquete, Coco Solo Hospital; Panamá City, Porto Bello, JMC.

Herdoniini

Paraxenetus gibbus (Distant), Coco Solo Hospital.
Paraxenetus bracteatus (Distant), Coco Solo Hospital.

PHYLINAE

Phylini

Campylomma cardini Barber & Brunner—Coco Solo Hospital.

Dicyphini

Macrolophus cuiabanus Carv.—Fort Amador, Ch. Keenan coll.

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BOOK REVIEW

Factors affecting dispersal distances of small organisms. D. O. Wolfenbarger. 1975. Exposition Press, Hicksville, New York, 230 pp. Hardbound. $15.00.

Entomologists interested in the phenomenon of dispersal will find this well-written book a useful reference. It is a welcome addition to entomological literature because it covers an area not otherwise treated in detail and should provide impetus for studies primarily directed toward dispersal per se. Insect examples are in the majority, but this undoubtedly stems from the fact that most research on the subject of dispersal has employed insects as subjects. However, Wolfenbarger has done an admirable job in trying to maintain a balanced perspective by presenting data on spores, pollen, mites, nematodes and bacteria.

The basic format treats inorganic and organic factors which influence dispersal, and each topic is treated systematically.

The primary shortcoming of this book is that of the 400 plus references cited, over 85% are more than 15 years old. A second weakness of the book, recognized by the author, is that virtually all of the references are English-language papers.

The cost of the book is somewhat high, but this seems to be a general trend of the present.

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TWO NEW SPECIES OF MIMOSEPSIS SABROSKY (DIPTERA: CHLOROPIDAE) FROM NIGERIA

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ABSTRACT—The generic diagnosis of *Mimosepsis* Sabrosky is modified and a key to the species is given. *Mimosepsis* **scutellaris** and *M.* **myrmecophila** are described as new species.

The genus *Mimosepsis* of the subfamily Oscinellinae was erected by Sabrosky (1951:748) to accommodate his new Nigerian species *M. mallochi* (1951:749).

Mr. M. A. Cornes of the Nigerian Stored Products Research Institute, Lagos has collected *M. mallochi* and series of two new species referable to this genus, which he has kindly asked me to describe. This new material exhibits some characteristics that differ from the original generic diagnosis, which calls for some modification of it. The number of pairs of orbital bristles varies from four to six, the ratio of the lengths of second to third costal sectors from 2.3 : 1 to 4.6 : 1 and the ratio of the length of hind crossvein to apical section of fifth vein from 1 : 1.5 to 1 : 2.0. The subbasal constriction of the abdomen varies from strongly petiolate (fig. 6, 7) to slightly constricted (fig. 8). The abdomen of the male bears, in addition to the hypopygium, only four visible segments. If the prehypopygial tergite, which bears no spiracles, is considered to be a fusion of tergites 6 + 7, then the apparent basal tergite is a fusion of 1 + 2 + 3. Hennig (1958:634, fig. 280), however, shows that in *Oscinella frit* (L.) the apparent prehypopygial tergite bears two pairs of spiracles and is therefore a fusion of two tergites (6 + 7), but he states (1958:676) "Bisher sind allerdings nur sehr wenige Arten auf dieses Merkmal hin untersucht worden und es wäre wichtig, durch ausgedehntere Untersuchungen festzustellen, ob im Grundplan der Chloropidae wirklich nur 1 Tergitkomplex zwischen Praeabdomen und Hypopygium vorhanden ist." Other diagnostic characters common to species of *Mimosepsis*, but not included in the original description, are: Proboscis geniculate, extending forwards to or almost to the tips of the palpi, the apical backwardly-directed section slightly longer than the basal section; lower occiput with a pair of long straight bristles situated midway between neck and mouth margin; hindermost jowlar bristle long and erect, not forwardly-directed as are the others; female abdomen with five apparent tergites, the oviposter, when extended, as long as the preabdomen.

Key to species of *Mimosepsis*

1. Wing with 2 conspicuous infuscate areas, basal 1 including area proximad and anterior to base of discal cell and embracing entire costal and 1st basal cells, and large preapical spot. Scutellum black. Abdomen (fig. 6,7) strongly petiolate, the basal dorsal membranous area (dotted in fig.) straplike. Hairs on arista (fig. 4) shorter, not longer than its basal diameter. Upper occiput medially concave. Mesonotum medially with double row of setulae 2

— Only preapical (in this case almost apical) dark spot present on wing. Scutellum lemon yellow, strongly contrasting with black thorax. Abdomen (fig. 8) only slightly constricted near base, the basal dorsal membranous area cupshaped. Upper occiput medially convex. Mesonotum medially with single row of setulae .... *scutellaris*, new species

2. Third costal sector twice as long as 4th (fig. 1). Preapical wing spot narrow, not or hardly wider than length of 4th costal sector .... *mallochi* Sabrosky

— Third costal sector 2.8 times as long as 4th (fig. 2). Preapical wing spot large, three times as broad as the length of the fourth costal sector .... *myrmecophila*, new species

Mimosepsis mallochi Sabrosky

fig. 1, 6

Female: W. Nigeria: Ilaro Forest, 3.iii.1974, M. A. Cornes. This is darker than any of the type-series, having the humerus black and the fore coxa reddish black.

Mimosepsis scutellaris Deeming, new species

fig. 3, 5, 8, 9

Male: Head black, very narrowly yellow on anterior and lower eye margins, more broadly so on orbits, with face and anterior part of frons reddish black, greyish dusted throughout with exception of shining black jowls; ratio of length of face to width of frons at fore margin = 1 : 1.7; 4 pairs orbital bristles; only 2 pairs incurved interfrontal bristles bordering ocellar triangle; ocellar bristles shorter than postverticals; antenna yellowish brown with apex of 3rd segment darker; arista (fig. 5) dark, rather long haired; palpus yellow to brown apically, becoming black basally; clypeus and proboscis black. Thorax black, greyish dusted, with scutellum lemon yellow and scutellar hairs and bristles dirty yellow; notopleural bristles subequal; mesonotum with single row of close set setulae medially and shorter row of much more irregular and widely spaced setulae between it and dorsocentral lines. Legs weakly grey dusted, yellow, with mid and hind coxae, apical half of mid-femur, basal ⅓ to ⅔ of mid-tibia and entire hind tibia black, sometimes also fore coxa and femur and entire mid-femur black or fore femur with infuscate longitudinal stripe posteriorly. Wing hyaline with dirty-yellow veins and distinct preapical dark spot (fig. 3); ratio of length of 2nd to 3rd to 4th costal sectors = 8.8 : 1.9 : 1; apical section of 5th vein 2× as long as posterior crossvein; haltere yellow with a slightly darker stem. Abdomen black, grey dusted, lacking long bristles, but little constricted near base in dorsal view (fig. 8), dorsal basal membranous area cupshaped; hypopygium (fig. 9); genital

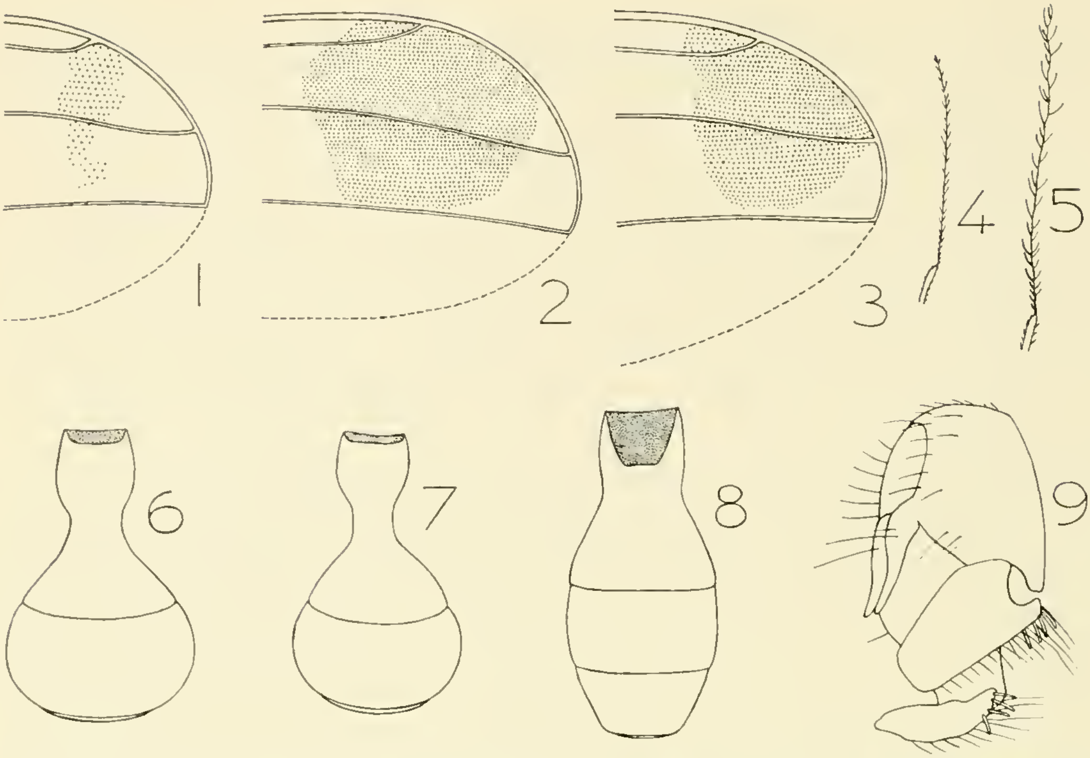

Fig. 1–3. Wing tip of *Mimosepsis* sp. 1, *M. mallochi.* 2, *M. myrmecophila.* 3, *M. scutellaris.* Fig. 4–5. Arista of *Mimosepsis* sp. 4, *M. myrmecophila.* 5, *M. scutellaris.* Fig. 6–8. Dorsal view of abdomen of *Mimosepsis* sp. 6, *M. mallochi.* 7, *M. myrmecophila.* 8, *M. scutellaris.* Fig. 9. Hypopygium and appendages of *M. scutellaris.*

forceps bearing long fine hairs and several short stout apically rounded bristles. Length about 3 mm.

Female: Resembling male, apart from sexual differences in abdominal structure, differing from male in having antennae dark brown throughout and legs colored as in darker males but with hind femur yellow only at extreme base.

Holotype: ♂, Nigeria, Lagos State, Ikorodu, 25.viii.1974, M. A. Cornes. Paratypes: 4 ♂♂, 3 ♀♀, same data; 3 ♂♂, 2 ♀♀, 10 miles W. of Lagos, 24.ii.1974, *Crematogaster* ant associated; 5 ♂♂, 1 ♀, 4 miles N.W. of Agege, 18.viii.1974; 4 ♂♂, W. Nigeria, Ilaro Forest, 29.xii.1974, all the above coll. M. A. Cornes; ♂, N. Nigeria, Niger Prov., Nr. Mokwa, Zugurma, 24.xii.1971, J. C. Deeming.

Holotype and paratypes in Brit. Mus. (Nat. Hist.), paratypes in Cornes/Riley Coll., Inst. Agric. Res., Samaru, U.S. Nat. Mus. and Mus. Nat. Hist. Nat., Paris.

Mimosepsis myrmecophila Deeming, new species

fig. 2, 4, 7

Male: Head black, grey dusted except on jowls, faintly and narrowly yellow on eye margin except posteriorly and with face and anterior part of frons reddish black; width of frons at fore margin twice length of face; 5 pairs incurved interfrontal hairs; antenna brown; arista (fig. 4) short haired; palpus yellow apically, dark basally; clypeus and proboscis black. Thorax black, grey dusted; mesonotum with 2 approximated rows of close-set setulae medially and equally long row of close-set setulae between them and dorsocentral lines. Legs weakly dusted, yellow on entire midtarsus and apical 3 segments of fore and hind tarsus, deep black on mid- and hind coxa, mid-tibia and hind femur and tibia, elsewhere reddish brown to reddish black. Wing hyaline with brown veins and a basal and (fig. 2) preapical dark spot; ratio of length of 2nd to 3rd to 4th costal sectors = 6.3 : 2.8 : 1; apical section of 5th vein 1.8 times as long as posterior crossvein; haltere vivid yellow with black stem. Abdomen (fig. 7) black, grey dusted with only fine hairs, strongly petiolate, the basal dorsal membranous area strap-like; hypopygium and appendages very similar to those of *scutellaris*, but hypopygium more extensively haired and genital forceps lacking short blunt bristles. Length about 2.8 mm.

Female unknown.

Holotype: ♂, W. Nigeria, Ilaro Forest, 2.xii.1973, ant associated, M. A. Cornes. Paratypes; ♂, same data; 3 ♂♂, same locality and collector, 3.iii.1974.

Holotype in Brit. Mus. (Nat. Hist.), paratypes in Cornes/Riley Coll., Inst. Agric. Res., Samaru, U.S. Nat. Mus. and Mus. Nat. Hist. Nat., Paris.

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NOTE

NEW NAMES FOR NORTH AMERICAN CERATOPOGONIDAE (DIPTERA)

I am taking this opportunity to propose new names for two species of Ceratopogonidae whose names are preoccupied. I am much indebted to A. V. Gutsevich and H. Remm for calling the homonymy to my attention.

Culicoides neomontanus Wirth, new name for *Culicoides montanus* Wirth and Blanton, 1969, Proc. Ent. Soc. Washington 52:225 (preoccupied by *Culicoides montanus* Shakirzjanova, 1962, Akad. Nauk Kazakhskoi SSR Inst. Zool. Trudy 18:258).

Dasyhelea neobifurcata Wirth, new name for *Dasyhelea bifurcata* Wirth, 1952, Univ. California Pubs. Ent. 9:161 (preoccupied by *Dasyhelea bifurcata* Kieffer, 1923, Arch. Inst. Pasteur d'Algerie 1:669).

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BIOLOGY AND IMMATURE STAGES OF EIGHT SPECIES OF LAUXANIIDAE (DIPTERA). II. DESCRIPTIONS OF IMMATURE STAGES AND DISCUSSION OF LARVAL FEEDING HABITS AND MORPHOLOGY

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ABSTRACT—The morphology of the eggs, 3 larval instars, and puparia of *Camptoprosopella confusa* Shewell, *Homoneura americana* (Wiedemann), *Lyciella browni* (Curran), *Minettia lupulina* (Fabricius), *M. lyraformis* Shewell, *Poecilominettia ordinaria* (Melander), *Pseudocalliope flaviceps* (Loew), and *Pseudogriphoneura gracilipes* (Loew) are described and illustrated. The significance of the larval feeding habits and of the morphology of the larvae is discussed.

The first part of this study (Miller and Foote, 1975) presented life history information and observations on larval food preferences for *Camptoprosopella confusa* Shewell, *Homoneura americana* (Wiedemann), *Lyciella browni* (Curran), *Minettia lupulina* (Fabricius), *M. lyraformis* Shewell, *Poecilominettia ordinaria* (Melander), *Pseudocalliope flaviceps* (Loew), and *Pseudogriphoneura gracilipes* (Loew), 8 species of lauxaniid flies that are common and widely distributed in eastern North America.

The present paper includes descriptions and illustrations of the eggs, 3 larval instars, and puparia of these same 8 species. It also discusses the significance of the larval feeding habits and of the morphology of the larvae.

Descriptions of Immature Stages

Several features held in common by the 8 species studied in this investigation are presented below. In the individual species descriptions given later, only the third instars are described in detail; descriptions of the 2 earlier instars are restrcted to distinctive characters.

Egg: White. Micropyle apical, shielded dorsally by small tubercle. Ends of eggs reticulated or pitted, without ridges. Elsewhere, chorion with few to numerous longitudinal ridges.

First Instar: White to colorless, integument transparent to translucent. Malpighian tubules white, usually inconspicuous. Metapneustic. Facial mask with at most 2 indistinct rows of spinules. Two spiracular slits, forming V-shaped structure. Cephalopharyngeal skeleton usually lightly pigmented and weakly developed; basal part of mouthhooks lacking windows; no dental sclerites; epistomal sclerite apparently fused to hypostomal sclerite; posteroventral margin of hypo-

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stomal sclerite fused with anterior border of pharyngeal sclerite, hypostomal bridge poorly developed; ligulate sclerites barely noticeable; posterior margins of ventral cornua of pharyngeal sclerite poorly defined, no parastomal bars, pharyngeal ridges in floor of pharyngeal sclerite indistinct.

Second Instar: Malpighian tubules white, usually evident. Facial mask with 3–4 rows of distinct spinules. Cephalopharyngeal skeleton deeply pigmented; mouthhooks with hook part and ventromedial portion of basal part less pigmented; hypstomal sclerite fused to pharyngeal sclerite; pharyngeal ridges 6–8.

Third Instar: White, integument translucent. Conic-cylindrical, usually tapering more anteriorly than posteriorly, somewhat flattened. Malpighian tubules white, conspicuous, convoluted, located between cephalopharyngeal skeleton and mid-point of body. All segments with spinule bands on anterodorsal margins, segments 3–12 with spinule bands also on anteroventral margins.

Segment 1 longitudinally bilobed apically; each lobe bearing short and fleshy 2-segmented antenna and unsegmented maxillary palp, palp without distinct sclerotized basal ring; facial mask with 4 or 5 distinct rows of spinules, most anteromedial spinules not in rows, spinules somewhat darkened and bifurcate apically.

Anterior spiracles white; located posterolaterally on segment 2; each spiracle with few to many apical papillae, each papilla surrounded by membrane; spiracles commonly projecting at nearly right angles to body of larva. Segment 12 with protrusible ambulatory lobes arising from the elongate-oval perianal pad on venter; anal slit elongate, in middle of perianal pad; posterior spiracular tubes generally arising close together on posterodorsal surface of spiracular disc; spiracular disc with variously placed marginal lobes and tubercles. Posterior spiracular plates at apices of frequently darkened spiracular tubes, each place with 3 spiracular slits, 4 variously branched interspiracular processes, and 1 oval spiracular scar.

Cephalopharyngeal skeleton mostly deeply pigmented. Mouthhooks well developed, converging anteriorly, not fused dorsally, hook part strongly decurved (except in *Lyciella browni*), basal part with 2 small, nearly contiguous windows medially (except in *Camptoprosopella confusa*). Dental sclerites well developed (except in *Minettia lyraformis* and *Lyciella browni*), triangular in lateral view and linear in ventral view. Epistomal sclerite arched; with rod-like rami posteriorly extending to near middle of hypostomal sclerite, rami parallel and mesad parastomal bars. Hypostomal sclerite generally H-shaped, not fused posteriorly to pharyngeal sclerite, no hypostomal plate. Subhypostomal sclerites paired, linear, located anterior to ventral bridge of hypostomal sclerite. Ligulate sclerites paired, each articulating with 1 subhypostomal sclerite, sclerites converging anteriorly and usually connected apically by thin membrane. Pharyngeal sclerite with anterodorsal bridge connecting anterior ends of dorsal cornua; anterior edge of pharyngeal sclerite underriding posterior edge of hypostomal sclerite; parastomal bars slender, arising from anterior margin of pharyngeal sclerite and ending laterad to epistomal sclerite; each ventral cornu with window of varying size and shape near posterodorsal margin (except in *Camptoprosopella confusa*, which lacks windows); floor of sclerite with 9 pharyngeal ridges.

Puparium: Integument more or less covered by calcareous, whitish secretion (except in *Pseudocalliope flaviceps*); puparium itself translucent, anterior end slightly flattened dorsoventrally forming lateral ridges. Facial mask black (except in *P. flaviceps*). Anterior spiracles anterolaterad on 1st apparent segment; marginal papillae varying in shape and number, usually white. Ambulatory lobes around perianal pad retracted. Spinule bands as in 3rd instar.

Camptoprosopella confusa Shewell, 1939

Egg (fig. 1): Length 0.62–0.66 mm, greatest width 0.23–0.27 mm. Ovoid, more convex dorsally than ventrally; anterior end gradually narrowing to broad tubercle shielding micropyle dorsally; posterior end narrowing to small, round tubercle borne on slightly constricted stalk. Chorionic ridges 11–13, undivided or occasionally branching posteriorly.

First Instar: Length 1.00–1.78 mm, greatest width 0.23–0.40 mm. Posterior spiracular plates (fig. 67) with numerous long, finely branched interspiracular processes with 3–4 branches. Cephalopharyngeal skeleton (fig. 27) length 0.18–0.21 mm; mouthhooks well developed, hook part with accessory tooth.

Second Instar: Length 1.41–3.22 mm, greatest width 0.37–0.61 mm. Anterior spiracles (fig. 11) with apical papillae short. Spiracular plates (fig. 74) with longer interspiracular processes. Cephalopharyngeal skeleton length 0.28–0.31 mm; hook part of mouthhooks (fig. 34) with 1 accessory tooth.

Third Instar: Length 3.01–5.18 mm, greatest width 0.56–1.05 mm. Prominent spinule bands on anterodorsal and anteroventral margins of segments, less prominent rows of spinules elsewhere on segments. Anterior spiracles (fig. 15) fan-shaped, with 5–7 finger-like, apical papillae. Segment 12 (fig. 93) ventrally with small pointed ambulatory lobes, posterior end of anal slit with cluster of 7–12 spinules; spiracular disc (fig. 90) with pair of small and pointed dorsolateral tubercles, pair of large and blunt lateral tubercles, and pair of small and blunt ventrolateral tubercles; spiracular plate (fig. 82) with 5- or 6-branched interspiracular processes.

Cephalopharyngeal skeleton (fig. 49–52) length 0.43–0.48 mm. Basal part of mouthhooks broad, with 2 small faint, widely separated windows (fig. 50). Epistomal sclerite narrow, posterior rami free apically (fig. 52). Hypostomal sclerite with narrow bridge (fig. 51). Ligulate sclerites much shorter than subhypostomal sclerites (fig. 51). Pharyngeal sclerite (fig. 49) deeply pigmented; anterodorsal bridge broad and indented anteromedially, with numerous oval windows anteriorly and laterally and faint windows centrally (fig. 52); dorsal cornua tapered posteriorly, slightly shorter than ventral cornua; ventral cornua without windows, somewhat rounded apically and with short linear spur extending posterodorsally; parastomal bars apparently fusing distally to dorsomedial surface of hypostomal sclerite.

Puparium (fig. 109): Length 2.45–3.36 mm, greatest width 0.98–1.40 mm. Shiny, light yellow to light orange. Elongate oval, more convex dorsally than ventrally, broadest at mid-length in dorsal view; posterior end rounded, about as broad as anterior end. Perianal pad depressed below general surface of puparium, with light brown transverse groove. Anterior spiracles sessile, with 5–7 marginal papillae.

Homoneura americana (Wiedemann), 1830

Egg (fig. 2): Length 0.58–0.73 mm, greatest width 0.23–0.32 mm. Ovoid; anterior end pointed and bearing small tubercle dorso-apically, posterior end more rounded; chorion with 11–13 undivided or rarely branching ridges, ridges con-

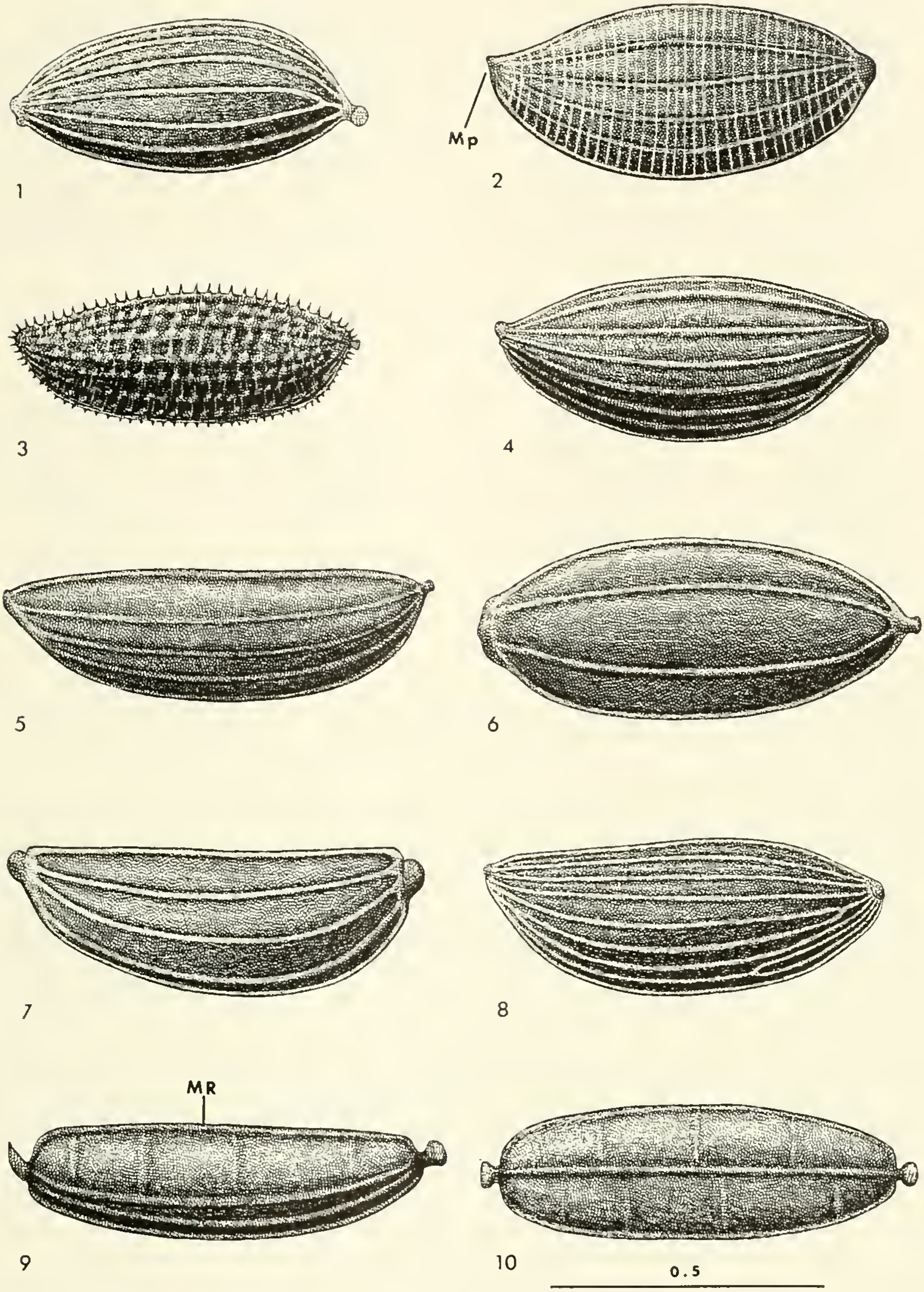


Fig. 1–10. Eggs. 1, *C. confusa.* 2, *H. americana.* 3, *L. browni.* 4, *M. lupulina.* 5, *M. lyraformis.* 6, same, dorsal view. 7, *P. ordinaria.* 8, *P. flaviceps.* 9, *P. gracilipes.* 10, same, dorsal view.

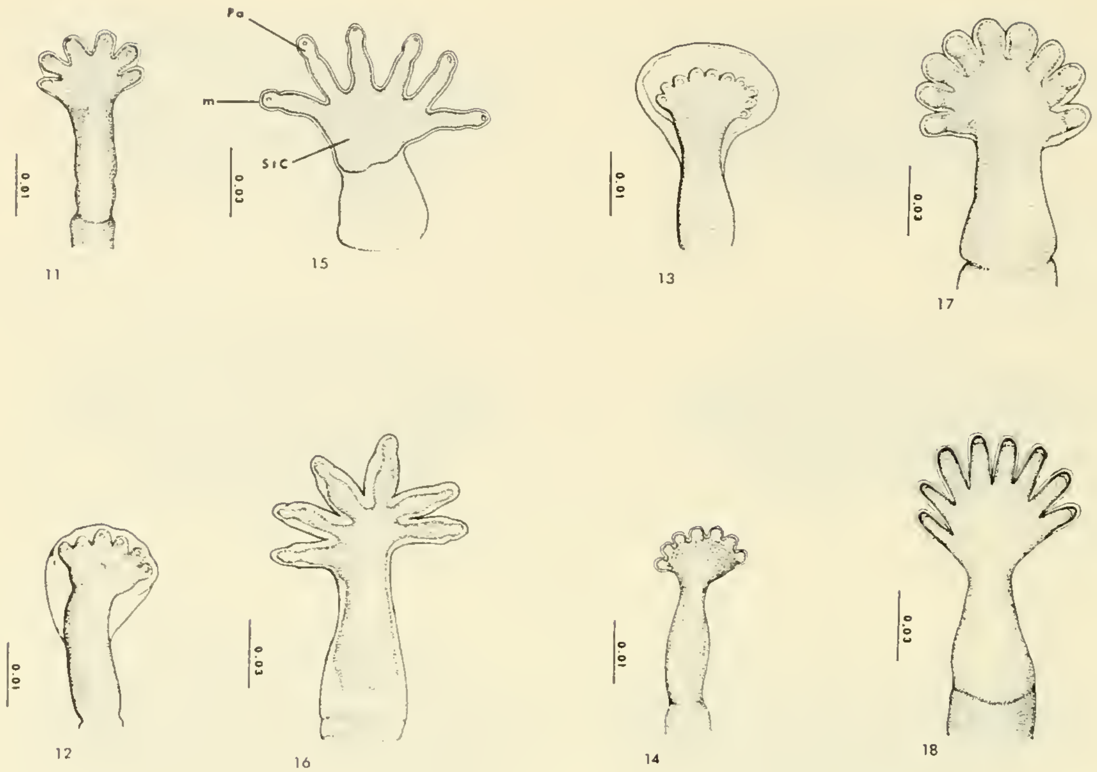


Fig. 11–18. Anterior spiracles. 11–14, 2nd instars. 15–18, 3rd instars. 11, 15, *C. confusa*. 12, 16, *H. americana*. 13, 17, *L. browni*. 14, 18, *M. lupulina*.

nected by faint transverse septae, 8–10 dorsal ridges more conspicuous than ventral ridges.

First Instar: Length 0.87–1.84 mm, greatest width 0.20–0.34 mm. Posterior spiracular plates (fig. 71) with 4 or 5 branched interspiracular processes, hairs composing processes not branching apically. Cephalophoryngeal skeleton (fig. 31) length 0.19–0.21 mm; mouthhooks with large accessory tooth laterad on tip and small tooth posteriorly; posterior portion of basal parts narrow, weakly sclerotized.

Second Instar: Length 2.03–3.12 mm, greatest width 0.35–0.66 mm. Spiracles (fig. 12) with 5–6 very short apical papillae. Spiracular plates (fig. 78) with longer interspiracular processes. Cephalopharyngeal skeleton length 0.35–0.41 mm; mouthhooks (fig. 38) with hook part bearing large accessory tooth arising from side of hook and faint accessory tooth close to base of hook.

Third Instar (Fig. 102–104): Length 2.91–3.52 mm, greatest width 1.11–1.33 mm. Prominent spinule bands on anterodorsal and anteroventral margins of segments; spinule bands less conspicuous elsewhere. Anterior spiracles (fig. 16) somewhat fan-shaped, with 5–8 finger-like papillae. Segment 12 (fig. 94) ventrally with very short, pointed ambulatory lobes arising from perianal pad; spiracular disc (fig. 91) with pair of blunt dorsolateral tubercles and pair of blunt 2-tipped, lateral tubercles; spiracular plates (fig. 86) with interspiracular processes having 5–7 branches, some branches bifurcating apically.

Cephalopharyngeal skeleton (fig. 53–55) length 0.53–0.63 mm. Hook part of mouthhooks with small accessory tooth; basal part with anterior window about twice as large as posterior window (fig. 53). Epistomal sclerite narrow, arched

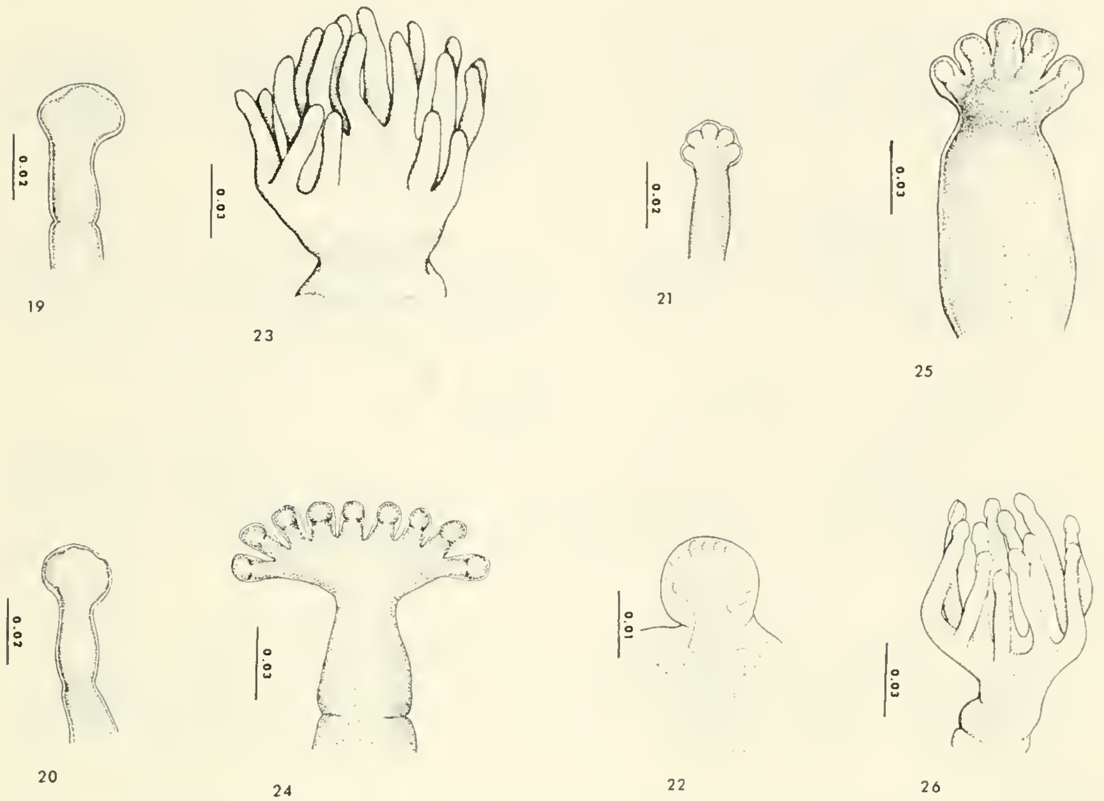


Fig. 19–26. Anterior spiracles. 19–22, 2nd instars. 23–26, 3rd instars. 19, 23, *M. lyraformis*. 20, 24, *P. ordinaria*. 21, 25, *P. flaviceps*. 22, 26, *P. gracilipes*.

dorsally. Hypostomal sclerite distinctly H-shaped, bridge arched ventrally (fig. 54). Ligulate sclerites linear, about same length and shape as subhypostomal sclerites (fig. 54). Pharyngeal sclerite less pigmented anterodorsally, with broad bridge; bridge (fig. 55) poorly pigmented medially and without windows; dorsal cornua heavily pigmented on ventral margin, slightly longer than ventral cornua; ventral cornua poorly pigmented ventrally and posteriorly, pigmented dorsal margin extending posteriorly as narrow black line (fig. 53). Parastomal bars entirely free from hypstomal sclerite.

Puparium (fig. 105, 106): Length 2.91–3.52 mm, greatest width 1.10–1.33 mm. Dull, light yellow to light orange. Elongate oval, slightly more convex dorsally; strongly tapering posteriorly; posterior end distinctly pointed. Perianal pad somewhat protruding. Anterior spiracles sessile, base of expanded portion black.

Lyciella browni (Curran), 1933

Egg (fig. 3): Length 0.62–0.69 mm, greatest width 0.23–0.29 mm. Ovoid; anterior end slightly narrowed to broad tubercle that shields micropyle dorsally; posterior end bearing very small, round tubercle apically. Longitudinal ridges 22–30, mostly not branching; dorsal ridges more prominent and not branching, bearing large, projecting spines at regular intervals; very faint ventral ridges occasionally bifurcating and bearing spines ⅓ size of spines on more dorsal ridges.

First Instar: Length 1.07–1.94 mm, greatest width 0.23–0.44 mm. Spiracular plates (fig. 68) with 3–5-branched interspiracular processes. Cephalopharyngeal skeleton (fig. 30) length 0.20–0.23 mm; only tip of mouthhooks sclerotized; epi-

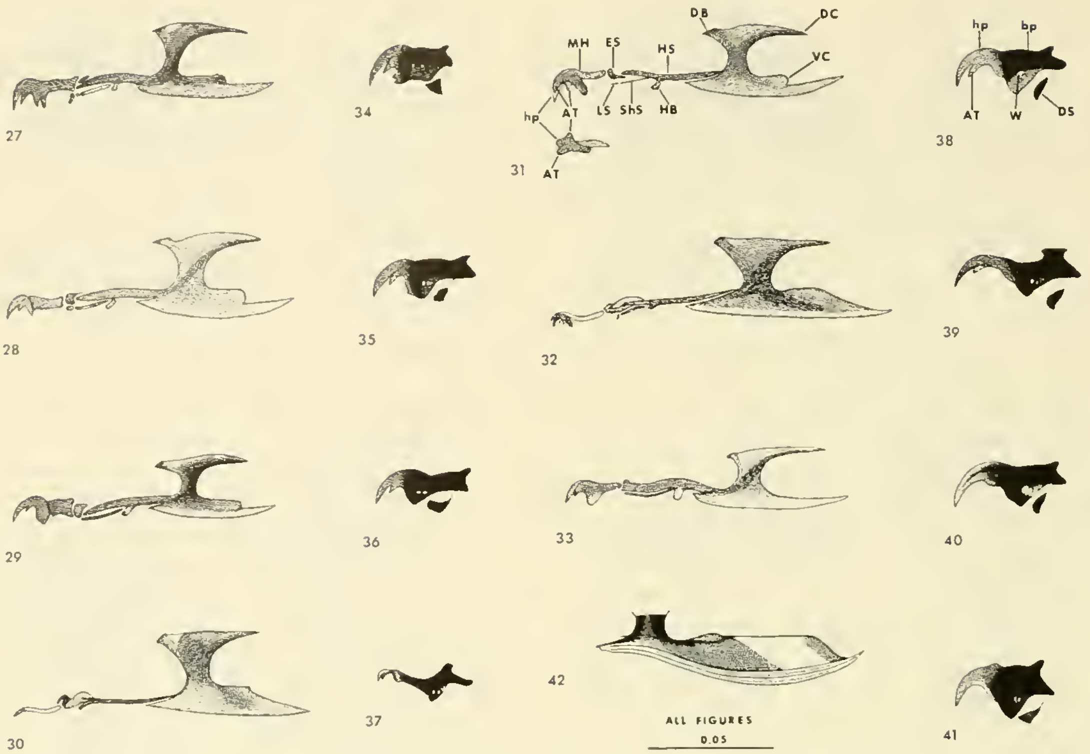


Fig. 27–33. Cephalopharyngeal skeletons of 1st instars. Fig. 34–41. Left mouthhooks of 2nd instars. 27, 34, *C. confusa*. 28, 35, *M. lupulina*. 29, 36, *P. gracilipes*. 30, 37, *L. browni*. 31, 38, *H. americana*. 32, 39, *M. lyraformis*. 33, 40. *P. flaviceps*. 41, *P. ordinaria*. Fig. 42. *L. browni*, ventral cornu of pharyngeal sclerite of 2nd instar.

stomal sclerite appearing to have small hook anteromedially on bridge; pharyngeal sclerite poorly sclerotized.

Second Instar: Length 1.82–3.85 mm, greatest width 0.42–0.91 mm. Anterior spiracles (fig. 13) with very short papillae apically. Posterior spiracular plates (fig. 75) with 3–5-branched, rather broad interspiracular processes. Cephalopharyngeal skeleton length 0.45–0.50 mm; mouthhooks (fig. 37) with hook part bearing accessory tooth nearly equal to length of hook tip, tooth arising from side of hook part; dental sclerites absent; ventral cornua (fig. 42) with hyaline parallelogram-shaped area near posterior end.

Third Instar: Length 3.50–5.43 mm, greatest width 0.70–1.19 mm. Integument with very large spinules not in distinct rows, spinules covering entire dorsal and lateral surfaces of all segments; anteroventral margin of each segment also with narrow band of small spinules. Anterior spiracles (fig. 17) fan-shaped, with 9–10 relatively short, apical papillae. Perianal pad with long, narrow, and tapering ambulatory lobes. Margin of spiracular disc (fig. 98) with pair of small dorsolateral tubercles; very small lateral tubercles; and pair of large, pointed ventrolateral tubercles. Spiracular plates (fig. 83) with 7 to 9-branched interspiracular processes.

Cephalopharyngeal skeleton (fig. 43–45) length 0.80–0.92 mm. Hook part of each mouthhook slightly decurved, mesally with faint window above small accessory tooth; basal part with anterior window slightly larger than posterior window (fig. 43). Epistomal sclerite broad, arched dorsally (fig. 45). Hypostomal sclerite

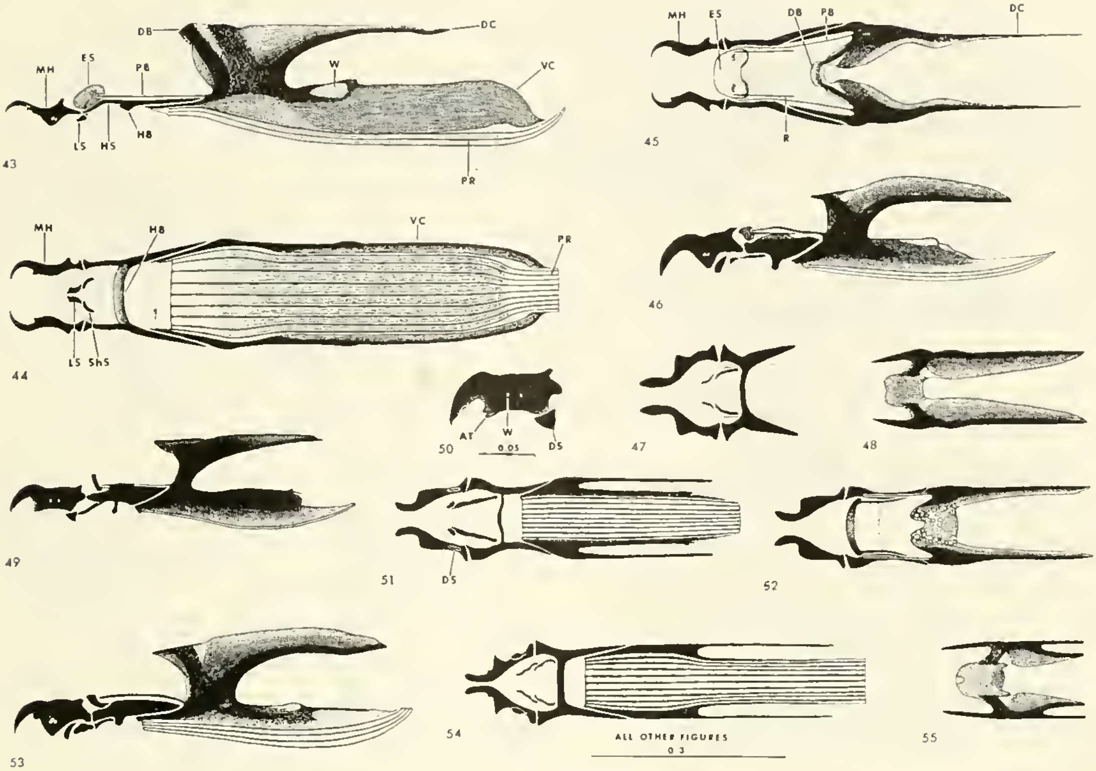


Fig. 43–55. Cephalopharyngeal skeleton of 3rd instars. 43, *L. browni*, lateral view. 44, same, ventral view. 45, same, dorsal view. 46, *M. lupulina*, lateral view. 47, same, ventral view of mouthhooks and hypostomal sclerite. 48, same, dorsal view of pharyngeal sclerite. 49, *C. confusa*, lateral view. 50, same, left mouthhook. 51, same, ventral view of cephalopharyngeal skeleton. 52, same, dorsal view. 53, *H. americana*, lateral view. 54, same, ventral view. 55, same, dorsal view of pharyngeal sclerite.

elongate, bridge narrow and arched ventrally (fig. 44). Subhypostomal sclerites slightly longer than ligulate sclerites. Pharyngeal sclerite narrowly bridged anterodorsally, bridge (fig. 45) without windows; dorsal cornua very narrow, shorter than broad ventral cornua; ventral cornua heavily pigmented only around large basodorsal window, strongly and abruptly narrowed apically to small tip. Parastomal bars free.

Puparium (fig. 110): Length 3.22–3.57 mm, greatest width 1.26–1.47 mm. Dull chestnut brown to dark brown to almost black. Elongate, semihemispherical in lateral view; strongly convex dorsally, flattened ventrally, tapering posteriorly from 4A; posterior end slightly flattened dorsally forming lateral ridges on segments 10 to 12. Posterior spiracles directed upward. Anterior spiracles sessile. Perianal pad depressed, dark brown to black.

Minettia lupulina (Fabricius), 1787

Egg (fig. 4): Length 0.68–0.76 mm, greatest width 0.26–0.31 mm. Ovoid; anterior end bearing small pointed tubercle, posterior end more rounded. Longitudinal ridges 12–16, running singly or occasionally bifurcating; ends of egg faintly reticulated.

First Instar: Length 0.94–2.01 mm, greatest width 0.26–0.40 mm. Posterior spiracular plates (fig. 73) with very long, branching interspiracular processes.

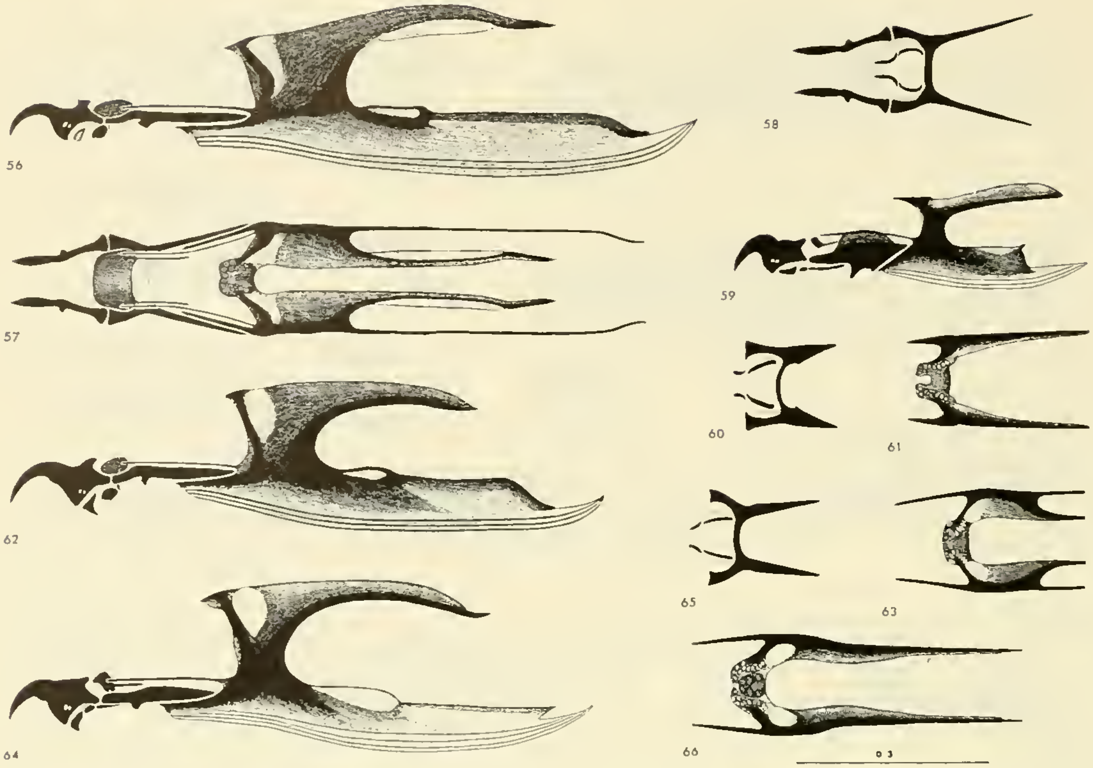


Fig. 56–66. Cephalopharyngeal skeleton of 3rd instars. 56, *M. lyraformis*, lateral view. 57, same, dorsal view. 58, same, ventral view of mouthhooks and hypostomal sclerite. 59, *P. gracilipes*, lateral view. 60, same, ventral view of hypostomal sclerite. 61, same, dorsal view of pharyngeal sclerite. 62, *P. ordinaria*, lateral view. 63, same, dorsal view of pharyngeal sclerite. 64, *P. flaviceps*, lateral view. 65, same, ventral view of hypostomal sclerite. 66, same, dorsal view of pharyngeal sclerite.

Cephalopharyngeal skeleton (fig. 28) length 0.19–0.22 mm; weakly pigmented except for broad line on pharyngeal sclerite. Mouthhooks with small accessory tooth posterior from hook tip; anteroventral margin of basal part tooth-like.

Second Instar: Length 1.68–3.22 mm, greatest width 0.42–0.63 mm. Anterior spiracles (fig. 14) with short, bluntly rounded apical papillae. Posterior spiracular plates (fig. 80) with 3 or 4-branched interspiracular processes. Cephalopharyngeal skeleton length 0.30–0.35 mm. Mouthhooks (fig. 35) with hook part bearing large accessory tooth.

Third Instar: Length 2.94–5.95 mm, greatest width 0.70–1.40 mm. Large spinules in distinct bands on anterodorsal and anteroventral margins, bands of minute spinules elsewhere on dorsal and ventral surfaces of segments.

Anterior spiracles (fig. 18) fan-shaped, with 5–9 apical papillae. Ambulatory lobes of perianal pad long and pointed. Posterior spiracular disc (fig. 97) with pair of small dorsolateral tubercles and pair of large, more pointed ventrolateral tubercles. Posterior spiracular plates (fig. 88) with many interspiracular processes bifurcating apically.

Cephalopharyngeal skeleton (fig. 46–48) length 0.51–0.60 mm. Basal part of mouthhook with 2 equal-sized windows (fig. 46). Epistomal sclerite broad and arched dorsally. Hypostomal sclerite relatively short and broad (fig. 47); lateral rami of epistomal sclerite appearing to fuse with more lightly pigmented area

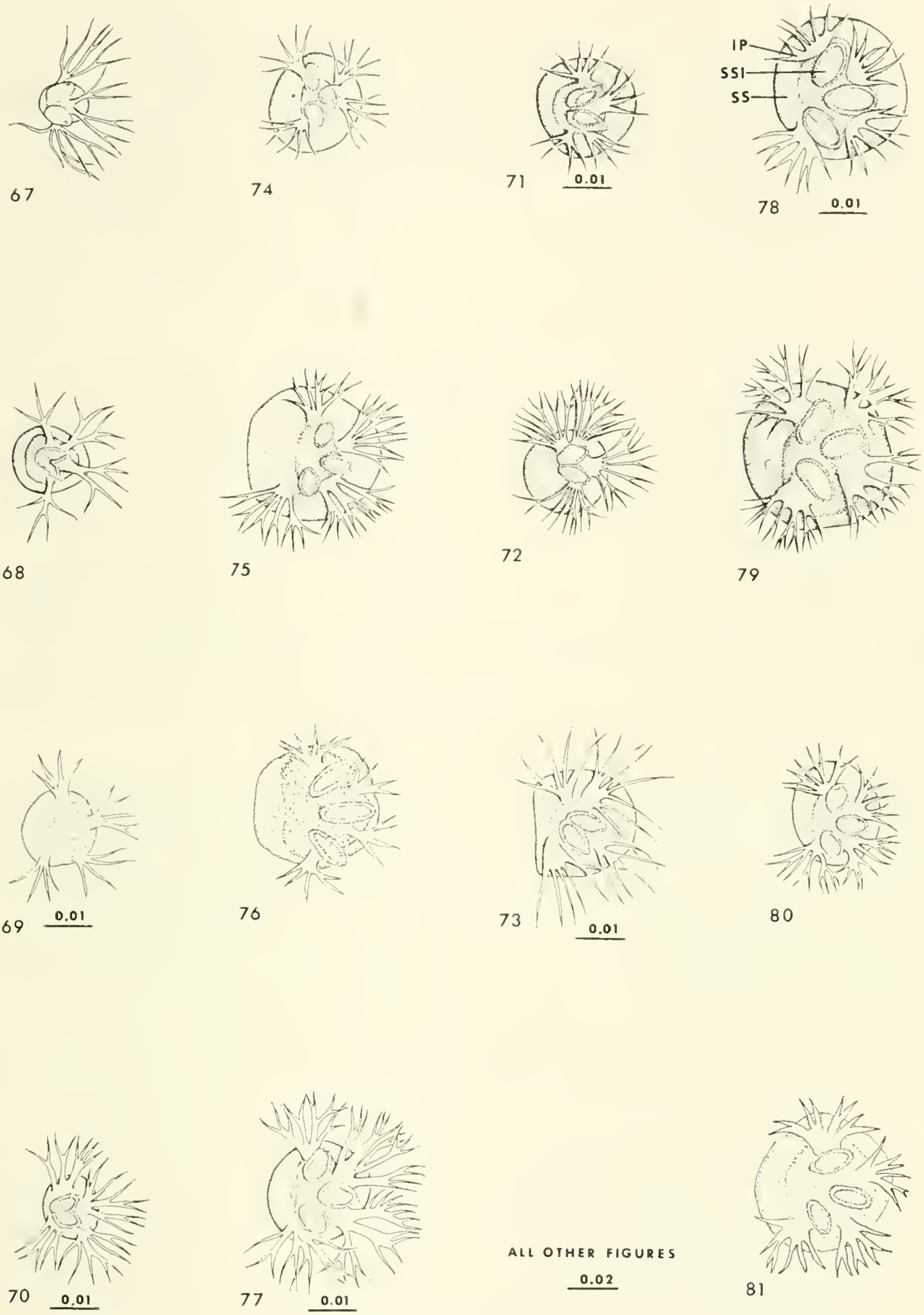


Fig. 67–81. Posterior spiracular plates. 67–73, 1st instars. 74–81, 2nd instars. 67, 74, *C. confusa.* 68, 75, *L. browni.* 69, 76, *P. flaviceps.* 70, 77, *P. gracilipes.* 71, 78, *H. americana.* 72, 79, *M. lyraformis.* 73, 80, *M. lupulina.* 81, *P. ordinaria.*

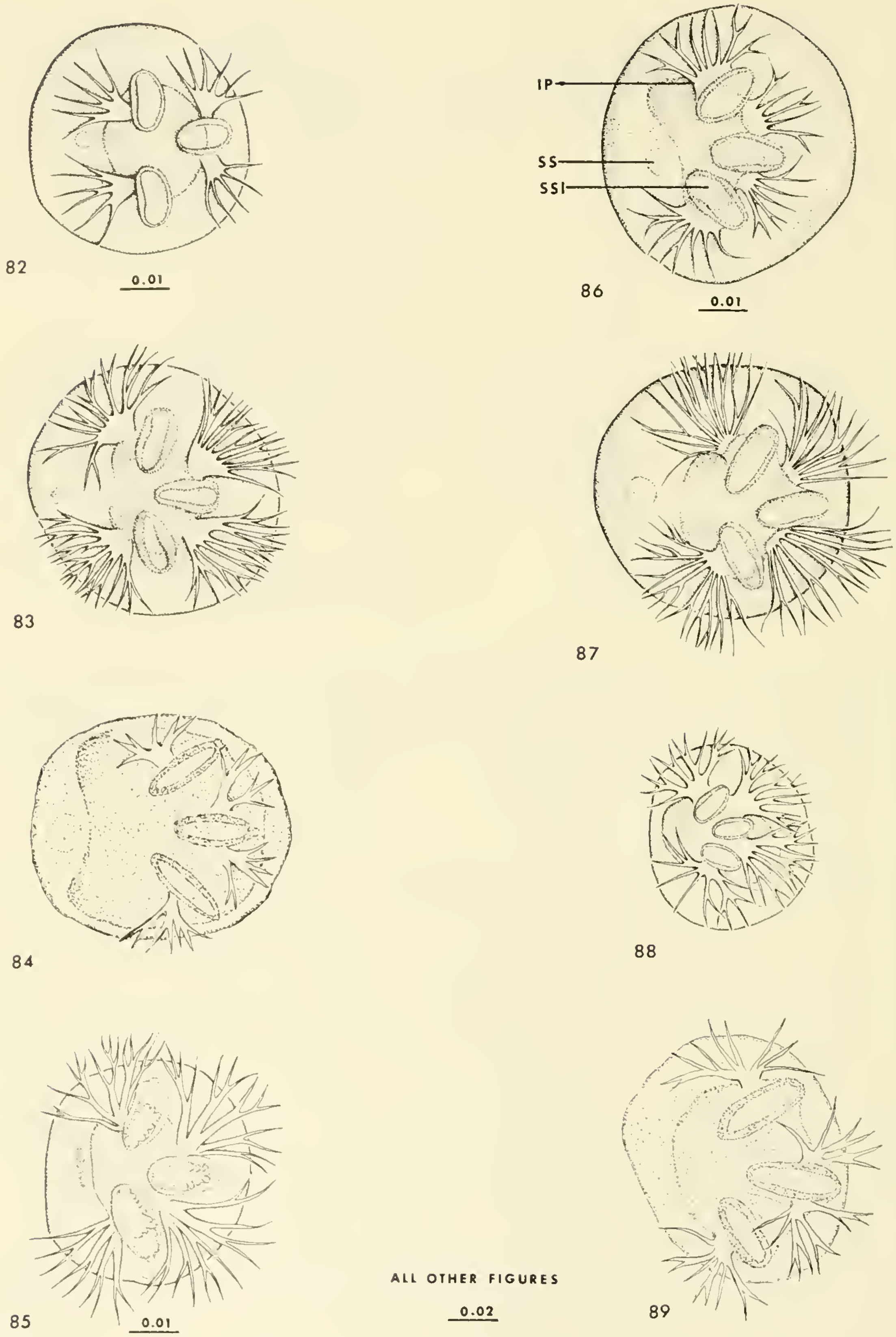
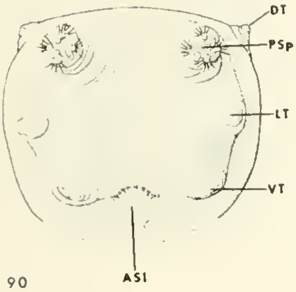


Fig. 82–89. Posterior spiracular plates of 3rd instars. 82, *C. confusa.* 83, *L. browni.* 84, *P. flaviceps.* 85, *P. gracilipes.* 86, *H. americana.* 87, *M. lyraformis.* 88, *M. lupulina.* 89, *P. ordinaria.*



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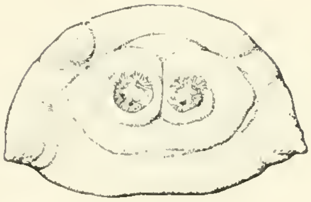

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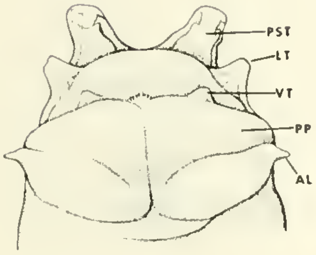

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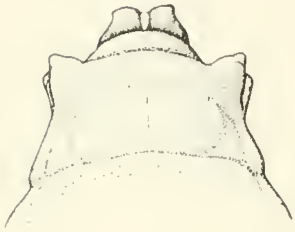

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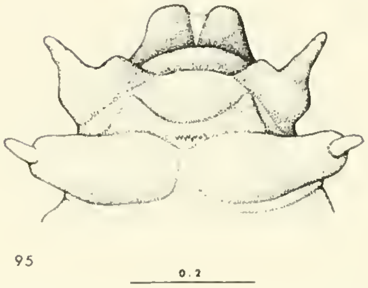

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Fig. 90–92. Posterior spiracular discs of 3rd instars. Fig. 93–95. Ventral view of posterior ends of 3rd instars. 90, 93, *C. confusa*. 91, 94, *H. americana*. 92, 95, *M. lyraformis*.

dorsad from hypostomal sclerite. Ligulate sclerites about ½ length of subhypostomal sclerites (fig. 47). Pharyngeal sclerite broadly bridged anterodorsally; bridge with slight indentation anteromedially, without windows (fig. 48); dorsal cornua heavily pigmented on ventral margin, shorter than ventral cornua; ventral cornua pigmented lightly around small dorsal window, sometimes with additional smaller window immediately posterior to larger one, cornua somewhat flaring and upturned apically (fig. 46). Parastomal bars free from hypostomal sclerite.

Puparium (fig. 115, 116): Length 3.01–3.99 mm, greatest width 1.19–1.75 mm. Shiny red orange to red brown. Elongate oval, strongly convex dorsally, flattened ventrally, abruptly tapering posteriorly, posterior end pointed. Anterior spiracles sessile. Perianal pad depressed.

Minettia lyraformis Shewell, 1938

Egg (fig. 5, 6): Length 0.76–0.84 mm, greatest width 0.20–0.27 mm. Elongate oval, somewhat convex ventrally and flattened dorsally; anterior end slightly narrowed, bearing broad tubercle; posterior end bearing small round tubercle on slightly narrowed, short stalk. Chorion with 6–8 undivided longitudinal ridges; 4 dorsal ridges very prominent and with broad grooves; 2–4 lateral ridges less prominent and closer together; occasionally with very faint indications of 2 additional ridges on ventral surface.

First Instar: Length 1.04–1.71 mm, greatest width 0.23–0.34 mm. Posterior spiracular plates (fig. 72) with finely branched interspiracular processes. Cephalopharyngeal skeleton (fig. 32) length 0.25–0.30 mm. Mouthhooks very poorly developed, somewhat resembling spinules on facial mask; hook part apparently


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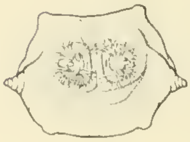
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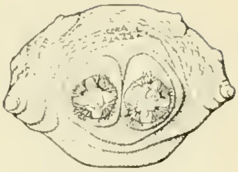
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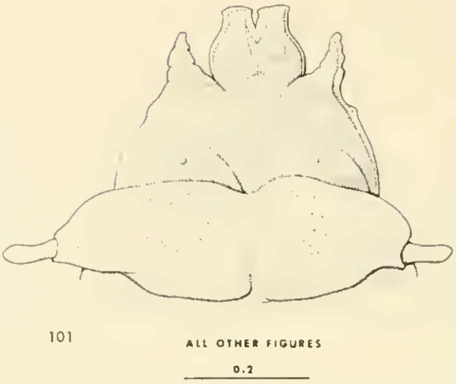
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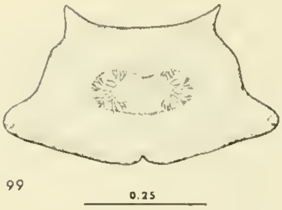
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Fig. 96–100. Posterior spiracular discs of 3rd instars. 96, *P. ordinaria.* 97, *M. lupulina.* 98, *L. browni.* 99, *P. flaviceps.* 100, *P. gracilipes.* Fig. 101. *P. gracilipes,* ventral view of posterior end.

with 3 accessory teeth, 1 tooth extending beyond tip of hook, posterior portion of basal part reduced and barely pigmented. Hypostomal sclerite appearing weakly bridged anteriorly. Ventral cornua of pharyngeal sclerite tapering posteriorly.

Second Instar: Length 1.68–4.34 mm, greatest width 0.49–0.77 mm. Anterior spiracles (fig 19) clubshaped, with 3 broadly rounded areas apically. Posterior spiracular plates (fig. 79) with interspiracular processes broad basally. Cephalopharyngeal skeleton length 0.49–0.56 mm. Mouthhooks (fig. 39) with hook part bearing very small accessory tooth. Dental sclerites subtriangular.

Third Instar: Length 4.20–7.14 mm, greatest width 0.84–1.75 mm. All segments with large spinule bands on anterodorsal and anteroventral margins; spinule bands less prominent bands elsewhere.

Anterior spiracles (fig. 23) handshaped, with 14–19 finger-like papillae. Segment 12 (fig. 95) ventrally with ambulatory lobes elongate and narrow; with 6–10 spinules behind anal slit. Posterior spiracular disc (fig. 92) bearing pair of pointed dorsolateral tubercles and pair of somewhat smaller, pointed ventrolateral tubercles. Posterior spiracular plates (fig. 87) with elongate, multibranching interspiracular processes, processes bifurcating apically.

Cephalopharyngeal skeleton (fig. 56–58) length 0.95–1.04 mm. Basal part of each mouthhook with anterior window twice as large as posterior window (fig. 56). Dental sclerites indistinct and poorly pigmented. Epistomal sclerite broad and arched dorsally (fig. 57). Ligulate sclerites approximately same length as subhypostomal sclerites (fig. 58). Hypostomal sclerite elongate, with narrow ventral bridge, posterior rami about twice as long as anterior rami (fig. 58). Pharyngeal sclerite with broad anterodorsal bridge, bridge slightly indented anteriorly and with numerous oval windows having pigmented spots (fig. 57); ventral cornua heavily pigmented only around window and along dorsal edge.

Puparium (fig. 113, 114): Length 3.50–4.27 mm, greatest width 1.54–2.03 mm. Shiny red orange or red brown to almost black. Elongate hemispherical in lateral view, convex dorsally and flattened ventrally; abruptly tapering posteriorly, posterior end somewhat pointed. Posterior spiracles directed upward. Anterior spiracles sessile. Perianal pad depressed, with black transverse groove.

Poecilominettia ordinaria (Melander), 1913

Egg (fig. 7): Length 0.68–0.79 mm, greatest width 0.23–0.27 mm. Elongate oval, strongly convex posteroventrally, flattened dorsally; anterior end slightly narrowing and bearing round tubercle; posterior end more rounded, bearing slightly larger and rounder tubercle. Longitudinal ridges 8–10, ridges undivided.

Second Instar: Length 1.65–3.65 mm, greatest width 0.32–0.75 mm. Anterior spiracles (fig. 20) clubshaped, without apical papillae. Posterior spiracular plates (fig. 81) with broad, branching interspiracular processes. Cephalopharyngeal skeleton length 0.37–0.44 mm. Mouthhooks (fig. 41) with hook part having very slight indication of unpigmented accessory tooth. Dental sclerite heavily pigmented, triangular.

Third Instar: Length 3.50–4.90 mm, greatest width 0.70–1.02 mm. Integument with large spinules in more or less distinct bands on all segments, no bands medially on dorsal and ventral surfaces, spinules on anterodorsal and ventral margins slightly larger.

Anterior spiracles (fig. 24) broadly fan-shaped, with 8–11 apical papillae. Segment 12 ventrally with large, cylindrical ambulatory lobes; posterior end of anal slit with 6–9 spinules. Posterior spiracular disc (fig. 96) bearing pair of large, blunt dorsolateral tubercles and larger pair of lateral tubercles. Posterior spiracular plates (fig. 89) with 3 to 6-branched interspiracular processes, some processes bifurcating apically.

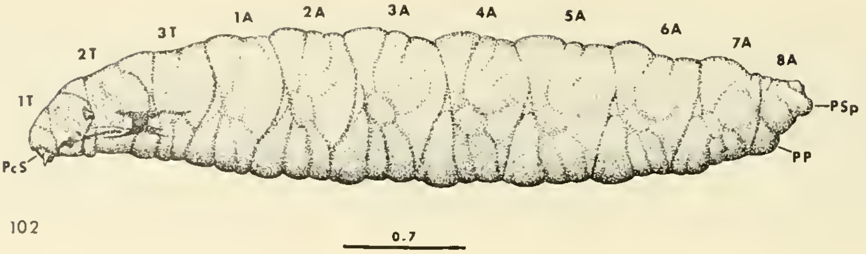
Cephalopharyngeal skeleton (fig. 62, 63) length 0.79–0.89 mm. Hook part of mouthhooks with very slight indication of accessory tooth; basal part with 2 equal-sized windows (fig. 62). Epistomal sclerite broad. Hypostomal sclerite narrow, with broad ventral bridge. Ligulate sclerites shorter than subhypostomal sclerites. Pharyngeal sclerite with broad anterodorsal bridge having numerous elongate-oval windows laterally (fig. 63); ventral cornua heavily pigmented around large window, with narrow band of pigment on dorsal margin extending well beyond tip of dorsal cornua, abruptly tapered apically (fig. 62).

Puparium (fig. 111): Length 2.94–3.85 mm, greatest width 1.25–1.68 mm. Dull, mostly clay colored, anterior and posterior ends black. Elongate ovoid, convex dorsally and flattened ventrally; tapering posteriorly, posterior end pointed. Anterior spiracles sessile, black basally. Perianal pad somewhat depressed, with brown median slit.

Pseudocalliope flaviceps (Loew), 1866

Egg (fig. 8): Length 0.70–0.81 mm, greatest width 0.23–0.33 mm. Ovoid, more convex ventrally; anterior end pointed and bearing small tubercle, posterior end more rounded. Longitudinal ridges 20–26, not or only occasionally bifurcating.

First Instar: Length 0.72–0.81 mm, greatest width 0.27–0.34 mm. Posterior spiracular plates (fig. 69) with few-branched interspiracular processes, processes



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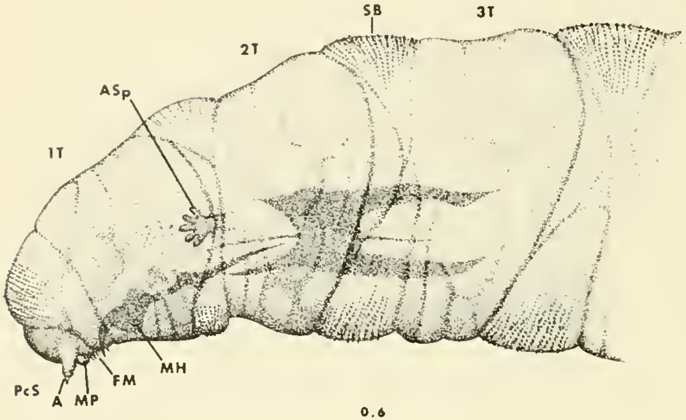

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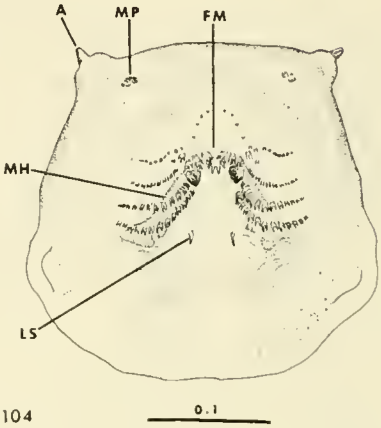

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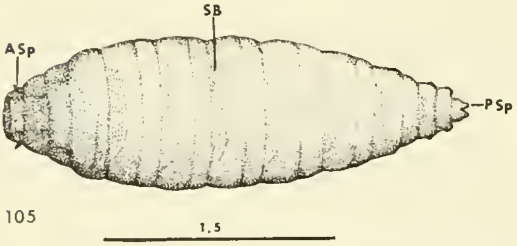

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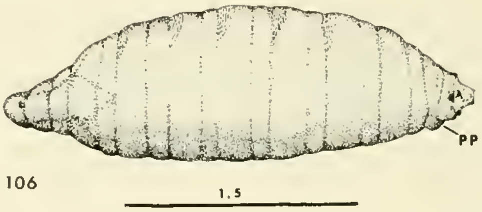

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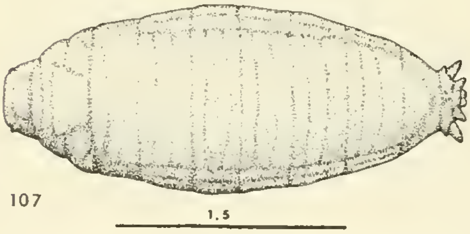

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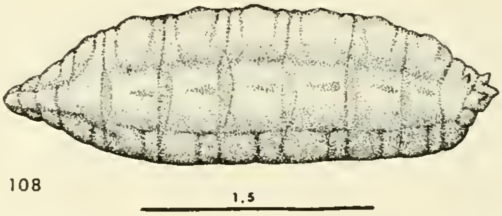

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Fig. 102–106. *H. americana.* 102, habitus of 3rd instar. 103, lateral view of anterior end of 3rd instar. 104, ventral view of segment 1. 105, puparium, dorsal view. 106, same, lateral view. Fig. 107–108. *P. flaviceps.* 107, puparium, dorsal view. 108, same, lateral view.

rarely bifurcating apically; spiracular slits narrow and elongate. Cephalopharyngeal skeleton (fig. 33) length 0.20–0.25 mm; weakly pigmented. Mouthhooks with hook part bearing small accessory tooth; anteroventral area of basal part very lightly pigmented. Epistomal sclerite strongly fused to hypostomal sclerite. Ventral cornua of pharyngeal sclerite very lightly pigmented, posterior margin indistinct.

Second Instar: Length 1.40–4.36 mm, greatest width 0.25–0.63 mm. Anterior spiracles (fig. 21) with 4–6 short, bud-like papillae. Posterior spiracular plates (fig. 76) with broad, 3 or 4-branched interspiracular processes. Cephalopharyngeal skeleton length 0.40–0.49 mm. Mouthhooks (fig. 40) with slight indication of accessory tooth on base of hook part.

Third Instar: Length 3.95–5.32 mm, greatest width 0.70–1.33 mm. Integument with large spinules not in distinct bands on anterodorsal and anteroventral margins of all segments; small spinules in distinct rows elsewhere.

Anterior spiracles (fig. 25) elongate with 5–6 relatively broad papillae apically; segment 12 ventrally with elongate, cylindrical, apically blunt ambulatory lobes; posterior end of anal slit with 5–8 spinules. Posterior spiracular disc (fig. 99) bearing pair of slender, pointed dorsolateral tubercles and 2 very large, blunt ventrolateral tubercles. Posterior spiracular plates (fig. 84) with short, few-branched interspiracular processes; spiracular slits elongate, each slit with small circular structures apically.

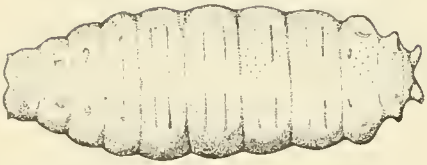
Cephalopharyngeal skeleton (fig. 64–66) length 0.75–0.84 mm; rather weakly pigmented. Hook part of mouthhooks with very slight indication of accessory tooth; basal part with anterior window nearly twice as large as posterior window (fig. 64). Epistomal sclerite broad and arched dorsally. Hypostomal sclerite with narrow ventral bridge (fig. 65). Ligulate sclerites shorter than subhypostomal sclerites (fig. 65). Pharyngeal sclerite with broad anterodorsal bridge, bridge slightly indented anteromedially, with numerous elongate-oval windows anteriorly and laterally and faint, large oval windows centrally (fig. 66); ventral cornua lightly pigmented, with very large window basodorsally.

Puparium (fig. 107, 108): Length 2.81–4.55 mm, greatest width 1.12–2.03 mm. Shiny light yellow to light brown. Elongate oval, with lateral ridges; somewhat convex dorsally and slightly flattened ventrally; posterior end rounded, as wide as anterior end, with noticeable tubercles around spiracular disc. Facial mask not blackened. Anterior spiracles white, slightly projecting. Perianal pad slightly depressed.

Pseudogriphoneura gracilipes (Loew), 1861

Egg (fig. 9, 10): Length 0.75–0.84 mm, greatest width 0.16–0.23. Elongate oval, flattened dorsally and slightly convex ventrally; anterior end more rounded and bearing elongate, apically flattened tubercle; posterior end slightly narrowing and bearing round tubercle on narrow, short stalk. Chorion with 5–7 undivided longitudinal ridges; egg on each side of middorsal ridge with 3–4 widely separated transverse septae; lateral ridges 4–6, close together, ventralmost pair indistinct.

First Instar: Length 0.87–1.71 mm, greatest width 0.23–0.37 mm. Posterior spiracular plates (fig. 70) with long several-branched interspiracular processes, spiracular slits with elongate structures apically. Cephalopharyngeal skeleton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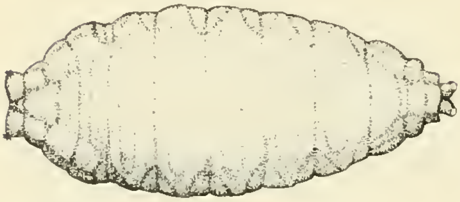
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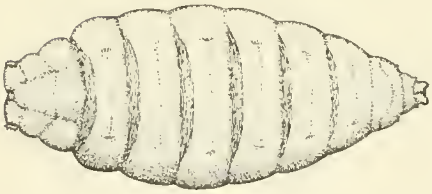
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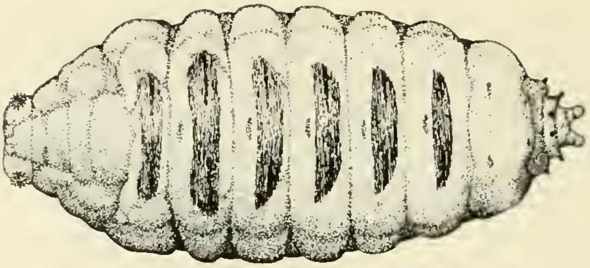
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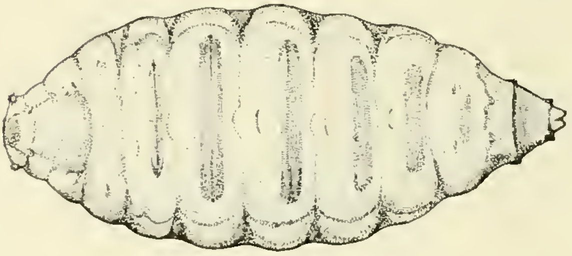
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Fig. 109–116. Puparia. 109, *C. confusa*, dorsal view. 110, *L. browni*, dorsal view. 111, *P. ordinaria*, dorsal view. 112, *P. gracilipes*, dorsal view. 113, *M. lyraformis*, dorsal view. 114, same, lateral view. 115, *M. lupulina*, dorsal view. 116, same, lateral view.

(fig. 29) length 0.17–0.19 mm; rather heavily pigmented. Mouthhooks well developed; hook part bearing small accessory tooth; basal part robust.

Second Instar: Length 1.75–3.15 mm, greatest width 0.42–0.63 mm. Anterior spiracles (fig. 22) somewhat fanshaped, with 12–15 short apical papillae. Posterior spiracular plates (fig. 77) with elongate many-branched interspiracular processes. Cephalopharyngeal skeleton length 0.28–0.33 mm. Mouthhooks (fig. 36) with hook part less heavily pigmented, bearing slender accessory tooth.

Third Instar: Length 3.08–5.32 mm, greatest width 0.63–1.12 mm. Integument with small spinules forming bands on anterodorsal and anteroventral margins of each segment, remainder of each segment devoid of conspicuous spinules.

Anterior spiracles (fig. 26) handshaped, with 11–14 finger-like papillae, each papilla slightly swollen apically. Segment 12 ventrally (fig. 101) with rather elongate ambulatory lobes. Posterior spiracular disc (fig. 100) bearing pair of small dorsolateral tubercles, pair of more elongate lateral tubercles, and 2 blunt ventrolateral tubercles. Posterior spiracular plates (fig. 85) with elongate spiracular scars, spiracular slits oval, with small round structures apically and short trabeculae laterally. Interspiracular processes multibranched and bifurcating apically.

Cephalopharyngeal skeleton (fig. 59–61) length 0.48–0.53 mm; deeply pigmented. Basal part of mouthhook with 2 equal-sized windows (fig. 59). Epistomal sclerite rather narrow; posterior rami free. Hypostomal sclerite with narrow ventral bridge, posterior rami very broad near bridge (fig. 60). Ligulate sclerites shorter than subhypostomal sclerites (fig. 60). Anteroventral projection of pharyngeal sclerite short (fig. 59); anterodorsal bridge broad and deeply indented anteromedially, with oval windows laterally (fig. 61); dorsal cornua with faint window posterodorsally; ventral cornua only slightly longer than dorsal cornua, each cornu with short spur dorsoposteriorly. Parastomal bars fused to lighter pigmented area of hypostomal sclerite.

Puparium (fig. 112): Length 2.73–3.50 mm, greatest width 1.10–1.41 mm. Shiny light yellow to light orange. Elongate oval, convex dorsally and flattened ventrally; anterior end with pronounced indentation medially; tapering posteriorly, posterior end distinctly pointed. Anterior spiracles sessile. Perianal pad somewhat depressed, with brown median slit.

Discussion

According to Oldroyd (1964), the Lauxaniidae have retained the ancestral acalyptrate habit of feeding on such compostlike material as vegetable debris. Our rearings support this assumption, although it is probable that the larvae are actually ingesting such microorganisms as fungi, yeasts, and bacteria. Dowding (1967) has described the structure and function of the longitudinal ridges that are so prominent in the floor of the pharyngeal sclerite of saprophagous cyclorraphous Diptera larvae, stating that these ridges constitute a filtering mechanism that separates particulate matter from a semi-liquid medium. Cross sections of lauxaniid larvae that we have studied clearly show pharyngeal ridges.

At least 2 lines of specialization have evolved among the saprophagous Lauxaniidae. One group, represented by *Homoneura americana* and *Minettia lupulina*, has become adapted to feeding as miners within the decaying mesophyll tissues of fallen leaves. A second group, including *Pseudocalliope flaviceps* and *Poecilominettia ordinaria*, have become specialized for utilizing decaying material found in birds' nests. Although larvae of 2 species were found in leaf litter, it was not determined whether each species was segregating onto different food resources. However, our rearings do indicate that larvae of one species at least prefer certain kinds of deciduous tree leaves over others. Thus, larvae of *Homoneura americana* completed development on a diet of sugar maple (*Acer saccharum* Marshall) and wild black cherry (*Prunus serotina* Ehrhart) leaves and were able to reach the third instar on American elm (*Ulmus americana* L.) and alder (*Alnus* sp.) leaves. In contrast, they failed to feed on decaying leaves of white oak (*Quercus alba* L.) and American beech (*Fagus grandifolia* Ehrhart). Possibly the high tannin content of the oak and beech leaves deterred feeding (Feeney, 1970). Larvae of other species seemed to prefer decaying leaves of maple, alder, and cherry, but much more testing is necessary before any valid conclusions as to segregation of larval feeding preferences can be drawn. There is also the possibility that larvae occupying the same microhabitat (e.g., leaf litter) are actually utilizing different microorganisms such as yeasts, fungi, and bacteria and thus avoid competition. Preference for different kinds of yeasts, for example, seems to be a common phenomenon in species of Drosophilidae (Lindsay, 1958; Wagner, 1944).

It is probable that the Lauxaniidae are the North American ecological homologues of the leaf-feeding species of Hawaiian Drosophilidae (Heed, 1968). In contrast to the Hawaiian drosophilids, however, the leaf-feeding Lauxaniidae do not seem to show a reduction in numbers of eggs produced (Kambysellis and Heed, 1971) and probably are best considered as being r-strategists (MacArthur and Wilson, 1967).

The two birds' nests species were not studied carefully enough to allow many generalizations, although there is some indication that these species have a lowered fecundity compared to the leaf-mining forms. Thus, females of *Pseudocalliope flaviceps* deposited less than 70 eggs each and this species may be a K-strategist (MacArthur and Wilson, 1967). In contrast, females of *Minettia lyraformis*, a leaf-feeding species, commonly produced nearly 500 eggs. Immature stages of the birds' nest-inhabiting species occasionally were found in the same nest during mid-summer months, but it is not known whether their larvae were competing for the same food resource. *Pseudocalliope flaviceps* overwinters as mature larvae or pupae, whereas *Poecilominettia ordinaria* apparently passes the winter as an adult. Possibly the larval feeding stages of the two species are separated in time.

Because so few lauxaniid eggs and larvae have been studied, it is impossible at this time to characterize the family or genera morphologically. In general, the mature larvae are rather typically muscoidan, although there has been some flattening of the body dorsoventrally. The most conspicuous character held in common by all of the second and third-stage larvae investigated is the pair of large white glands that appear to be extensions of the Malpighian tubules. These structures apparently store calcium carbonate and are most noticeable in the anterior half of the living nearly mature larva. Before forming its puparium, a larva voids the gut contents and then releases the whitish calcium compound through the anus. By vigorous movements, the larva manages to cover itself with the moist material which subsequently hardens to form a whitish deposit over the surface of the puparium. The function of this material is unknown, but it is strongly hydrofuge and may serve to prevent wetting of the puparium in the damp leaf litter. Although larvae of *Pseudocalliope flaviceps* possess these glands, their puparia are not covered by a whitish deposit. Possibly the material is incorporated into the mud-fiber case formed by the mature larva shortly before it pupates.

Another morphological trait possessed by all 8 species examined in this investigation is a pair of protrusible lobes that arise from the perianal pad. When evaginated, these lobes project laterally and are slender and tapering. They are repeatedly extended during locomotion and probably are best considered as being ambulatory structures.

The cephalopharyngeal skeleton is of the generalized type found throughout the cyclorrhaphous Diptera having saprophagous larvae. Pharyngeal ridges are present and the mouthhooks, hypostomal sclerite, and pharyngeal sclerite are not fused to each other. The pharyngeal sclerite has an anterodorsal bridge, and slender parastomal bars are present. The hypostomal sclerite is basically H-shaped and possesses a narrow bridge. The epistomal sclerite lying above the anterior end of the hypostomal sclerite varies in shape but always seems to possess slender rami that project posteriorly. These rami are not connected to the anterior end of the parastomal bars as they are in the rather closely related family Sciomyzidae (Bratt *et al.*, 1969; Knutson and Berg, 1966). Paired ligulate and subhypostomal sclerites are present, and each is usually composed of slender rodlike structures. A dental sclerite, usually somewhat triangular in shape, is present below the posteroventral border of each mouthhook. The mouthhooks are rather simple structures and may possess accessory teeth or serrations along the ventral margin of the hook part.

The anterior spiracles of the third-stage larvae are quite diverse, varying in shape, length, and number of apical papillae. Variation within a genus, as shown by fig. 18 (*Minettia lupulina*) and fig. 23 (*M. lyraformis*), can be as great as that between genera, and it is doubtful whether the anterior spiracles can have any diagnostic value except at the species level.

The posterior spiracles (fig. 82–89) of the mature larvae likewise seem to possess little diagnostic value at the generic level, as they are rather uniform in appearance. They differ between species somewhat in the degree of branching of the interspiracular processes, position and shape of the spiracular openings, and color of the spiracular tubes.

The posterior spiracular discs vary considerably in shape, distribution and size of the marginal tubercles, and ornamentation and can be used to distinguish among the species studied in this investigation. The number of marginal tubercles varies between 4 and 6. The tubercle shape ranges from low, broad mounds (*M. lupulina*, fig. 97) to slender, tapering structures (*Pseudocalliope flaviceps*, fig. 99).

Perhaps the best external morphological character for separating species lies in the arrangement, size, and shape of the spinules that are present on the dorsum and venter of the various segments. The spinules frequently form distinctive patterns that can be used to distinguish species.

Based on knowledge currently available, the cephalopharyngeal skeletons of the first-stage larvae offer the single best diagnostic character for separating the species of Lauxaniidae studied in this investigation. Unfortunately, however, their small size, lack of sclerotization, and close attachment to the surrounding integument makes taxonomic use of this structure difficult. Rather surprisingly, differences in the mouthhooks (e.g. position and number of accessory teeth) are more apparent in the first instars than they are in the older larvae. Probably the rather similar structure found in the mouthhooks and other cephalopharyngeal sclerites of the second and third instars is the result of morphological convergence arising from the utilization of a common food substrate by a diversity of species. Thus, the morphology of the cephalopharyngeal skeleton of the first instar may be more significant phylogenetically than that of more mature larvae.

Abbreviations Used in Figures

A, antenna; AL, ambulatory lobe; ASl, anal slit; ASp, anterior spiracle; AT, accessory tooth; bp, basal part of mouthhook; DB, dorsal bridge; DC, dorsal cornu; DS, dental sclerite; DT, dorsolateral tubercle; ES, epistomal sclerite; FM, facial mask; HB, hypostomal bridge; hp, hook part of mouthhook; HS, hypostomal sclerite; IP, interspiracular process; LS, ligulate sclerite; LT, lateral tubercle; M, micropyle; m, membrane; MH, mouthhook; MP, maxillary palp; MR, middorsal ridge; Pa, papilla; PB, parastomal bar; PP, perianal pad; PR, pharyngeal ridge; PSp, posterior spiracle; PST, posterior spiracular tube; R, ramus; SB, spinule band; ShS, subhypostomal sclerite; SSc, spiracular scar; SSl, spiracular slit; StC, stigmatic chamber; Tr, trabeculae; VC, ventral cornu; VT, ventrolateral tubercle; W, window.

All measurements indicated by scale lines are in millimeters.

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EDITORIAL NOTE

Beginning with issue number 1, volume 78 (1976), the Proceedings of the Entomological Society of Washington will be published during the months of January, April, July, and October. This schedule will eliminate the difficulties of publishing an issue during the month of December, when the overburdened postal service, vacations, etc., occasionally cause a delay in publication that stretches over into the following year, and thus creates (particularly for taxonomic papers) confusion as to date of publication.

STUDIES OF NEOTROPICAL LEAFHOPPERS. II. (HOMOPTERA: CICADELLIDAE)

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ABSTRACT—This paper updates our knowledge of American tropical leafhoppers in three subfamilies. The genera *Synogonia* Melichar and *Tahura* Melichar are transferred from the Cicadellinae to the Nirvaninae, a key is provided for their separation, and **fowleri** new species from Peru is designated as the type-species of *Tahura*. *Ichthyobelus* **youngi** from Colombia and *Pseudophera* **heveli** from Costa Rica are described as new Cicadellinae, Proconiini. In the subfamily Agalliinae, five new species are described from Peru: *Agalliopsis* **coluber**, *Agalliopsis* **moesta**, *Agalliopsis* **talpa**, *Euragallia* **prion**, and *Agallia* **kosmetron**.

The purpose of this series of papers is to supplement and update our knowledge of the Neotropical leafhoppers. Included in this paper are additions to the subfamilies Nirvaninae, Cicadellinae, and Agalliinae.

Subfamily NIRVANINAE

Kramer (1964) presented a key and described the genera of this subfamily and later added two additional monobasic genera (1965). Study of two genera, *Tahura* and *Synogonia*, described by Melichar and assigned to the Cicadellinae (= Tettigellinae) shows that their proper placement is in the Nirvaninae. Both will trace to couplet 4, *Jassosqualus* Kramer in my previous key. All three genera can be separated by the following key.

1. Coronal suture elevated as distinct longitudinal carina; crown and thoracic dorsum smooth and polished with few scattered minute punctures (Fowler, 1900: pl. 19, fig. 28) .... *Synogonia* Melichar

— Coronal suture not elevated; crown and thoracic dorsum finely rugulose or rugulose punctate 2

2. Forewing with a long "tail" (fig. 1); transocular width of head equal to or more than greatest pronotal width (fig. 1) .... *Tahura* Melichar

— Forewind normal; transocular width of head less than greatest pronotal width (Kramer, 1964: fig. 26) .... *Jassosqualus* Kramer

Synogonia Melichar 1926:344

Type-species: *Tettigonia nasuta* Fowler; China, 1938:134.

This genus is close to and differs from *Jassosqualus* Kramer (1964: 122) by the following characters: entire dorsum, especially crown and pronotum, highly polished and strongly shiny; coronal suture distinctly

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elevated; weak irregular carina sublaterally along coronal margins from ocellus to near apex. Male unknown.

Synogonia nasuta (Fowler)

Tettigonia nasuta Fowler, 1900:291, pl. 19, fig. 28.
Synogonia nasuta (Fowler); China, 1938:184.

Length of female 5.5 mm.

Structure: Antennae about as long as head; coronal surface with few minute scattered punctures, finely rugulose near eyes; surface of face finely granular or scaly with vague parallel ridges laterally on clypeus; pronotum with finely scattered punctures, most numerous in basal discal portion, and faint transverse rugulae; scutellum faintly and irregularly rugulose; forewing with most of clavus and adjacent portions of corium, coriaceous, and more or less irregularly punctate rugulose, rest of forewing somewhat thickened but not coriaceous.

Coloration: Venter of abdomen and legs stramineous to pale brown, female pygofer black or fuscus, last segment of hind tarsus infuscated; thoracic venter with same ground color, lateral edges fuscus or black; face black except for yellowish lower portions of genae, lora, and clypellus; crown, pronotum, and scutellum entirely black; forewing fuscus or black with yellow subtriangular patch followed by pale spot on clavus, costal margin in area near base of apical cells anteriorly to point in line with middle of clavus, yellowish white and marked with 2 fuscus or black transverse slightly oblique stripes.

Male genitalia: Male unknown.

Female genitalia: Posterior margin of pregenital sternum tapering to acute tooth.

Notes: The type, discussed by Young, 1965:185, is a specimen without an abdomen from Vera Paz, Guatemala, in the British Museum (Natural History). The only other known specimen is a female from Punta Gorda, British Honduras, February 1931, White in the USNM. The colored habitus illustration published with the original description (Fowler, 1900: pl. 19, fig. 28) shows the general markings well.

Tahura Melichar 1926:343

Type-species: *Tahura fowleri* Kramer, new species.

Form elongate and slender; crown strongly produced beyond eyes, median length greater than interocular width; in dorsal view, lateral coronal margins carinate, converging distally to narrowly or sharply rounded apex, coronal surface irregularly rugulose, ocelli on disc anterior to eyes, near coronal margins, head and pronotal widths subequal; crown in lateral view marginally carinate, carinate coronal margin straight, ending at or near anterior margin of eye, antennal base in deep depression in front of eye with oblique carinate ledge dorsally; in facial view, clypeus narrowing downward with sides rounded, short carina at apex of clypeus, lora slender; pronotum laterally carinate; forewing with venation rather obscure, 4 apical and 2 preapical cells, surface of forewing at least in part coriaceous with taillike extension at apex. *Male genitalia*: Pygofer with macrosetae distally in apical portion; plates long, exceeding pygofer, with macrosetae on inner submargin and hairlike filaments on distal margins, plates divided and appearing 2-segmented; valve poorly developed; connective subcruciform; style elongate with apical lobes well developed; aedeagus elongated, basal portion prolonged and hinged to connective, apical portion of shaft upturned with gonopore subapical on ventral margin, dorsal apodeme rigid and stout.

Tahura fowleri Kramer, new species

fig. 1–4

Length of male 5.4 mm, of females 5.5–5.6 mm.

Structure: Antennae moderately long, about as long as head (fig. 1); coronal surface entirely rugulose; head in lateral view with narrower submarginal carina below carinate lateral coronal margin, submarginal carina gradually upturning at each end, distally usually touching or fading near extreme coronal apex, basally usually touching or fading on margin in line with anterior edge of ocellus; extreme coronal apex below margin shiny; face with clypeal surface finely granular or scaly, lateral edges of lora elevated above genae, lower edges of genae at least partially obliquely wrinkled, rest of lower face finely rugulose to smooth, pronotum transversely rugulose with scattered fine punctures; scutellum rugulose with some scattered fine punctures; forewing with clavus, except apex, and adjacent portion of corium, coriaceous, finely rugulose and/or punctate; rest of forewing somewhat thickened, not coriaceous, area of inner apical cells often convex, extension slender and long.

Coloration: Venter of abdomen yellow or yellowish brown with segments variably blackened; pygofer of female entirely black or fuscus; thoracic venter black or fuscus; legs yellow or yellowish brown with apex of hind tibia and terminal tarsal segment fuscus; face black with antennae pale; crown, pronotum, and scutellum black (fig. 1) only paler at coronal edges; forewing largely black on basal ⅔, claval commissure narrowly yellow, pale subapical patch on clavus, usually extending to adjacent portion of corium, orange-brown patch on basal portion of apical cells and distal portion of preapical cells; apical portion of wing largely black or fuscus; extension of forewing pale on lateral portion; costal area yellowish white, broad distally and narrowing basally, marked with 2 black or fuscus transverse or slightly oblique stripes in distal half.

Male genitalia: Aedeagus in lateral view (fig. 3) with pair of slightly upturned sharp processes arising from ventral margin near apex; in dorsal view (fig. 2) connective convex in basal half, stalklike distally; style with mesal lobe long, sharp, curved laterad, lateral lobe broad and subquadrately produced; plates divided in basal half (fig. 4).

Female genitalia: Posterior margin of pregenital sternum (fig. 1) bilobed, notched at middle, central portion of segment subcarinate.

Types: Holotype male and allotype female Callanga, Peru, in collection of Hungarian Natural History Museum; paratype female Sinchono, Peru, in DeLong Collection at Ohio State University; paratype female Giraldo, Antioquia, Colombia, 29 August 1973, E. Urueta, on *Passiflora* sp. in USNM.

Notes: *Tahura* was described (Melichar, 1926:343) without included species. The holo- and allotype described by me represent

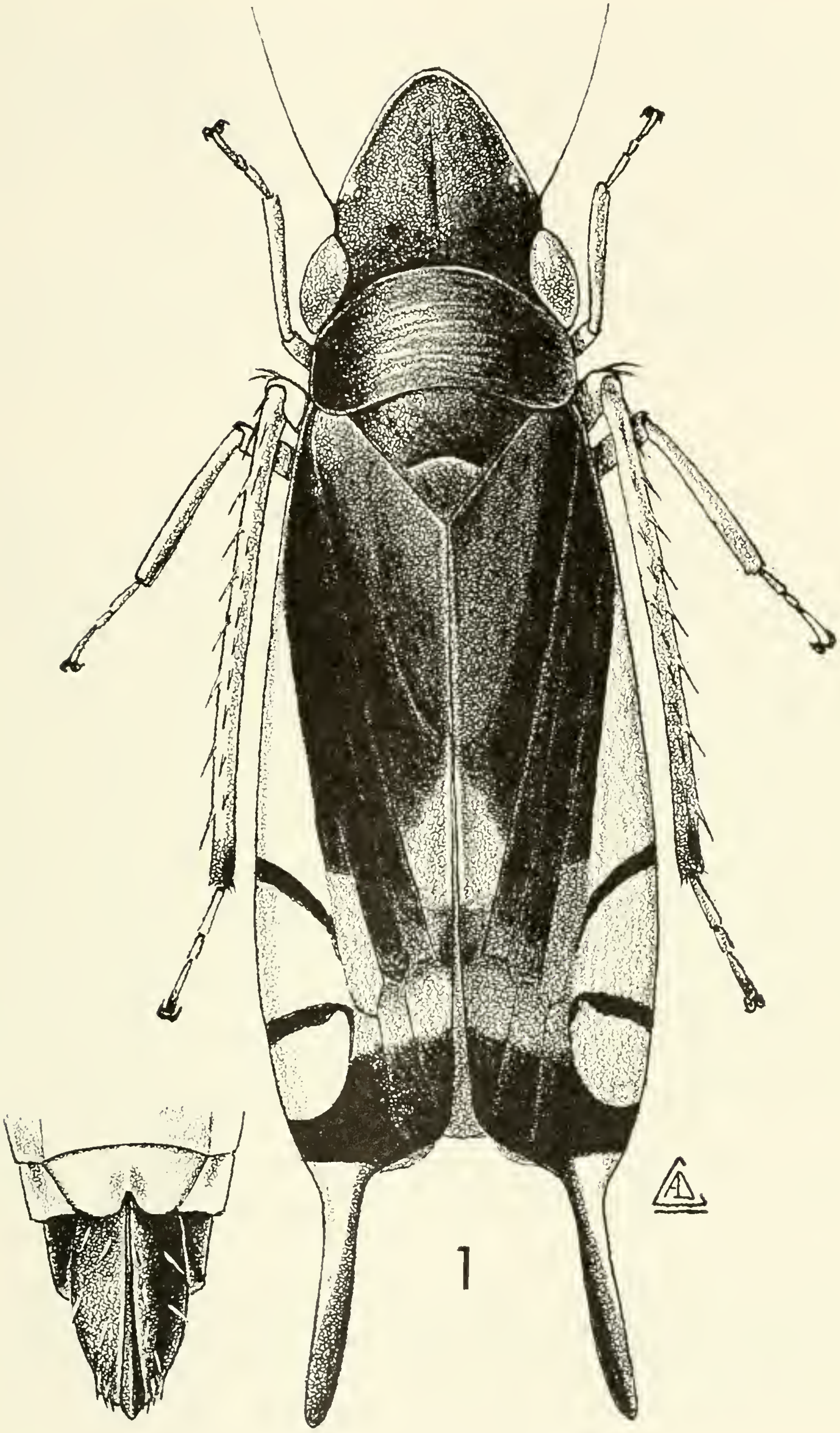

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Fig. 1. *Tahura fowleri.* At left, female genital segments.

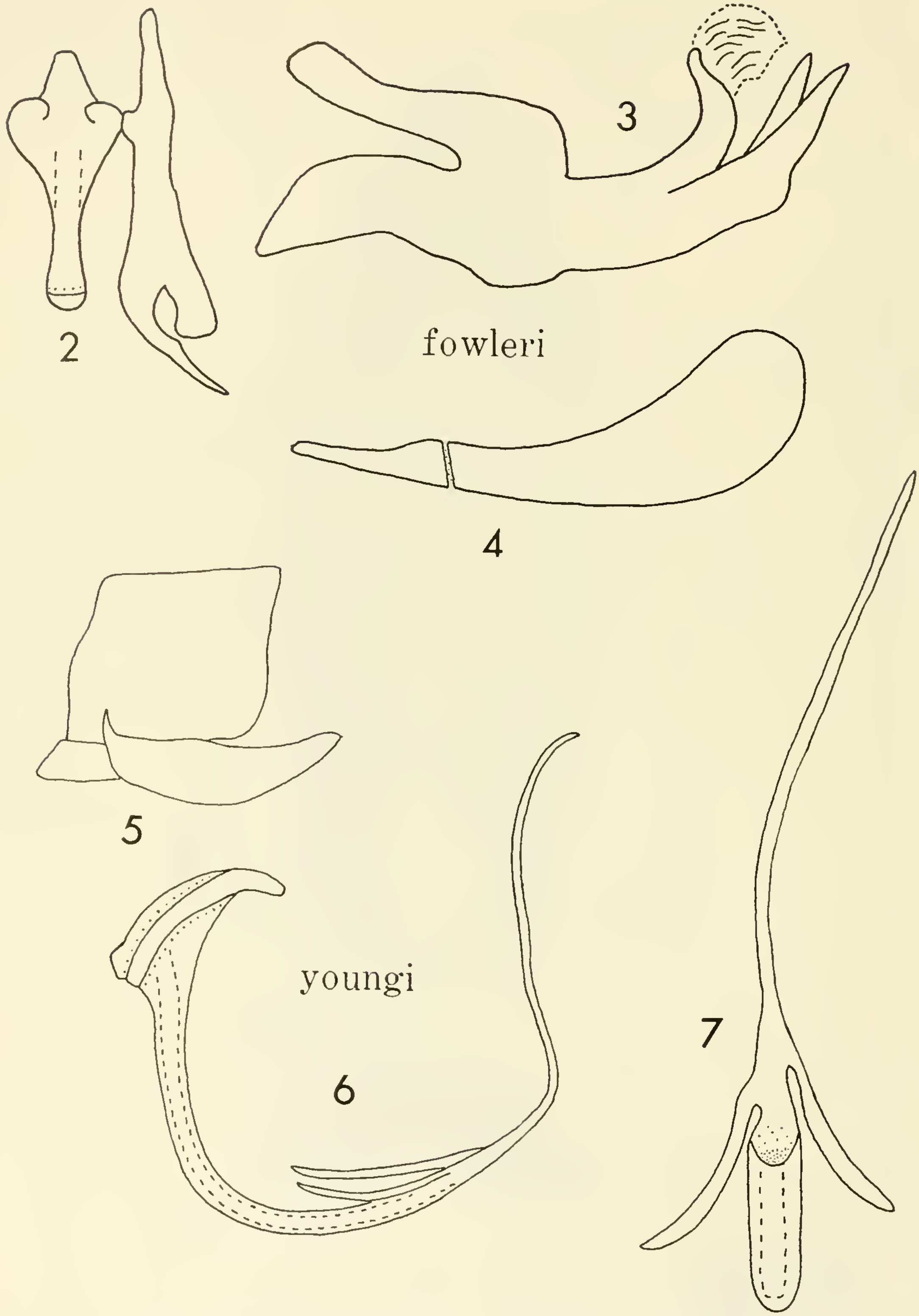


Fig. 2–4. *Tahura fowleri.* 2, Connective and style in dorsal view. 3, Aedeagus in lateral view. 4, Male plate in lateral view. Fig. 5–7. *Ichthyobelus youngi.* 5, Genital capsule in lateral view. 6, Aedeagus in lateral view. 7, distal portion of aedeagus in posterior view.

specimens of the species studied by Melichar and intended as his type-species. I am most grateful to Dr. A. Soos of the Hungarian Natural History Museum, Budapest, Hungary, for allowing me to study these specimens. The species is named for Rev. W. W. Fowler, the author of the leafhopper portion of the famed *Biologia Centrali-Americana.*

Subfamily CICADELLINAE, Tribe PROCONIINI

Young (1968) published a splendid revision of the Proconiini and established the first firm foundation for a classification of this tribe of New World leafhoppers. The Proconiini contains the largest and most robust leafhoppers found in the Americas.

Ichthyobelus youngi Kramer, new species

fig. 5–7

Length of male slightly more than 14 mm.

Structure: Typical of genus in all respects. Head with anterior process spoon-shaped and like that of *I. platyrrhinus* Young (Young, 1968, fig. 128a).

Coloration: Face, thoracic venter, legs, and abdomen drab and variably washed with purplish; central portion of clypeus irregularly blackened. Ground color of dorsum olive drab; edges and central portion of anterior process and areas on coronal disc dark purplish to black; pronotum with 2 narrow transverse dark purplish bands, anterior band narrowest at middle, posterior band produced cephalad at middle; scutellum dark with 2 transverse but incomplete olive drab bands on middle portion; forewing olive drab with veins mostly dark purplish, with 4 irregular dark purplish transverse bands, 1st band near wing base inconspicuous and incomplete, 2nd band narrow, 3rd and 4th bands comparatively broad, 3rd band bisects clavus, 4th band transects claval apex; preapical cells mottled with dark purplish, sparse mottling also in cells between 3rd and 4th bands.

Male genitalia: Setosity typical of genus; pygofer with hind margin broad and subtruncate (fig. 5); aedeagus in lateral view (fig. 6) with shaft slender and distal portion extended dorsally as narrow flagellum, with pair of slender basally projecting processes near base of flagellum; aedeagus in posterior view (fig. 7) with gonopore near base of asymmetrical processes; connective and style similar to that of *I. regularis* Young (Young, 1968, fig. 129e), but apex of connective not expanded and mesal lobe of style stouter and straighter on inner margin.

Type: Holotype male (USNM 73276) Leticia, Amazonas, Colombia, 1–3 Feb. 1969, R. Deitz. Leticia is the southernmost point in Colombia.

Notes: In Young's revision (1968:137) this species keys to *I. nasutus* Young. *Ichthyobelus youngi* differs from this species and all its congeners by the broad subtruncate hind margin of the pygofer and by the long terminal aedeagal flagellum. The species is named for Professor David A. Young in recognition of his masterful revision of the Proconiini.

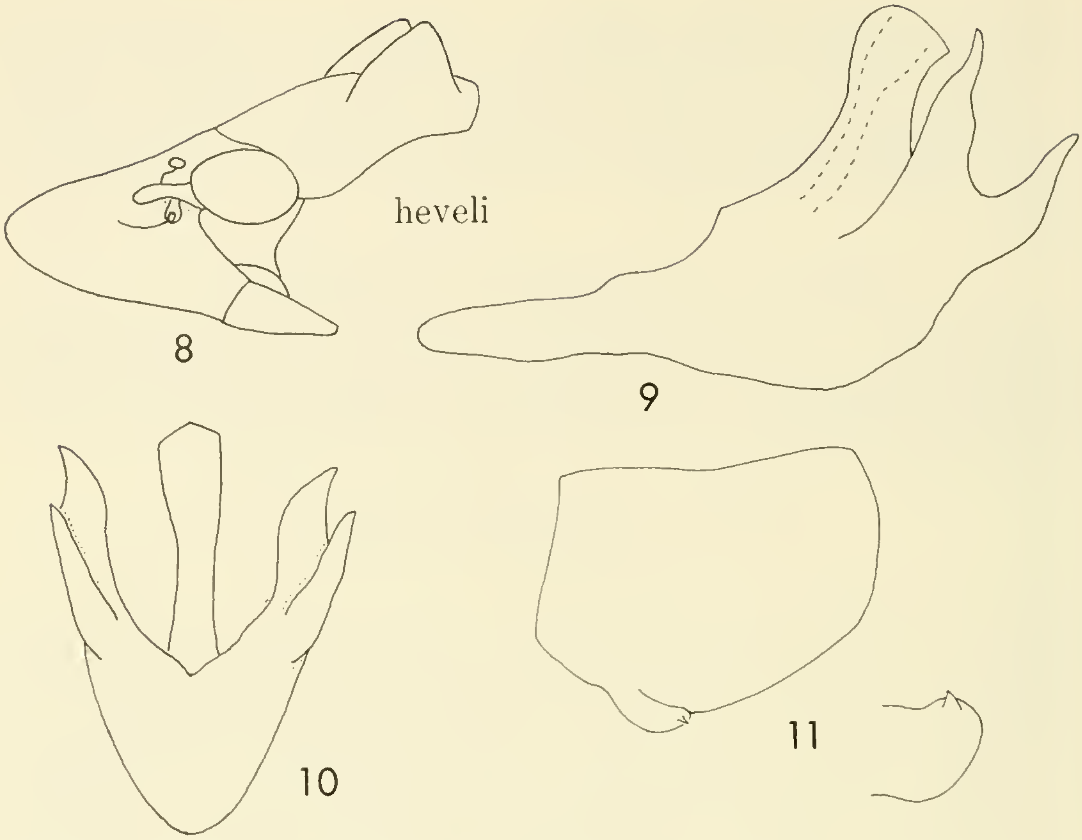


Fig. 8–11. *Pseudophera heveli.* 8, Head and pronotum in lateral view. 9, Aedeagus in lateral view. 10, Aedeagus in posterior view. 11, Pygofer in lateral view, at lower right pygofer process in ventral view.

Pseudophera heveli Kramer, new species

fig. 8–11

Length of male 19 mm.

Structure: Typical of the genus in all respects but with broad hornlike projections near posterior angles of pronotum (fig. 8).

Coloration: Head, thorax, legs, and abdomen deep dark red; tarsi, thoracic venter, and abdomen variably infuscated; forewings with veins deep dark red and most cells translucent dark blue, apical cells transparent smoky brown.

Male genitalia: Setosity typical of genus; pygofer with blunt lobe on ventral margin in proximal half (fig. 11); aedeagus stout but weakly sclerotized, in lateral view (fig. 9) with broad forked ventral paired processes extending dorsally to near aedeagal apex, in posterior view (fig. 10) aedeagus broadest distally with proximal fork of each process curved laterally and distal fork of each process fairly straight.

Type: Holotype male (USNM 73277) Puntarenas Monteverde area, Costa Rica, 6–14 June 1973, Gary F. Hevel.

Notes: In Young's revision (1968:210) this species keys to *P. heterogena* Schmidt. *Pseudophera heveli* differs from this species and all its congeners by the obvious pronotal projections which were previously unknown in species of the genus *Pseudophera.* The species is named for the collector.

Subfamily AGALLIINAE

Kramer (1964) published a key to the New World genera of this subfamily, added new species from both the Nearctic and Neotropical Regions, and updated previous checklists of species in all of the genera. The list below is an updating of the species from the Americas described since then.

Agallia kosmetron Kramer, n. sp. (Peru)
Agallia pumila Oman, 1971:326 (Oregon)
Agallia sagittifer Linnavuori, 1968:149 (Colombia)
Agalliopsis abietaria Oman, 1970:27 (Oregon)
Agalliopsis ancistra Oman, 1970:23 (Vermont)
Agalliopsis coluber Kramer, n. sp. (Peru)
Agalliopsis hamatilis Oman, 1970:16 (Mexico)
Agalliopsis moesta Kramer, n. sp. (Peru)
Agalliopsis sonorensis Oman, 1970a:32 (Mexico)
Agalliopsis stella Oman, 1970:21 (Texas)
Agalliopsis talpa Kramer, n. sp. (Peru)
Euragallia prion Kramer, n. sp. (Peru)
Euragallia striata Linnavuori, 1968:149 (Colombia)

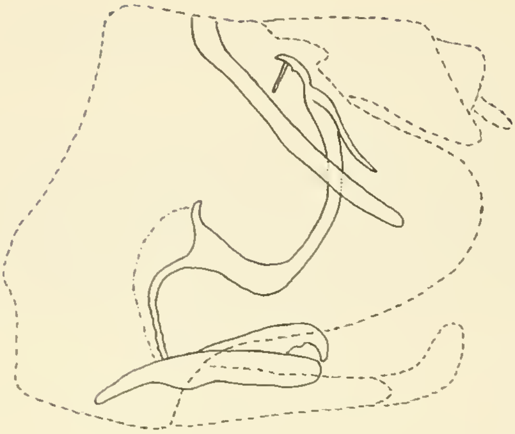
Agalliopsis moesta Kramer, new species
fig. 12–15

Length of male and female 4.2 mm.

Coloration: Entire venter fuscus to black; legs sordid stramineous, hind leg embrowned; face with lower half black (fig. 15), upper half pale orange brown with black band between eyes and 3 black spots at coronal margin, central coronal spot joined to band. In dorsal view (fig. 14) crown with 5 black spots, central 3 extensions of those visible in facial aspect; both pronotum and scutellum black anteriorly and whitish posteriorly; forewing translucent brown to reddish brown with pale spot on clavus adjacent to scutellar apex and oblique fuscus-margined whitish band across middle, band terminates near center of corium and touches large blackish or fuscus patch which covers most of costal area and at least half of corium.

Male genitalia: Genital capsule in lateral view (fig. 12) with projection on dorsal margin of pygofer; plate secondarily segmented in distal ⅓; style hooked distally; long, oblique, simple paired processes from dorsal inner margin of pygofer directed toward rounded distal edge of pygofer; aedeagus slender, upturned, with short subapical process on proximal margin and longer process below 1st on distal margin. Aedeagus in posterior view (fig. 13) narrowed preapically, angularly expanded apically with gonopore terminal; distal paired processes simple and moderately long; proximal paired processes long and branched distally; apex of each branch expanded with distal edge finely dentate.

Female genitalia: Not characterized because of distortion in only available specimen.



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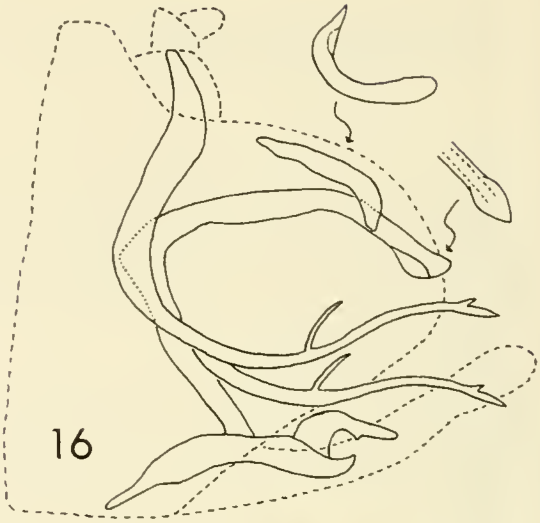

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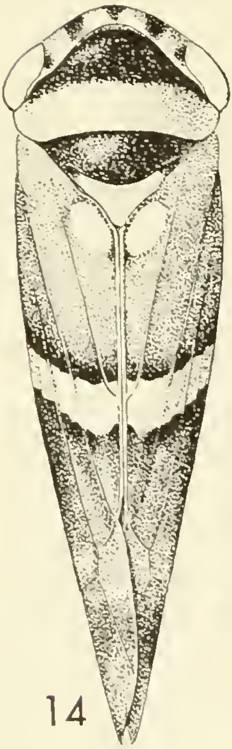

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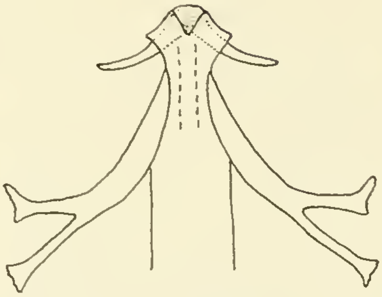
moesta



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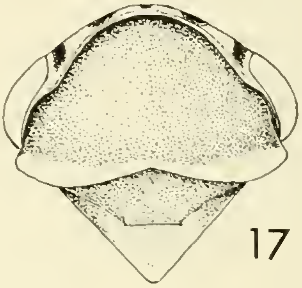

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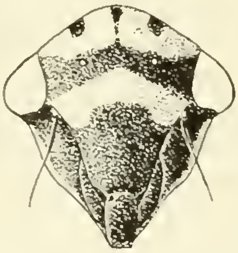
coluber



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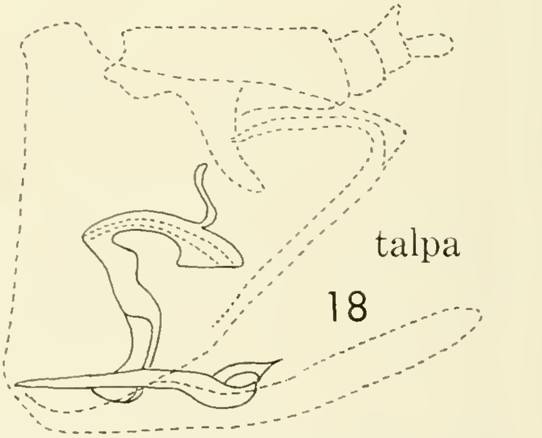

talpa

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Fig. 12–15. *Agalliopsis moesta.* 12, Genital capsule in lateral view. 13, Aedeagal apex in posterior view. 14, Habitus. 15, Face. Fig. 16–17. *Agalliopsis coluber.* 16, Genital capsule in lateral view. 17, Head and thorax in dorsal view. Fig. 18. *Agalliopsis talpa.* Genital capsule in lateral view.

Type: Holotype male, Sinchono, Peru, November, 1943 in DeLong Collection at Ohio State University; additional female with same data in USNM.

Notes: The color pattern, unusually distinct for a species of *Agalli-*

opsis, and the male genitalia, particularly the aedeagus in posterior aspect, readily distinguish the species.

Agalliopsis coluber Kramer, new species

fig. 16–17

Length of male 4 mm, of female 4.2 mm.

Coloration: Entire venter, legs, and face pale brown; clypellus laterally and distally and patch under each eye fuscus to black; clypeal arcs faintly orange brown; weak, arched, brownish, mesally broken line below ocelli running width of face; edges of ocelli darkened; extreme apex of face with 3 angular black spots, central spot smaller and less regular. In dorsal view (fig. 17) crown with 5 black spots, central 3 extensions of those visible in facial aspect; hind margin of pronotum whitish, rest of pronotum varying from light orange brown to nearly mahogany, with anterior margin blackened narrowly in female and broadly in male, whitish hind margin of pronotum bordered anteriorly with black in male; scutellum unmarked; forewing hyaline and varying from light orange brown to nearly mahogany, unmarked except for whitish claval suture.

Male genitalia: Genital capsule in lateral view (fig. 16) with paired excessively long processes from 10th segment; processes slender, directed ventrally, and curved posteriorly, each process with simple branch on dorsal margin in distal ⅓ and shorter branch on dorsal margin subapically; paired sclerites near dorsal inner margin of pygofer; style hooked distally; aedeagus slender, downcurved in distal ⅓, gonopore ventral near apex.

Female genitalia: Pregenital sternum long with sides converging to form bluntly angular hind margin.

Types: Holotype male, Monson Valley, Tingo Maria, Peru, 2 November 1954, E. I. Schlinger and E. S. Ross in California Academy of Sciences; allotype female with same data in USNM.

Notes: The species is readily distinguished on the basis of color pattern and male genitalia. Even though the color pattern is the same in both sexes, the male is distinctly darker. This condition is not unusual in agalliine leafhoppers.

Agalliopsis talpa Kramer, new species

fig. 18

Length of male 4 mm.

Coloration: Venter of abdomen and thorax fuscus to black; face and legs stramineous, only distinct markings at upper edge of face, center of extreme margin with narrow dark line and 1 black spot on each side. In dorsal view, crown stramineous with dark line at center and pair of spots on each side, central 3 markings extensions of those visible in facial view; pronotum, scutellum, and forewings fuscus to black, center of pronotum with pair of elongate pale areas on long axis; edge of scutellum pale in distal half; forewing with pale spot at middle of commissural margin and irregular pale patch at claval apex.

Male genitalia: Genital capsule in lateral view (fig. 18) with paired, ventrally

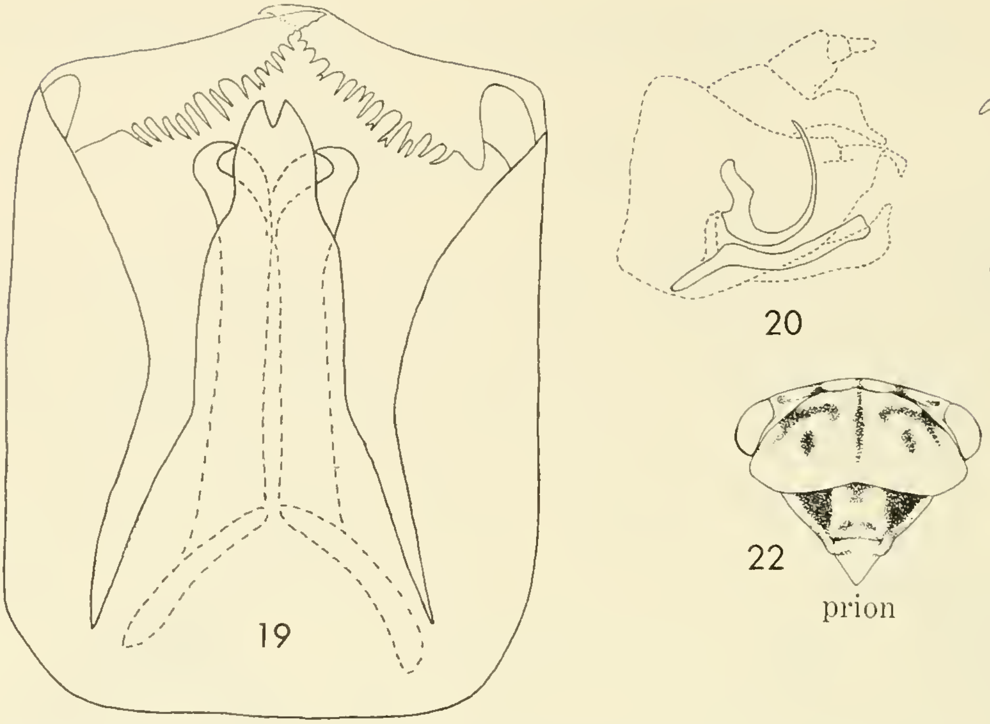

Fig. 19–22. *Euragallia prion.* 19, Genital capsule in ventral view. 20, Same in lateral view. 21, Aedeagal apex in posterior view. 22, Head and thorax in dorsal view.

projecting extensions from anal ring; inner edge of oblique hind margin of pygofer with paired thickenings which follow distal dorsal inner edge of pygofer; style hooked distally; aedeagus rather short, broadest distally, with distinct dorsal flap, gonopore ventral near apex. Not shown in fig. 18, long hairlike setae on dorsal margin of plate.

Type: Holotype male, Sinchono, Peru, DeLong Collection at Ohio State University.

Notes: The features of the male genitalia readily distinguish the species.

Euragallia prion Kramer, new species

fig. 19–22

Length of male 5.9–6.2 mm.

Structure: Contour of face irregular in upper half, with distinct pit near each eye on anterior margin.

Coloration: Venter of thorax and abdomen largely fuscus to black; sutures of thorax and distal edges of abdominal segments tawny; legs tawny and variably infuscated; face tawny and marked with black on all sutures, clypeal arcs, tip of clypellus, and antennal pits; narrow black arc below ocelli running width of face, black line from center of arc to extreme upper edge of face, black spot on upper margin on inner edge of each pit, moderately large irregular black patch between ocellus and eye, usually touching and partly surrounding ocellus. Head

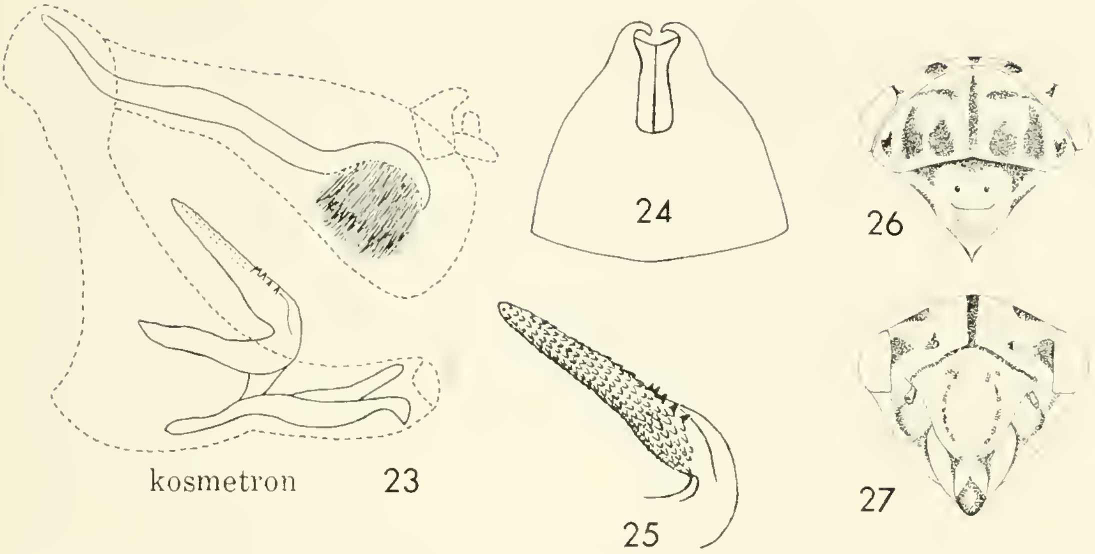

Fig. 23–27. *Agallia kosmetron.* 23, Genital capsule in lateral view. 24, Same in ventral view. 25, Detail of aedeagal shaft in lateral view. 26, Head and thorax in dorsal view. 27, Face.

and thorax in dorsal view (fig. 22) tawny and marked with black as indicated; forewing translucent tawny washed with fuscus, veins in distal half often infuscated or blackened, irregular blackish area at center of corium and sometimes between veins on commissural margin.

Male genitalia: Genital capsule in ventral view (fig. 19) with plates narrow and fused except at extreme apex; valve obsolete; distal edges of pygofer produced mesally as pair of large sawlike appendages. Genital capsule in lateral view (fig. 20) with 10th segment avicephaliform, dorsal distal margin of pygofer modified as illustrated; aedeagus simple, upturned, with distal portion thin, almost ribbonlike. Aedeagal apex in posterior view (fig. 21) with pair of short simple processes subapically; gonopore apical.

Types: Holotype male and paratype male Sinchono, Peru, in DeLong Collection at Ohio State University; one paratype male with same data in USNM.

Notes: The sawlike appendages of the male pygofer are unique in the genus and at once distinguish the species.

Agallia kosmetron Kramer, new species

fig. 23–27

Length of male 4.5 mm.

Structure: Crown slightly shorter at middle than next to eyes; pronotal surface finely granular.

Coloration: Thoracic venter and abdomen largely fuscus; legs pale brown and marked with fuscus or black; face yellowish brown and marked with fuscus to black as in fig. 27, inverted V-shaped marking on clypellus most distinctive. Crown, pronotum, and scutellum in dorsal view (fig. 26) yellowish brown and marked with fuscus to black as indicated; forewing sordid yellowish brown, veins concolorous or slightly darker, some infuscation between veins, especially in basal half.

Male genitalia: Genital capsule in ventral view (fig. 24) with valve absent and plates reduced and fused. Genital capsule in lateral view (fig. 23) with pygofer greatly narrowed and 10th segment much enlarged and elongated; process of 10th segment long, slender, somewhat undulate, with brush of long hairlike setae distally on ventral margin, teeth concealed by setae; style forked distally; aedeagus more or less V-shaped with few teeth on distal submargin near base of shaft, gonopore slightly subapical on distal margin. Detail of aedeagal shaft in lateral view (fig. 25) shows most of surface covered with sharp scales.

Type: Holotype male (USNM 73278) La Florida, Peru, 6 May 1967, C. Korytkowski.

Notes: Externally, the highly modified male genital capsule at once separates this species from its congeners. The brushlike structure of the tenth segment and the scaly aedeagus provide additional highly distinctive characters.

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NORTH AMERICAN DELTOCEPHALINE LEAFHOPPERS OF THE GENUS DESTRIA AND A NEW SPECIES OF LONATURA FROM ARIZONA (HOMOPTERA: CICADELLIDAE)

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ABSTRACT—The North American species of *Destria* Oman are revised, keyed, and redescribed. *Destria crocea* (Beirne) is reported from the United States for the first time. *Lonatura* **delongi** is described as a new species from Arizona. All critical diagnostic features are illustrated. Distributional and host-grass records are included.

The genus *Destria* Oman belongs to a large group of deltocephaline leafhoppers which share in common a linear connective solidly fused to the base of the aedeagus. Oman (1949:178) described the genus and included two species. Later, Kramer (1967:459) transferred *Lonatura crocea* Beirne to *Destria*. *Destria* is transcontinental in distribution. Hosts are likely to be grasses of the genus *Spartina* or related genera. This paper presents the first taxonomic treatment of the included species, all of which occur in North America.

Destria Oman

Destria Oman, 1949:178. Type-species: *Thamnotettix bisignatus* Sanders and DeLong.

Moderate-sized to fairly large deltocephaline leafhoppers (3.8–5 mm). Head wider than pronotum. Anterior margin of head rounded to face. Clypeal suture distinct or obscure. Ocelli close to eyes. Pronotum moderately long. Forewings long, extending well beyond apex of abdomen, or much shortened, rounded apically, exposing 4 abdominal segments dorsally, without extra crossveins in clavi. *Male genitalia*: Valve small; plates subtriangular, spinelike setae uniseriate; pygofer strongly setose; aedeagus moderately elongated and tubelike, notched apically on ventral margin, gonopore fairly large and delimited by distinct rim on dorsal margin, connective with stalk at juncture with aedeagus. *Female genitalia*: Pregenital sternum narrowed distally and exposing underlying sclerites laterally. Color stramineaous to ochreous, unmarked or with blackened areas on or near anterior coronal margin.

KEY TO THE NORTH AMERICAN SPECIES OF DESTRIA

1. Crown marked with black along anterior margin (fig. 1); distribution: East Coast from New Jersey to Florida .... *bisignata* (Sanders and DeLong)
— Crown unmarked; distribution: central and northwestern states and adjacent provinces of Canada 2

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2. Aedeagus in dorsal view with notch at apex long and narrow (fig. 12); distribution: Minnesota, Wisconsin, Missouri, and Kansas .... *fumida* (Sanders and DeLong)
— Aedeagus in dorsal view with notch at apex short and broad (fig. 17); distribution: Oregon, Saskatchewan and Manitoba .... *crocea* (Beirne)

Destria bisignata (Sanders and DeLong)
fig. 1–7

Thamnotettix bisignatus Sanders and DeLong, 1923:154.
Graminella bisignata (Sanders and DeLong); DeLong and Mohr, 1937:626.
Destria bisignata (Sanders and DeLong); Oman, 1949:178.

Length: Males 3.8–4.5 mm. Females 4–5 mm.

Structure: Crown in dorsal view (fig. 1) bluntly angular apically, interocular width greater than median coronal length. Head in lateral view with crown flat or slightly depressed in posterior half; clypeal suture usually faint; forewing much longer than abdomen; inner anteapical cell closed basally, basal crossvein often weak; central anteapical cell undivided; outer anteapical cell normal or slightly reduced; without extra crossveins in forewing.

Coloration: Uniformly pale stramineous with pair of wide, curved, black marks on anterior margin (fig. 1); abdominal dorsum variably infuscated; forewings hyaline with veins unpigmented.

Male genitalia: Aedeagus in lateral view (fig. 3–4) elongate with shaft uniformly wide; apical portion slightly expanded on ventral margin and lobed on dorsal margin, then graduallly narrowing to rounded tip; apical portion of aedeagus in dorsal view (fig. 7) with ventral notch widest basally; connective in dorsal view (fig. 2) with narrow stalk at juncture with aedeagus; style in dorsal view (fig. 6) with mesal lobe fairly stout and moderately long, lateral lobe short and bluntly angular; stylar lobes in dorso-lateral view (fig. 5) with mesal lobe bearing blunt subapical tooth and lateral lobe broad.

Female genitalia: Posterior margin of pregenital sternum narrower than anterior margin, truncate to slightly concave, at times with vague or poorly defined blunt tooth at middle.

Records: The type-locality is Cleveland, Florida. My confirmed records: FLORIDA, Cleveland, Fort Pierce, Jacksonville, Sanford; MARYLAND, Annapolis, Berlin, Cambridge, Chestertown, Crisfield, Easton, Gibson Island, Ocean City, Salisbury, Snow Hill, Sparrows Point; NEW JERSEY, Tuckerton; VIRGINIA, Exmore, Onley.

Notes: The black marks on the anterior margin of the crown will at once distinguish *D. bisignata* from its congeners. Only the specimens from New Jersey were collected with a host plant association: saltmeadow cordgrass, *Spartina patens* (Ait.) Muhl. Saltmeadow cordgrass occurs along the Atlantic and Gulf Coasts from Maine to

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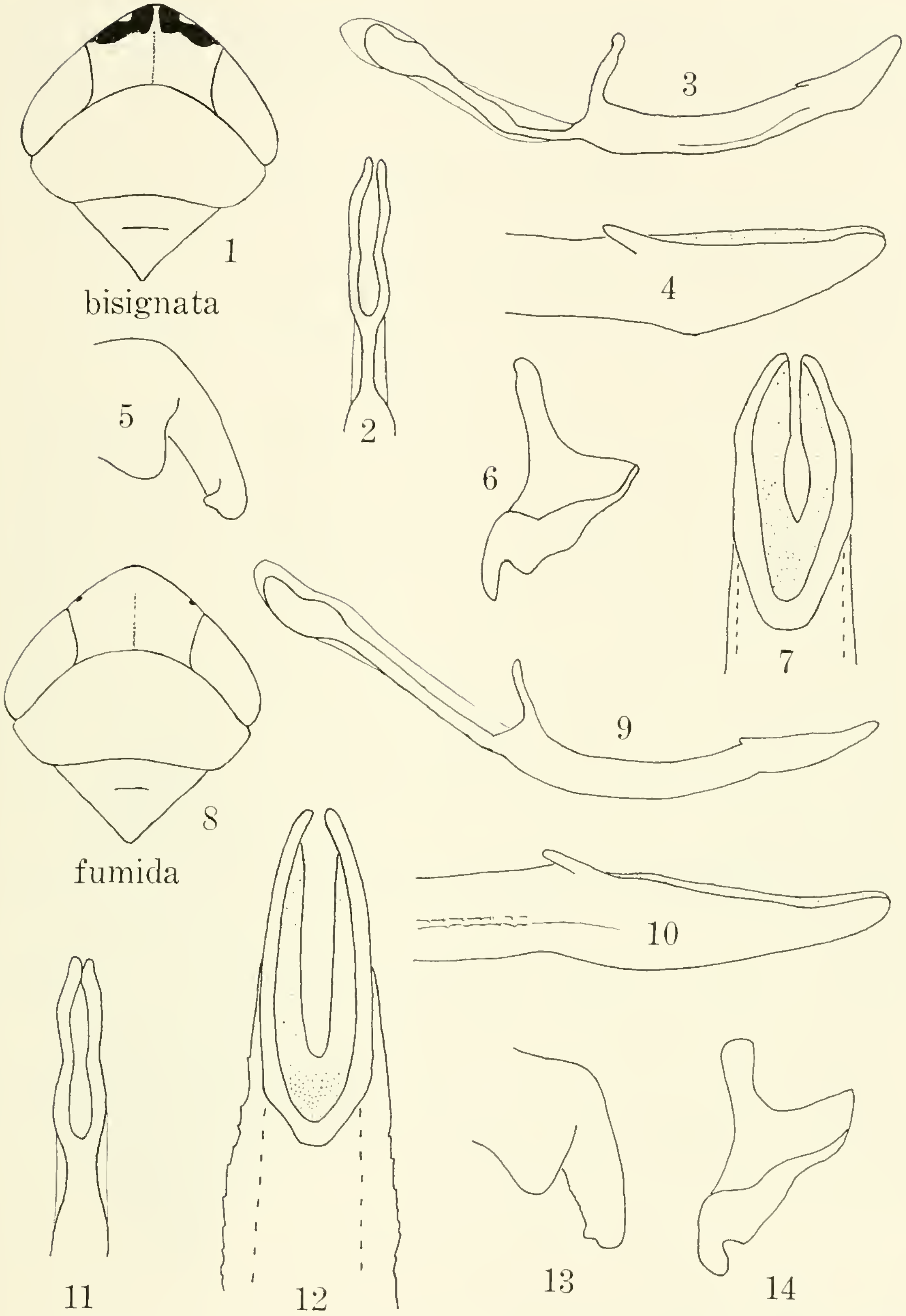
4, Aedeagal apex in lateral view. 5, Distal portion of style in dorsolateral view.

Fig. 1–7. *Destria bisignata.* 1, Head and thoracic dorsum. 2, Connective and base of aedeagus in dorsal view. 3, Aedeagus and connective in lateral view.



6, Style in dorsal view. 7, Aedeagal apex in dorsal view. Fig. 8–14. *Destria fumida*. 8, Head and thoracic dorsum. 9, Aedeagus and connective in lateral view. 10, Aedeagal apex in lateral view. 11, Connective and base of aedeagus in dorsal view. 12, Aedeagal apex in dorsal view. 13, Distal portion of style in dorsolateral view. 14, Style in dorsal view.

eastern Texas in salt marshes, sandy meadows, and in saline marshes inland. The distributional records of the leafhopper fall within the range of saltmeadow cordgrass, and it seems likely that this grass is the true host.

Destria fumida (Sanders and DeLong)
fig. 8–14

Deltocephalus fumidus Sanders and DeLong, 1917:86.
Polyamia algosus DeLong and Davidson, 1935:165.
Destria fumida (Sanders and DeLong); Oman, 1949:178.
Destria algosa (DeLong and Davidson); Oman, 1949:178. As = *fumida.*

Length: Males 4–4.4 mm. Females 4.7–5 mm.

Structure: Crown in dorsal view (fig. 8) not significantly different from that of *D. bisignata.* Head in lateral view with crown flat or slightly depressed in posterior half; clypeal suture faint or absent; forewing clearly exceeding apex of abdomen; inner anteapical cell either closed or open basally; central anteapical cell undivided; outer anteapical cell normal; without extra crossveins in forewing.

Coloration: Somewhat variable, uniformly pale stramineous to fumose stramineous with vague darkening along veins of hyaline forewings; abdominal dorsum lightly infuscated.

Male genitalia: Aedeagus in lateral view (fig. 9–10) similar to that of *D. bisignata* except for exceedingly narrow finely dentate ridge on sides; apical portion of aedeagus in dorsal view (fig. 12) with long ventral notch nearly uniformly wide or slightly narrower basally; connective in dorsal view (fig. 11) with broad stalk at juncture with aedeagus; style in dorsal view (fig. 14) with mesal lobe stout and moderately long, lateral lobe short and bluntly angular; stylar lobes in dorsolateral view (fig. 13) with mesal lobe bearing blunt subapical tooth and lateral lobe broad.

Female genitalia: Posterior margin of pregenital sternum like that of *D. bisignata* except the blunt tooth at middle more clearly delimited by darkened area on each side.

Records: The type-locality is Woodman, Wisconsin. My confirmed records: KANSAS, Douglas Co., Saline Co., MINNESOTA, Crookston, St. Paul; MISSOURI, Landon; WISCONSIN, Wisconsin Rapids, Woodman.

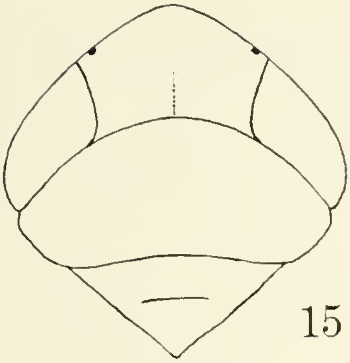
Notes: The lack of coronal markings and the long ventral notch at the aedeagal apex distinguish *D. fumida* from its congeners. No host records are available, but the host might well prove to be a species of *Spartina* found in the middle portion of the United States.

Destria crocea (Beirne)
fig. 15–18

Lonatura crocea Beirne, 1955:375.
Destria crocea (Beirne); Kramer, 1967:495.

Length: Males and females 4–4.5 mm.

Structure: Crown in dorsal view (fig. 15) not significantly different from that of *D. bisignata.* Head in lateral view with crown flat; clypeal suture faint;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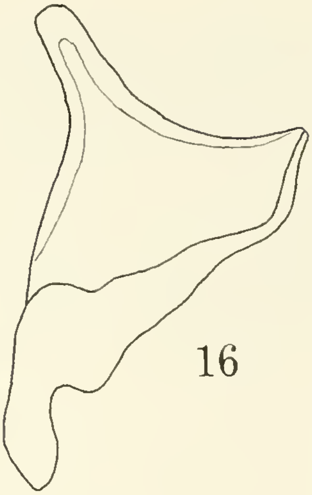
crocea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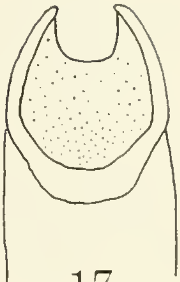
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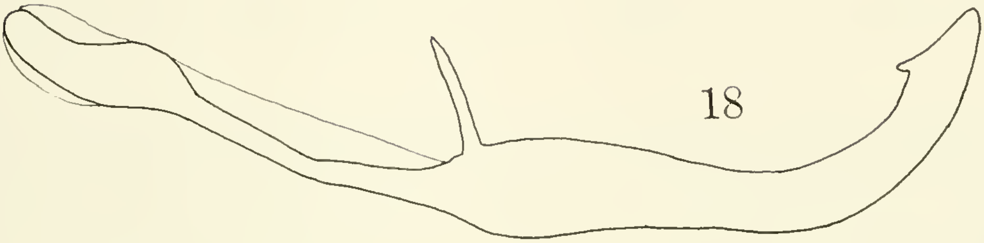
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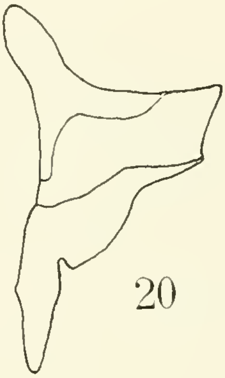
delongi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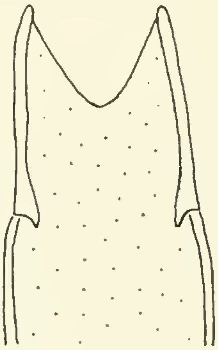
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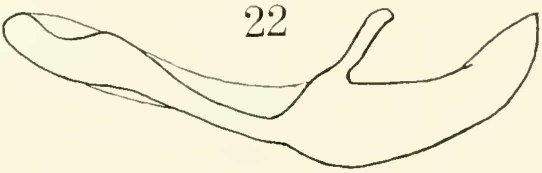
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Fig. 15–18. *Destria crocea.* 15, Head and thoracic dorsum. 16, Style in dorsal view. 17, Aedeagal apex in dorsal view. 18, Aedeagus and connective in lateral view. Fig. 19–22. *Lonatura delongi.* 19, Habitus in dorsal view. 20, Style in dorsal view. 21, Aedeagal apex in dorsal view. 22, Aedeagus and connective in lateral view.

forewing either clearly exceeding abdomen with venation similar to that of *D. bisignata* or much shortened, rounded apically, with venation reduced; in the shortwinged condition, 4 abdominal segments exposed dorsally.

Coloration: Somewhat variable, uniformly stramineous to ochreous; basal angles of scutellum at times pale orange; abdominal dorsum at times lightly infuscated.

Male genitalia: Aedeagus in lateral view (fig. 18) similar to that of *D. bisignata* but more clearly upturned distally; apical portion of aedeagus in dorsal view (fig. 17) with ventral notch broad but shallow, its width and length about equal; connective in dorsal view like that of *D. fumida*; style in dorsal view (fig. 16) with mesal lobe stout and moderately long, lateral lobe short and bluntly angular.

Female genitalia: Pregenital sternum not distinguishable from that of *D. fumida*.

Records: The type-locality is Bateman, Saskatchewan. My confirmed records: MANITOBA, Aweme; OREGON, La Grande; SASKATCHEWAN, Bateman, Elbow.

Notes: The lack of coronal markings and the short and broad ventral notch at the aedeagal apex distinguish *D. crocea* from its congeners. No host records are available, but the host might well prove to be a species of *Spartina* found in the Northwest and adjacent portions of Canada. The Oregon report provides the first United States record of *D. crocea*. It is based on a single longwinged male in the USNM with the data: "La Grande, Oregon, 17 August 1947, J. E. Davis Coll."

Lonatura Osborn and Ball

The genus *Lonatura* belongs to the same group of deltocephaline leafhoppers as does *Destria*. In *Lonatura* brachyptery is the rule rather than the exception; although macropterous specimens are sometimes found, they are rather rare and possess a somewhat distorted venational pattern in the forewings. Even though brachyptery occurs in a few species as the exception in related genera, in these exceptions the shortened forewings are always rounded apically and no more than four abdominal segments are exposed dorsally. In *Lonatura* the forewings are truncated apically and five to seven abdominal segments are exposed dorsally. *Lonatura* was last revised by Kramer (1967).

Lonatura delongi Kramer, new species

fig. 19–22

Length: Male 3–3.2 mm.

Structure: Head bluntly angular, coronal length at middle less than interocular width, ocellus removed from eye, 6–7 abdominal segments visible in dorsal view, venation of forewings variably distinct.

Coloration: Thoracic venter, legs, and most of face stramineous to ochreous; face below upper margin black as extension of coronal marking. In dorsal view (fig. 19) crown with anterior half black and posterior half stramineous to yellow, usually with ill-defined spot on each side of coronal suture in basal half; pronotum stramineous to yellow and broadly marked with black or fuscus along anterior margin; scutellum infuscated in all angles; forewing yellowish to whitish with a variable number of scattered fuscus or brown patches or spots; abdominal segments both dorsally and ventrally black or fuscus with distal margins yellowish, thus appearing to be transversely banded.

Male genitalia: Aedeagus in lateral view (fig. 22) simple, stout, distally slightly upturned, extreme apex acutely angular, with minute subapical tooth on dorsal margin; aedeagal apex in dorsoanterior view (fig. 21) with broad and moderately deep notch at apex, gonopore not delimited; style in dorsal view (fig. 20) with mesal lobe moderately long and tapering toward apex, lateral lobe short and broad.

Female genitalia: Female unknown.

Types: Holotype male (USNM 73291) and five paratype males, Douglas, Arizona, 21 August 1932, E. D. Ball.

Notes: In my key to species (Kramer, 1967:435), this species will trace to couplet 2 and no further. It is easily distinguished from all its congeners on the basis of the bicolored crown, pronotum, and abdominal segments plus the spotted forewings. The male genitalia resemble those of *L. noctivaga* Ball (Kramer, 1967: fig. 25–28), but that species is a larger and differently marked leafhopper (Kramer, 1967: fig. 24). I take great pleasure in naming this distinctive species for Professor Dwight M. DeLong as a small recognition of his numerous contributions to leafhopper taxonomy over the last 50 years.

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PRELIMINARY REPORT ON THE FALSE SPIDER MITES (ACARI: TENUIPALPIDAE) FROM BRAZIL AND PARAGUAY

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ABSTRACT—An annotated list of 11 species of tenuipalpid mites from Brazil and Paraguay is presented.

Very little is known about false spider mites in Brazil and Paraguay. References from Brazil are from Bondar (1928), Bitancourt *et al.* (1933), Amaral (1951), Ehara (1966), Arruda & Flechtmann (1967), Paschoal (1968), Paschoal & Reis (1968); references from Paraguay are from Alvarez *et al.* (1955), Nickel (1958) and Knorr *et al.* (1968).

There are also two general papers by Flechtmann (1967) and by Aranda (1969) which were presented as thesis to the Escola Superior de Agricultura "Luiz de Queiroz", Univ. São Paulo, Piriacicaba. Since these are not widely distributed, it has been though best to bring the literature up to date, even though much is yet to be done on plant mites from these areas.

Pentamerismus oregonensis McGregor

Pentamerismus oregonensis McGregor, 1949:27.

This widespread species on conifers was collected from these plants in Piracicaba, São Paulo, Brazil. Ehara (1966) mentioned it from Rio Claro, São Paulo.

Brevipalpus phoenicis (Geijskes)

Tenuipalpus phoenicis Geijskes, 1939:230.
Brevipalpus phoenicis; Sayed, 1946:99.

This species worldwide in distribution and exhibits an enormous host range. It has been taken from many plants in Brazil in the states of Alagoas, Pernambuco, Ceará, Minas Gerais, Bahia, Rio de Janeiro, São Paulo and Paraná.

Known hosts in Brazil: *Acalypha, Acnistus, Allamanda, Amarilis, Bidens, Calathea, Capsicum, Carica, Castanea, Citrus, Coffea, Dahlia, Esembeckia, Lantana, Luffa, Manihot, Melissa, Mespilus, Passiflora, Pereskya, Persea, Petunia, Pittosporum, Podranea, Potomorphae, Prunus, Psidium, Punica, Pyrus, Rhododendron, Rollinia, Rosmarinus, Rubus, Sechium, Tabebuya, Thea, Theobroma, Vitis, Zinnia.*

In Paraguay it has been collected on *Citrus, Ligustrum japonicum* Hort, *Mani-*

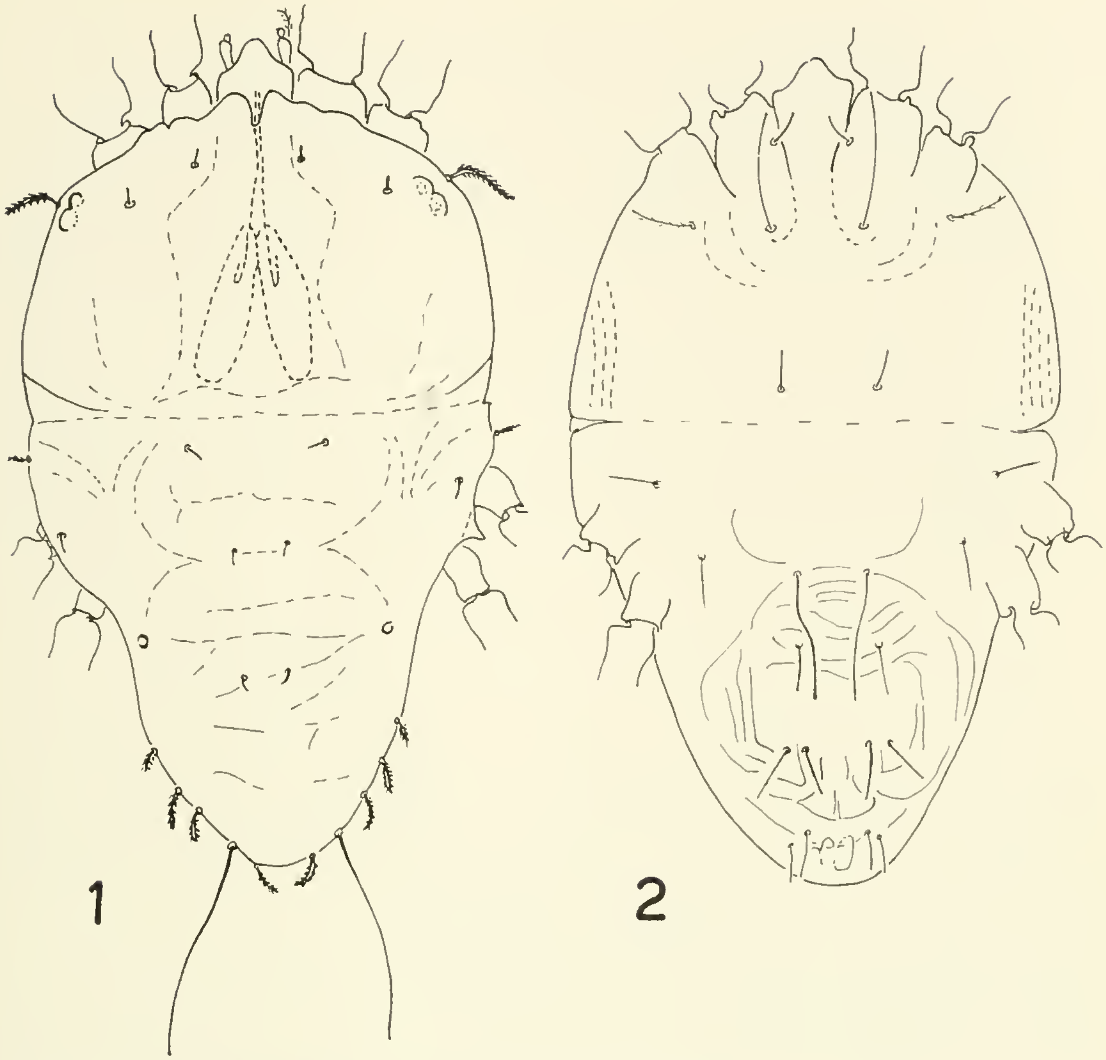

Fig. 1–2. *Tenuipalpus cedrelae*, female. 1, Dorsal. 2, Ventral.

hot utilissima Pohl, *Psidium guajava* Raddi, *Prunus persica* Stokes, *Saccharum* sp. and *Vitis vinifera* Marsh.

Brevipalpus obovatus Donnadieu

Brevipalpus obovatus Donnadieu, 1875:116.

This is also a widespread species and has been taken, in the State of São Paulo, Brazil, from: *Artemisia, Calathea, Coffea, Cucurbita, Dahlia, Ficus, Hibiscus, Holocalyx, Jasminum, Melissa, Pyrus, Poinciana, Punica, Rhododendron, Rubus* and *Vitis*, and in the state of Bahia, Brazil, from *Citrus*.

Tenuipalpus heveae Baker

Tenuipalpus heveae Baker, 1945:36.

This species is only known from the type-species, on *Hevea*, Belterra, Pará, Brazil.

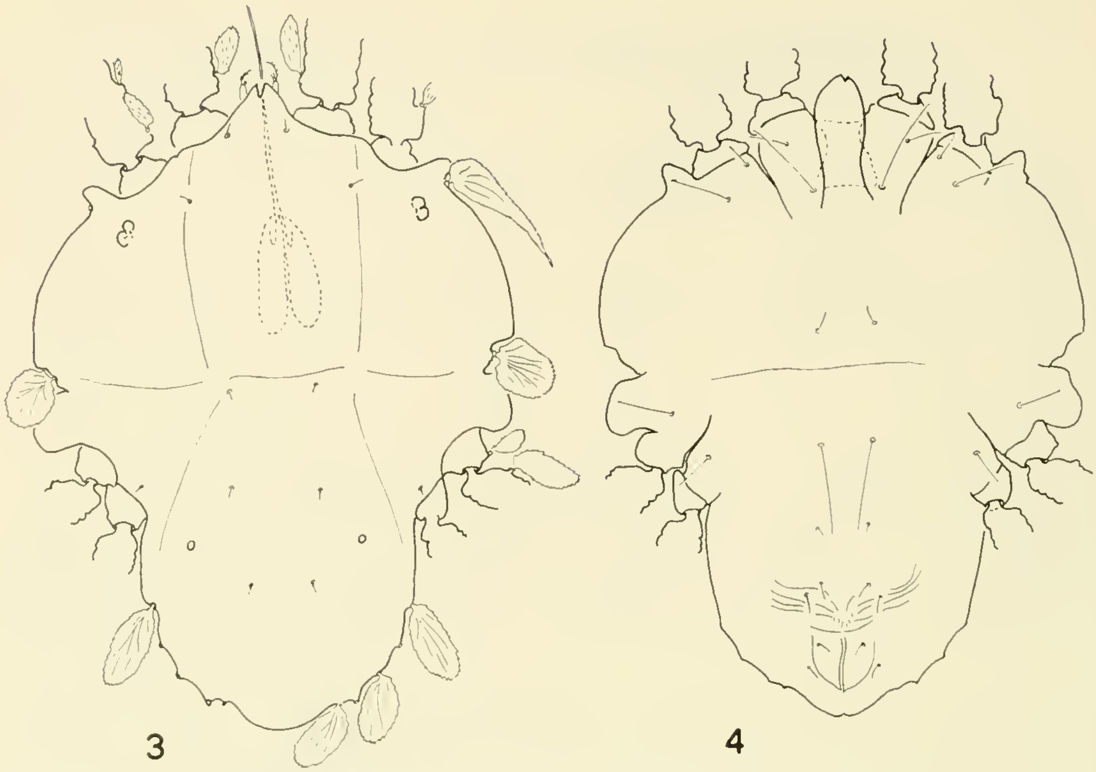

Fig. 3–4. *Tenuipalpus latiseta*, female. 3, Dorsal. 4, Ventral.

Tenuipalpus pacificus Baker

Tenuipalpus pacificus Baker, 1945:38.

This species is a well known orchid pest; it was taken from several Orchidaceae at Fortaleza, Ceará, Brazil.

Tenuipalpus anacardii De Leon

Tenuipalpus anacardii De Leon, 1965:67.

This species, described from British Guyana, was collected from cashews, *Anacardium occidentale* L., at Fortaleza, Ceará, Brazil.

Tenuipalpus micheli Lawrence

Tenuipalpus micheli Lawrence, 1940:111.

This species is reported from *Campomanesia rhombea* Berg. and *Psidium guajava* Raddi from Paraguay (Aranda, 1969).

Tenuipalpus cedrelae De Leon

fig. 1, 2

Tenuipalpus cedrelae De Leon, 1957:90.

This species, described from *Cedrela fissilis* Vell. from Mexico, was collected at Joinville, Santa Catarina, Brazil, from the same host, causing intense bronzing and early leaf drop.

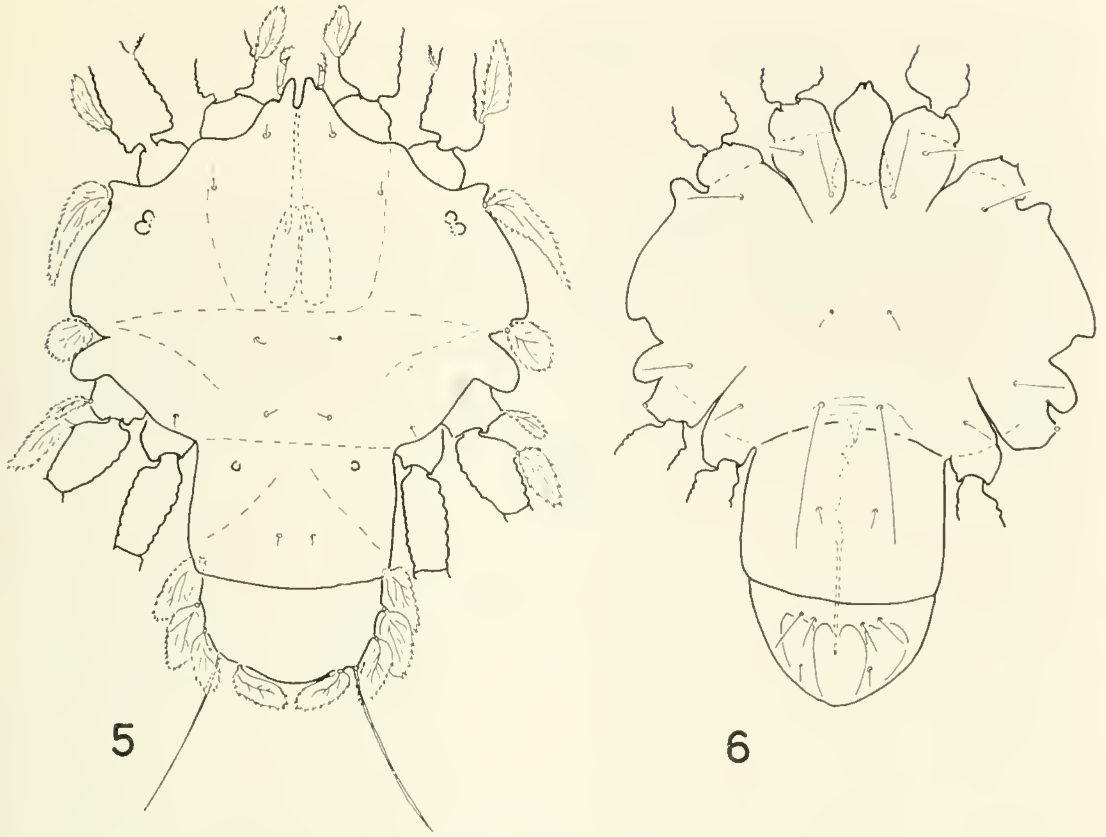

Fig. 5–6. *Tenuipalpus latiseta*, male. 5, Dorsal. 6, Ventral.

Tenuipalpus latiseta Aranda
fig. 3–6

Tenuipalpus latiseta Aranda, 1974:16.

This species is close to *T. hastaligni* De Leon, *T. lucumae* De Leon and *T. anacardii* De Leon, differing mainly in the much longer third dorsopropodosomal setae and by its shape.

Female: Bright red, greatly flattened. Palpus with 3 segments, the 2nd bearing a serrate seta dorsally, the 3rd with 2 terminal sensory rods and a smooth minute seta. Femur I with inner setae broadly spatulate. Rostral shield with short medioanterior incision. Body with chaetotaxy and markings as shown in fig. 3. First and 2nd dorsopropodosomal setae minute, 3rd arising from small tubercle, elongate, spatulate, reaching almost to caudal margin of propodosoma. Mediodorsal area of hysterosoma smooth; 3 pairs of mediodorsal setae, minute; humeral setae orbicular spatulate. First dorsolaterals minute; 2nd, 4th and 6th dorsolaterals broadly spatulate; other dorsolaterals not seen.

Length of body 360 μ; width 270 μ.

Male: Similar to female; 1st dorsolateral setae minute; 5th dorsolateral long, flagelliform; other dorsolaterals broadly spatulate. As figured.

Length of body 280 μ; width 200 μ.

Holotype: Female, collected from a non-identified plant of the family Celastraceae, at Corumbataí, São Paulo, Brazil (B. R. Aranda

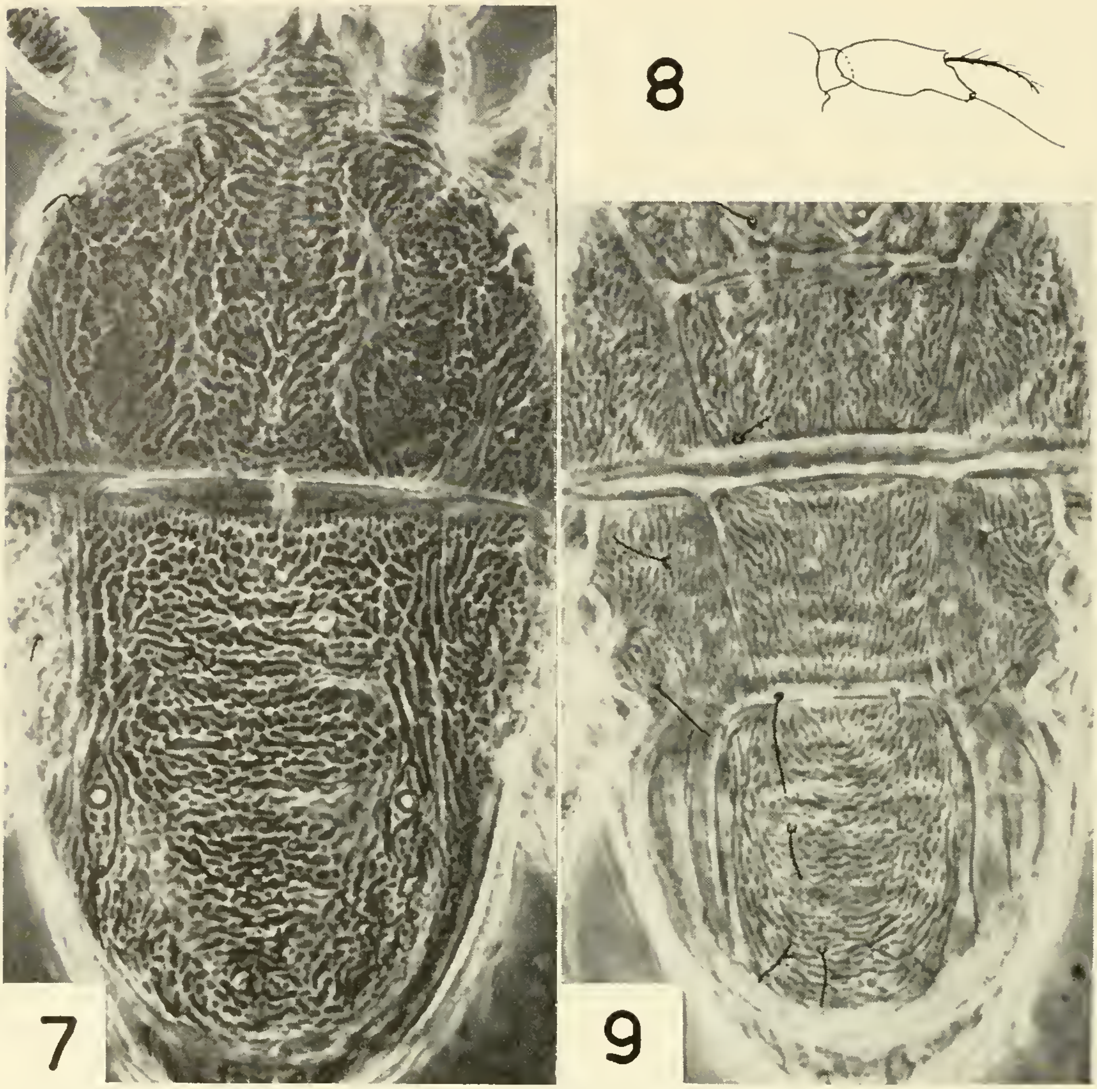

Fig. 7–9. *Colopalpus oxalis,* female. 7, Dorsal. 8, Palpus. 9, Ventral.

C.), in the collection of the Dept. Zoology, ESA"LQ", Univ. São Paulo, Piracicaba.

Paratype: One male, same data and on the same slide as holotype.

Dolichotetranychus floridanus (Banks)

Stigmaeus floridanus Banks, 1900:77.
Dolichotetranychus floridanus; Sayed, 1938:606.

This species is spread throughout the tropics on pineapples. It is a serious pest of *Ananas* in the states of Paraiba, Pernambuco, Minas Gerais, Espírito Santo and São Paulo. Variety Cayenne of pineapples seems to be the most susceptible, where this mite causes intense wilting of the plants. It was also found on a wild Bromeliaceae in Pernambuco (Arruda and Flechtmann, 1967).

Colopalpus oxalis Flechtmann

fig. 7–9

Colopalpus oxalis Flechtmann, 1971:46.

This species is distinct in presenting a barbed subterminal seta on the palpus, by the dorsal sculptures and by presenting simple and short dorsopropodosomal setae.

Female: Rostrum extending to middle of femur I. Distal segment of palp with barbed subterminal seta. Tarsus I and II each with 1 solenidion; claws represented by elongate padlike structure with 2 rows of tenent hairs; empodium identical to claws. Rostral scutum with deep median incision. Dorsum of idiosoma characteristically reticulated. Dorsal setae simple; 4th pair of dorsolateral hysterosomal flagelliform. Anterior medioventral setae half as long as posterior medioventral.

Length of body 214 μ, including gnathosoma 240 μ; width 72 μ.

Male: Not seen.

Holotype: Female, on *Oxalis* sp., Piracicaba, São Paulo, Brazil, (C. H. W. Flechtmann) in the collection of the Dept. Zoology, ESA"LQ", Univ. São Paulo, Piracicaba.

Paratypes: 7 females, same data.

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NESTING OF STIZUS IRIDIS AT THE TYPE-LOCALITY (HYMENOPTERA: NYSSONIDAE)

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ABSTRACT—The type-series of *Stizus iridis* Dow was collected in 1935 near Rainbow Bridge, Utah, not within Rainbow Bridge National Monument as indicated in the original description. When the type-locality was visited in late July 1974, few males were active, but nesting was in progress and adult Acrididae were found as prey in 2 nests.

On July 16, 1935, Professor C. T. Brues caught 3 males of a large digger wasp near Rainbow Bridge, San Juan County, Utah. Several years later these specimens were described by me as *Stizus iridis* (Dow, 1942). Though no further information on the species has ever been reported, specimens of both sexes collected at other localities are treated in an unpublished master's thesis on the North American *Stizus* by J. W. Stubblefield (1973).

In the notes which Professor Brues contributed to my paper, the wasp site is correctly placed "about half a mile" from Rainbow Bridge and "near the camp established for visitors." The wasp habitat and what remains of the camp site (now little used) are both in a short lateral canyon which is upstream from Rainbow Bridge on the east side of Bridge Canyon, and well beyond the boundary of Rainbow Bridge National Monument. The right (south) wall of this canyon ends in an arc of overhanging cliffs that bends left to the northeast and finally meets the north wall. Under these cliffs is a curving talus of sand and rocks that rises about 10 m above a level area at the head of the canyon. Here, on the canyon floor, my wife and I camped three nights in 1974 (July 24–27). It had rained heavily a day or two before our visit, but during our stay, there was only a sprinkle of rain, and no plants in the vicinity were conspicuously in flower.

On July 25, about sunrise, while the canyon was still in full shadow, I started out to look for *Stizus iridis* by climbing the left end of the talus toward the deepest part of the overhang, and then proceeded clockwise. At a point more than halfway around the talus, shortly after passing the last clump of vegetation near the cliff wall, I became aware of a wasp in flight and soon caught the first specimen of *S. iridis*. A few meters beyond, the upper part of the talus becomes a wide terrace that slopes gently from the cliff wall to the rim of the steep part below. This terrace, where I later observed most of the nesting and flight activity, continues to the right end of the overhang. It is bare of vegetation, has no sign of seepage or rain, and as seen in late July, is not reached by direct sunlight until afternoon.

Adults of *Stizus iridis* were not abundant, and there was seldom, if ever, more than one to be heard or seen at a time. Most of the flight observed was over the terrace, often very close to the ground. I saw only a minimum of flight to and from the steep slope of the talus, but it was there that Professor Brues apparently collected the 3 original males. All 4 of my males were caught within 2 hours of sunrise; 3 were simply taken in flight, the 4th shortly after alighting on the cliff wall.

Only one of the 5 females captured was observed merely in flight. Two were noticed digging; another was caught after it had taken prey into its nest (no. 1); and the last was overtaken as I excavated the main burrow of its nest (no. 2). Both of these identified nests, found on the terrace on July 26, had a single cell at the end of a long sloping tunnel. No branches or other cells could be positively associated with these tunnels whose length was estimated at 22 and 35 cm respectively. The cell in nest no. 1, about 4½ cm long, 3 cm wide, and 2½ cm high, contained 8 adult short-horned grasshoppers: 7 *Trimerotropis pallidipennis* (Burmeister) and 1 *Trimerotropis sparsa* (Thomas). The cell in nest no. 2, about 2½ cm wide and 2½ cm high, contained 3 adult *T. pallidipennis*. An egg had been laid on the thorax of one *T. pallidipennis* in each of the two cells.

In excavating nest no. 1 and also a unidentified burrow, I came across 3 vacated cocoons which probably belong to *Stizus iridis*. They are distinctly more cylindrical than the cocoon of *S. pulcherrimus* Smith illustrated by Evans (1966, fig. 207A). The broken edge is 23–25, 24–27, and 24–26 mm from the posterior end (exclusive of the nipple containing extruded feces), and the maximum diameter (apparently also that of the cocoons when entire) measures 9, 9½, and 10½ mm, respectively. I found no trace of any pores. The abundant uric acid waste appeared to have been excreted in a semifluid state. It occurred mostly as a large pellet near the open end of the cocoon.

For various sorts of helpful information, I am especially grateful to Professor Alice M. Brues, Dr. Karl V. Krombein, Dr. Ashley B. Gurney (who identified the grasshoppers), Mr. J. W. Stubblefield, and many persons in the National Park Service.

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SAWFLIES OF THE TRIBE PSEUDODINEURINI IN NORTH AMERICA (HYMENOPTERA: TENTHREDINIDAE)

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ABSTRACT—Keys are given for the three world genera of Pseudodineurini, *Pseudodineura*, *Kerita*, and *Endophytus* and for the species of the two North American genera, *Pseudodineura* and *Kerita*. Species treated are *Kerita fidala* Ross from eastern North America, *K.* **atira**, n. sp. and *K.* **difala**, n. sp. both from western North American, *Pseudodineura parvula* (Klug), *P. parva* (Norton), and *P.* **releda**, n. sp. from eastern North America, and *P.* ***lehosa***, n. sp. from western North America. Larvae of members of this tribe are leaf miners. The known North American hosts are *Mertensia* (Boraginaceae), *Hepatica* and *Ranunculus* (*Ranunculaceae*).

The Pseudodineurini, a tribe of the Nematinae, are a small group of leaf mining sawflies consisting of three world genera. Adults are small and not commonly collected; consequently, this tribe has received scant attention in North America where only two genera, *Pseudodineura* and *Kerita*, with one species in each, have been recorded. The two North American species were known from only several localities in the eastern United States west to Illinois. In this study, three species of *Pseudodineura* and two species of *Kerita* are added to the North American fauna, and both genera are shown to be transcontinental in distribution. Four of the species are new, and one species, *P. fuscula* (Klug), is possibly an adventive from Europe.

In contrast to the little amount of work in North America, several articles have been published on the European species, mostly by Hering (1929, 1935), Buhr (1941), Wahlgren (1944), Enslin (1914, 1921), Hellén (1960), and Vikberg (1967). Nine species of *Pseudodineura* and one species of *Endophytus* are known from Europe, and biological notes have been published on nearly all of them. All are leaf miners in the larval stage in herbaceous plants of the Ranunculaceae such as species of *Ranunculus*, *Clematus*, *Trollius*, and *Anemone*.

Benson (1938) first established the tribe Pseudodineurini and separated it from other members of the Nematinae by the absence of the anal cell of the hindwing and tridentate mandibles, characters which still distinguish the tribe. Members of the Pristolini also lack an anal cell in the hindwing but have only one minute tooth on the mandibles, and the postnotum is flat and exposed, separating the posttergite and metascutellum.

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KEY TO WORLD GENERA OF PSEUDODINEURINI

1\. Forewing with vein 2A and 3A curved up and meeting 1A, forming a basal anal cell; European .... *Endophytus* Hering

— Forewing wihout basal anal cell, stub of 2A and 3A straight (fig. 1–3) 2

2\. Malar space very narrow to absent; head punctate; holarctic [female lancet with narrow, rounded serrulae; male penis valve with slender lateral spine] .... *Pseudodineura* Konow

— Malar space as broad or broader than diameter of front ocellus; head smooth; North American [female lancet with broad, flat serrulae; male penis valve with broad lateral spine] .... *Kerita* Ross

Kerita Ross

Kerita Ross, 1937, p. 80.
Type-species: *Kerita fidala* Ross. Orig. desig.

This genus is separated by characters used in the preceding key. Only one species has been recorded, *K. fidala* from Illinois. Two new species from the western United States are here described. This genus is known only from North America.

Ross (1937) used the position of the ocelli as another character for separation of *Kerita* and *Pseudodineura*. The ocelli in *Kerita* form a "flatter" triangle and those in *Pseudodineura* form a "wide" triangle (Ross, 1937, fig. 294, 295). This appears to be a good character in addition to those used in the key, but it is extremely difficult to use when only single specimens are at hand.

KEY TO SPECIES OF KERITA

(The male of only one species, *K. atira*, n. sp. is known)

1\. Lancet without a spurette above each serrula (fig. 15) western .... *K. atira*, new species

— Lancet with a distinct spurette above each serrula 2

2\. Antenna stout, its length only twice head width; spurettes on lancet small (fig. 14); eastern .... *K. fidala* Ross

— Antenna long, its length three times head width; spurettes on lancet large (fig. 16); western .... *K. difala*, new species

Kerita atira Smith, new species

Female: Length 3.8 to 4.0 mm. Antenna and head black, clypeus sometimes brownish, labrum whitish, apex of each mandible reddish. Thorax black; tegulae

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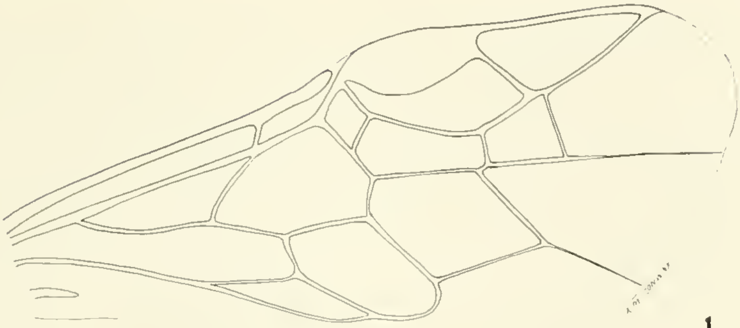
→

Fig. 1. Forewing of *Pseudodineura fuscula*. Fig. 2. Forewing of *Kerita atira*. Fig. 3. Forewing of *K. fidala*. Fig. 4. Hindwing of *K. fidala*. Fig. 5. Antenna of *K. fidala*, ♀. Fig. 6. Antenna of *P. parva*, ♀. Fig. 7. Antenna of *P. rileda*, ♀. Fig. 8, 9. *K. atira*. 8, Sheath lateral. 9, Sheath dorsal. Fig. 10, 11. *P. parva*. 10, Sheath lateral. 11, Sheath dorsal. Fig. 12, 13. *P. fuscula*. 12, Sheath lateral. 13, Sheath dorsal.



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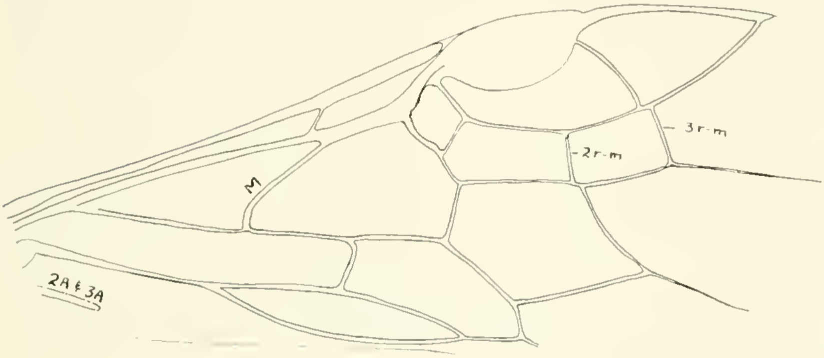

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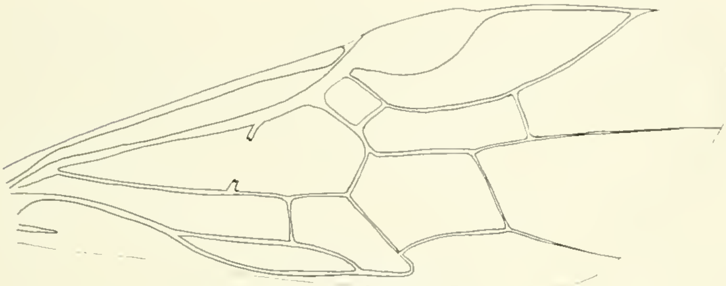

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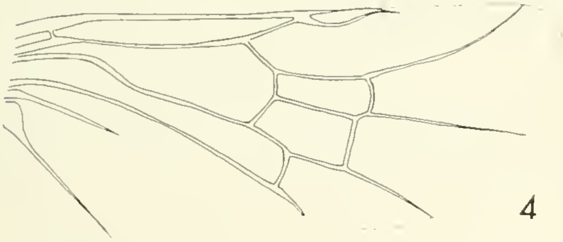

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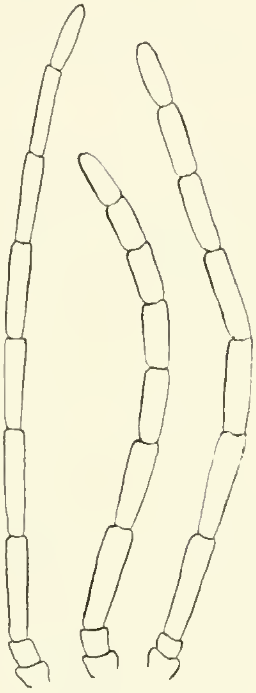

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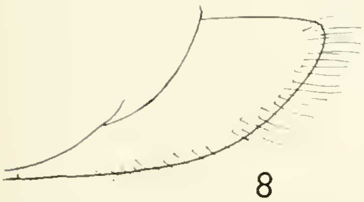

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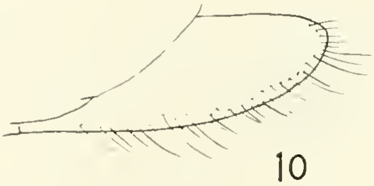

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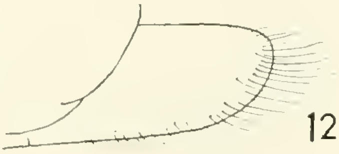

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sometimes whitish. Legs yellowish white; each coxa, each trochanter, and basal ⅔ of each front and middle femur black; basal half of hind femur sometimes black; each tarsus infuscated. Abdomen black, posterior margin of each segment with narrow white band. Wings hyaline, veins and stigma brownish.

Head and body smooth and shining, with short white pubescence. Length of antenna twice head width, segment 3 subequal in length to segment 4. Clypeus truncate; malar space equal to diameter of front ocellus. Forewing with radial crossvein faint, veins 2r-m and 3r-m both present, vein M present, intercostal vein present. Hindwing with cells Rs and M both present; anal cell absent. Sheath straight above, rounded below, in dorsal view narrow, broadest at base and tapering to acute apex. Lancet with 12 or 13 segments; serrule low, apical serrulae extended and pointed anteriorly, basal serrulae flat without anterior projection, each with no anterior and 7 to 10 fine posterior subbasal teeth; no spurettes evident (fig. 15).

Male: Length 3.7 to 3.9 mm. Coloration similar to that of female but with hypandrium yellowish. Antenna longer and more slender than in female, more than 2½ times head width and with segment 4 longer than segment 3. Other features as for those of female. Harpe and parapenis as in fig. 21; penis valve slender, with long apical filament and broad lateral spine (fig. 22).

Holotype: Female, Weston, Oregon, April 29, 1938, on mustard, K. Gray. USNM type no. 73208.

Paratypes: ALBERTA: Bilby, June 1, 1924, O. Bryant (1 ♀). CALIFORNIA: Tracy, San Joaquin Co., III-10-1933, collected from alfalfa, A. C. Browne (1 ♀); Concord, III-25-37 (1 ♀); Diablo, III-14-37 (1 ♂). IDAHO: Moscow, April 19, 1937, 2560 ft., C. C. Ball (1 ♂); Worley, V-14-33, R. D. Shenefelt (1 ♀); Lewiston, V-8-1935, 550 ft., W. E. Shull (1 ♀). OREGON: same data as for holotype (2 ♀♀, 8 ♂♂); 5 mi. N. Dufur, May 5, 1938, K. Gray and J. Schuh (1 ♀); Thorn Hollow, April 29, 1938, K. Gray and J. Schuh (1 ♀); Talent, April 20, 1938, L. G. Gentner (1 ♀); Aneroid Lake, Wallowa Mts., 7500 ft., B. Malkin (1 ♂). WASHINGTON: Maryhill, April 28, 1938, on wild sunflower, K. Gray (1 ♂). At the U.S. National Museum, Oregon State University, University of California, California Academy of Sciences, and Illinois Natural History Survey.

Host: Unknown. Adults have been collected from various plants such as mustard, alfalfa, and wild sunflower, none of which may represent the true host plant of the larva.

Discussion: The female lancet of this species lacks evidence of spurettes above the serrulae which are present in *fidala* and *difala*. The antennae is also much shorter than that of *difala* being only twice the head width in length, whereas it is three times the head width in *difala*.

The name is an arbitrary combination of letters and is to be treated as a noun.

Kerita difala Smith, new species

Female: Length, 4.0 mm. Antenna and head black; labrum and maxillary and labial palpi brownish; apex of each mandible reddish. Thorax black with tegulae yellowish. Legs yellowish; each coxa except for extreme apex black; basal half of each front and middle femur and each tarsus infuscated. Abdomen brownish. Wings hyaline, veins and stigma brownish.

Head and body smooth and shining with short white pubescence. Length of antenna nearly 3 times head width; segment 3 subequal in length to segment 4. Clypeus truncate; malar space equal diameter of front ocellus. Forewing with radial crossvein faint; veins 2r-m and 3r-m both present; vein M present; intercostal vein present. Hindwing with cells Rs and M both present; anal cell absent. Sheath narrow in lateral view, straight above, rounded below, acute at apex; in dorsal view slender, broadest at base and tapering to acute apex. Lancet with 11 to 12 segments; apical serrulae extended anteriorly, basal serrulae flat, each with no anterior and 7 to 10 fine posterior subbasal teeth; rather large, distinct spurette dorsal to each serrula (fig. 16).

Male: Unknown.

Holotype: Female. Salt Lake, Utah, Bells Canyon, July 19, 1917, 7000 to 9000 ft., A. B. Gahan, collector. USNM type no. 73207.

Paratype: WASHINGTON: Sunrise Ridge, Mt. Rainier, 5500′, VII-23-40, H. and M. Townes (1 ♀). At the University of California.

Host: Unknown.

Discussion: The long antenna, its length being three times the width of the head, and the large spurettes of the female lancet will distinguish this species from both *atira* and *fidala.*

This species name is an arbitrary combination of letters and is to be treated as a noun.

Kerita fidala Ross

Kerita fidala Ross, 1937, p. 80, ♀; Ross, 1945, p. 155 (figure of clypeal region); Ross, 1951, p. 53 (in catalog); Maxwell, 1955, p. 74 (internal larval anatomy).

Female: Length 3.7 to 4.0 mm. Antenna and head black, labrum and maxillary and labial palpi brownish, apex of each mandible reddish. Thorax black. Legs whitish yellow, each coxa except for apex, and basal half of each front and middle femur black; hind femur sometimes infuscated at base. Abdomen black with narrow whitish band on posterior margin of each segment. Wings hyaline, veins and stigma brownish.

Head and body smooth and shining, with white pubescence. Malar space a little more than diameter of front ocellus. Length of antenna about 2 times head width; segment 3 subequal in length to segment 4. Forewing with vein M absent or partially atrophied, 2r-m and sometimes 3r-m absent, r absent or faint, intercostal vein present or absent. Hindwing with cells Rs and M both present, anal cell absent. Sheath straight above, rounded below and at apex, from above slender, broadest at base tapering to acute apex. Lancet with 13 segments; serrulae low, those on apical part of lancet narrow and directed anteriorly, those on basal part of lancet flat, without projection, each with no anterior and 8 to 10 fine posterior subbasal teeth; small spurette dorsal to each serrula (fig. 14).

Male: Unknown.

Type: From Muncie (spelled Munsey on label) Ill., April 25, 1914, ♀ holotype at the Illinois Natural History Survey.

Distribution: ILLINOIS: Muncie, Apr. 25, 1914; LaSalle Co., April 5, 1938, April 27, 1937; Wedron, April 14, 1937, April 16, 1946, on *Mertensia virginica*; Cornland, April 28, 1949, in woods. INDIANA: Veedersburg April 23, 1950, on *Mertensia*.

Host: *Mertensia*.

Discussion: The presence of small spurettes above each serrula of the lancet will distinguish this species from *atira*. From *difala* it is separated by the smaller spurettes and shorter antennae with their length being only twice the head width. Many of the specimens examined of this species, including the holotype, lack vein M in the forewing or vein M is present as only a short stub. This wing venation was not found in the other species and not in all specimens of *fidala*. The presence or absence of vein M must be highly variable and cannot be a generic character as given by Ross (1937). Also veins 2 r-m and 3 r-m may be present or absent, even in the opposite wings of the same individual.

There were no males among the hundred or more specimens examined from Illinois.

Pseudodineura Konow

Dolerus subg. *Pelmatopus* Hartig, 1837, p. 244. Preocc. by Fischer de Waldheim, 1824. Type-species: *Dolerus* (*Pelmatopus*) *minutus* Hartig. Monotypic.

Pseudodineura Konow, 1885, p. 297. Type-species: *Tenthredo* (*Allantus*) *parvula* Klug. Desig. by Rohwer, 1911.

Phyllopais Hering, 1934, p. 353. N. name for *Pelmatopus* Hartig.

This genus is characterized by the characters given in the preceding key to genera. Four species are now known from North America, *parva* (Norton), *fuscula* (Klug) which may be an adventive from Europe, and two new species described here. Keys to the European species of this genus are given by Enslin (1921) and Hering (1929).

Key to North American Species of Pseudodineura

1. Female 2
— Male 5
2. Sheath from above short and broad, broader than long, broadly rounded at apex (fig. 13); serrulae of lancet long, slender (fig. 17) .... *fuscula* (Klug)
— Sheath from above slender, longer than broad, tapering to narrow, blunt point at apex (fig. 11); serrulae of lancet low (figs. 18–20) 3
3. Lancet with 11 serrulae, each serrula slightly longer than broad (fig. 19) western .... *lehosa*, n. sp.
— Lancet with 13 or 14 serrulae, each serrula low, broader than long (fig. 18, 20); eastern 4
4. Mesopleuron usually pale reddish orange (sometimes black); abdomen

with considerable brown toward apex (sometimes more black than brown); antenna less than twice head width .... *parva* (Norton)
— Mesopleuron and abdomen black; antenna 2 times or more head width .... *rileda*, n. sp.
5. Mesopleuron usually pale reddish orange (sometimes black); abdomen with considerable brown toward apex (sometimes more black than brown); antenna less than 2 times head width .... *parva* (Norton)
— Mesopleuron and abdomen black; antenna 2½ times or more head width .. 6
6. Eastern .... *rileda*, n. sp.
— Western .... *lehosa*, n. sp.

Pseudodineura fuscula (Klug)

Tenthredo fuscula Klug, 1814, p. 70.

Pseudodineura fuscula: Dalla Torre, 1894, p. 159 (many references prior to 1894); Konow, 1905, p. 88–89 (*Dineura despecta* Hartig, 1837, *Pelmatopus minutus* Hartig, 1837, and *Dineura simulans* Cameron, 1877, listed as synonyms); Wahlgren, 1944, p. 143 (biology); Benson, 1958, p. 155 (England); Lorenz and Kraus, 1957, p. 144 (larva); Hellén, 1960, p. 6 (Finland); Viramo, 1969, p. 30 (Finland).

Pelmatopus fuscula: Enslin, 1914, p. 273; Enslin, 1921, p. 185 (distribution, hosts); Hering, 1929, p. 103 (biology); Buhr, 1941, p. 920 (biology).

Female: Length, 4.2 to 4.5 mm. Antenna and head black; labrum and maxillary and labial palpi brownish. Thorax black; tegula brownish. Legs with each coxa and usually basal ⅔ of each femur black; each trochanter, apical ⅓ of each femur, each tibia, and each tarsus dark reddish brown. Abdomen black. Wings lightly, uniformly infuscated; veins and stigma brown.

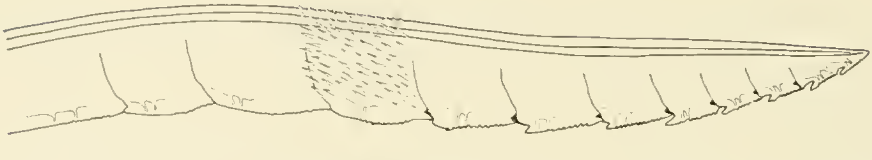
Clypeus truncate; malar space narrow, less than half diameter of front ocellus; head moderately shining but roughened with punctures. Sheath narrow and rounded at apex in lateral view; in dorsal view broader than long, broadly-rounded at apex with short median keel (fig. 12, 13). Lancet with 11 to 12 serrulae; each serrula long, slender rounded at apex and without subbasal teeth; central and apical serrulae each longer than broad; lancet evenly clothed with fine hairs (fig. 17).

Male: Unknown in North America. I have not seen specimens. According to Benson (1958) similar in coloration to the female.

Types: Not seen. The interpretation of this species is based on Hering (1929), Enslin (1914), Benson (1958), and specimens in the U.S. National Museum identified by Benson and Forsius.

Distribution: North and Central Europe to Siberia. I have seen the following from North America. CONNECTICUT: Stamford, 5-18-1944. MAINE: Kents Hill, Kennebec Co., May 28, 1967; Brownville Junction, May 27, 1966; 3 mi. N. Passadumkeag, Penobscot Co., May 26, 1966; Orono, May 30, 1958. VERMONT: 2 mi. N. Concord, Essex Co., May 22, 1966.

Host: In Europe, this species is a leafminer in the larval stage on various species of *Ranunculus*. The collections I made in Maine in 1966 and 1967 were mostly sweepings from various herbaceous plants in open fields.



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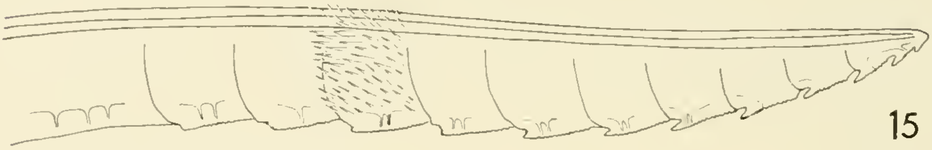

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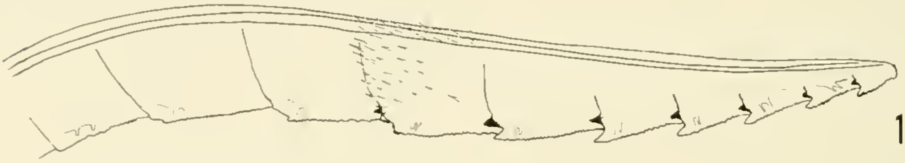

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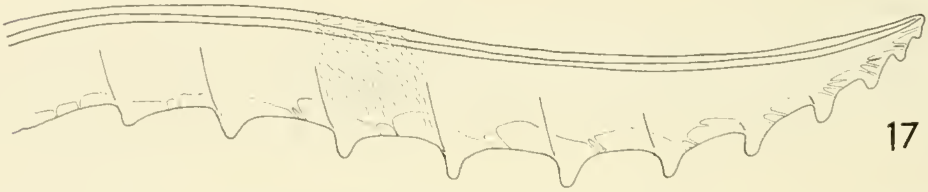

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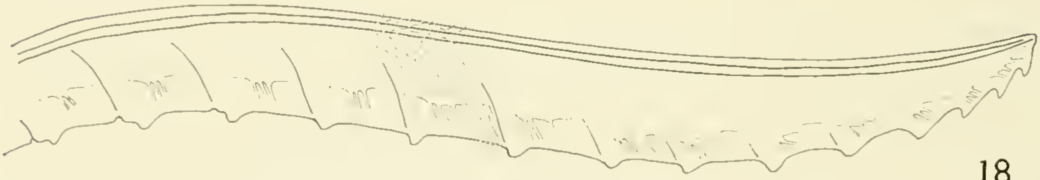

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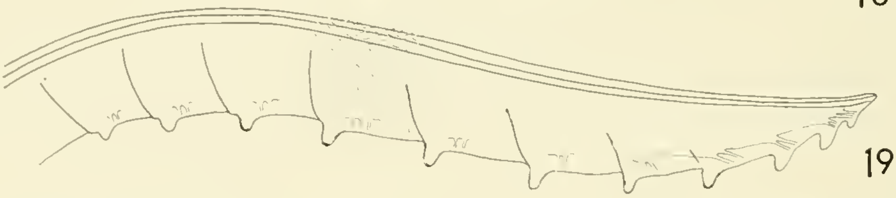

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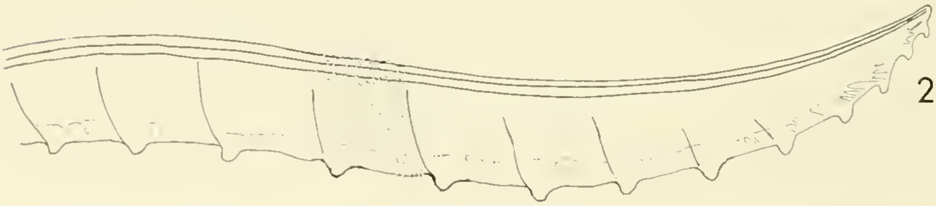

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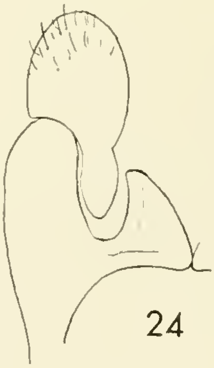

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Discussion: This species is distinguished from other North American *Pseudodineura* by the shape of the sheath (very broad and blunt at the apex in dorsal view), and by the long slender serrulae of the lancet. It is possible that this species is adventive from Europe. It has not before been recorded from North America and the earliest date of capture is 1944. It also follows the distribution pattern of some other adventive species such as *Fenusa pusilla* (Lepeletier), *Messa nana* (Klug), and *Heterarthrus nemoratus* (Fallén).

The references given for this species are only the more significant ones.

Pseudodineura lehosa Smith, new species

Female: Length, 4.0 to 4.3 mm. Antenna and head black; labrum and maxillary and labial palpi brownish. Thorax black with tegula and pronotum pale brown; anterior portion of pronotum may be blackish and mesopleuron sometimes tending toward brown. Legs yellow orange with most of each coxa black. Abdomen black, sometimes more brownish toward apex. Wings lightly, uniformly infuscated; veins and stigma brown.

Antenna stout, about 1½ times head width. Malar space nearly absent; clypeus truncate; head moderately shining but with numerous punctures. Sheath in lateral view straight above, rounded below and at apex; in dorsal view, slender, longer than broad, broadest at base and tapering to bluntly rounded apex (fig. 10, 11). Lancet with 11 serrulae; each serrula rounded, somewhat elongate and slightly longer than broad, without subbasal teeth (fig. 19).

Male: Length, 4.0 to 4.2 mm. Coloration similar to that of female except thorax which is entirely black, front femur which has basal ⅓ blackish, and apex of hypandrium which is pale brown. Antenna long, slender, more than 2 times head width. Harpe and parapenis and penis valve as in fig. 24, 26.

Holotype: Corvallis, Oregon, May 17, 1929, Francis B. Foley, collector. ♀. USNM type no. 73206.

Paratypes: BRITISH COLUMBIA: London Hill Mine, Bear Lake, 21-7-03, Altitude 7000 ft., R. P. Currie, collector (1 ♂). IDAHO: Moscow Mt., June 26, 1920, A. L. Melander (1 ♀); Lochsa Riv., 8 mi. NE Lowell, Clearwater Co., Glade Cr., IV-25-63, W. F. Barr, A. R. Gittins, collectors (1 ♀, 1 ♂). In the U.S. National Museum and University of Idaho.

Host: Unknown.

←

Fig. 14. Lancet of *Kerita fidala.* Fig. 15. Lancet of *K. atira.* Fig. 16. Lancet of *K. difala.* Fig. 17. Lancet of *Pseudodineura fuscula.* Fig. 18. Lancet of *P. rileda.* Fig. 19. Lancet of *P. lehosa.* Fig. 20. Lancet of *P. parva.* Fig. 21. Harpe and parapenis of *K. atira.* Fig. 22. Penis valve of *K. atira.* Fig. 23. Harpe and parapenis of *P. parva.* Fig. 24. Harpe and parapenis of *P. lehosa.* Fig. 25. Harpe and parapenis of *P. rileda.* Fig. 26. Penis valve of *P. rileda.* The figures of the lancets show one segment complete; this texture, either hairs or short spines, is found on all segments.

Discussion: Though very similar to two eastern species, *parva* and *rileda*, the lancet of *lehosa* appears to be distinctive in having fewer serrulae and with the serrulae somewhat longer than broad. The mesopleuron of *lehosa* is never reddish as in some specimens of *parva*, and the antennae are only one and half times the head width, whereas they are two times or more the head width in *rileda*. I could not separate the males of *lehosa* and *rileda*.

The species name is an arbitrary combination of letters and is to be treated as a noun.

Pseudodineura parva (Norton)

Dineura parva Norton, 1867, p. 241. ♂.
Mesoneura parva: Dalla Torre, 1894, p. 185; Konow, 1905, p. 78.
Pseudodineura parva: Ross, 1935, p. 203; Ross, 1951, p. 53.

Female: Length, 4.0 to 4.5 mm. Antenna and head black; clypeus usually light brownish, sometimes mostly black; labrum and maxillary and labial palpi brownish. Thorax black with tegula, pronotum, and mesopleuron reddish orange; mesopleuron may be black or partly black and pronotum may be blackish on anterior half. Legs pale yellow orange with base of each coxa black. Abdomen brownish to black, normally with anterior half of each segment black and posterior half brown with brownish areas increasing in size toward apex. Wings very lightly, uniformly infuscated; veins and stigma brown.

Antenna stout, less than twice head width and usually 1½ times head width. Malar space nearly absent; clypeus truncate; head densely punctate to roughened with punctures indistinct. Sheath in lateral view slender, rounded at apex; in dorsal view rather slender, longer than broad, broadest at base and tapering to narrow, bluntly rounded apex (fig. 10, 11). Lancet with 13 serrulae; each serrula low, rounded, no longer than broad, and without subbasal teeth (fig. 20).

Male: Length, 4.0 to 4.3 mm. Coloration similar to that of female except for mesepisternum which is normally black; apical tergite and hypandrium yellow orange. Antenna stout, less than twice head width. Harpe and parapenis and penis valve as in fig. 23, 26.

Holotype: At the Academy of Natural Sciences of Philadelphia, ♂, type no. 10309, and, according to the original description, from Farmington, Connecticut. A female allotype, as designated by Ross (1935) from Hampton, N. H., is in the Illinois Natural History Survey.

Distribution: Eastern North America west to Alberta. ALBERTA: Edmonton, 10-VII-1929. CONNECTICUT: Farmington (type). MARYLAND: Plummers Is., 4-14-08; Cabin John, April, 1917. NEW HAMPSHIRE: Hampton, V-9-1906, V-1-1907. NEW YORK: Ithaca, V-6-1936; McLean Bogs Reserve, Tompkins Co., July 31, 1940. PENNSYLVANIA: Castle Rock, IV-13-10, IV-17-08.

Host: Ross (1951) recorded the host as *Hepatica*.

Discussion: This is the only species which has a reddish mesopleuron and somewhat brownish abdomen; however, in a few specimens, these areas tend to be darker tending toward brown or black. Other than color, the females are separated by the 13 or 14 segmented lancet with the serrulae somewhat broader than long and by the short antennae which are less than two times the head width. The males are separated by the usually reddish mesopleuron and by the short antennae which are less than two times the head width.

Until now, this was the only species of *Pseudodineura* recorded in North America.

Pseudodineura rileda Smith, new species

Female: Length, 4.4 to 4.6 mm. Antenna and head black; clypeus sometimes brownish on anterior margin; labrum and maxillary and labial palpi brownish. Thorax black wih tegula and posterior margin of pronotum brownish. Legs yellow orange; most of each coxa black. Abdomen black, rarely with brownish markings; sheath black. Wings lightly uniformly infuscated; veins and stigma brownish.

Antenna rather slender, its length 2 times or more head width. Malar space nearly absent; clypeus truncate; head densely punctate to roughened. Sheath in lateral view slender, rounded at apex; in dorsal view slender, longer than broad, broadest at base and tapering to narrow, bluntly rounded apex (fig. 10, 11). Lancet with 14 serrulae, each serrula low, rounded, broader than long, and without subbasal teeth (fig. 18).

Male: Length, 4.2 to 4.4 mm. Coloration similar to that of female though normally with clypeus black, thorax black except for brownish tegulae, and apex of hypandrium pale brown. Antenna long, its length 2½ times or more width of head. Harpe and parapenis and penis valve as in fig. 25, 26.

Holotype: LaSalle Co., Ill., 4-24-1937, Floyd G. Werner, ♀, in the Illinois Natural History Survey.

Paratypes: ILLINOIS: same data as for holotype (3 ♂♂). MICHIGAN: E. Lansing, Ingham Co., 24 April 1960, George Eickwort (1 ♀). NEW YORK: N. Evans, 5-14-10, M.C.V. coll. (♀). At the Illinois Natural History Survey, California Academy of Sciences, Michigan State University, and U.S. National Museum.

Host: Unknown.

Discussion: The darker coloration, longer and more slender antennae, and more slender lancet with lower and broader serrulae should separate this species from *parva* and *rileda*.

The name is an arbitrary combination of letters and should be treated as a noun.

I express my appreciation to the following for allowing me to examine specimens in their respective collections: D. W. Webb, Illinois Natural History Survey, Urbana; P. Arnaud, Jr., California Academy of Sciences, San Francisco; R. Fischer, Michigan State University, East Lansing; D. Rentz, Academy of Natural Sciences, Philadelphia, Pa.; A. Gittins, University of Idaho, Moscow; W. W. Middlekauff, University of California, Berkeley; P. O. Ritcher, Oregon State University, Corvallis; G. Gibson, Biosystematics Research Institute, Canada Depart-

ment of Agriculture, Ottawa. Other material used in this paper is in the U.S. National Museum, Washington, D.C. The figures of the lancets and wings were drawn by K. M. Conway.

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BOOK NOTICES

The Earwigs of California (Order Dermaptera). 1975. By R. L. Langston and J. A. Powell. Bulletin of the California Insect Survey, vol. 20: pp. 1–25, 11 figs., 10 maps. University of California Press. $2.00.

In this recent number of the well known Survey series, 21 species are recorded from California. Only one of them is considered really native; the others have come from elsewhere, in some cases a great many years ago. This bulletin is a very useful contribution.—A.B.G.

Borne on the Wind. The Extraordinary World of Insects in Flight. 1975. By Stephen Dalton. 160 pp., 74 color plates, other black and white figures. Reader's Digest Press, E. P. Dutton & Co. $18.95.

The outstanding feature of this splendid volume is the colored photographs of untethered insects in natural flight, which became possible when precision equipment was developed which involved utilizing the insects themselves to trigger camera action by flying through a light beam, an electronic shutter with opening speed of about 1/450 second, and fantastic film exposure speed. Many pictures were taken in Everglades National Park, Florida. As a result, Stephen Dalton, an English naturalist-photographer, has done for insects largely what Crawford H. Greenewalt did for flying hummingbirds.

In a foreword, Howard E. Evans has contributed thought-provoking comments on the nature and unusual uses of insect wings, the possibilities of very rapid flight, and some records of long flights. In the brief text chapters, Dalton has given general accounts of the chief insect orders, with comments on the species which were photographed.—A.B.G.

TWO NEW GENERA OF COCKROACHES FROM INDIA AND PERU (DICTYOPTERA: BLATTARIA, BLABERIDAE)

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ABSTRACT—**Princisola**, a new genus from India, is based on the previously described *Audreia pulchra* Shelford. True *Audreia*, a relative of *Epilampra*, is entirely Neotropical and differs from *Princisola* principally in the male subgenital plate and genitalia. **Orchidoeca peruvia**, a new genus and species from Peru, is closely related to *Dryadoblatta*.

In the course of our studies we have found 2 new genera of cockroaches. One is based on *Audreia pulchra* Shelford, described from India in 1910. We have examined the holotype and allotype of *pulchra* and find that this species does not properly belong to *Audreia* Shelford, now regarded as strictly Neotropical. The male of the other new genus and species has very distinctive dorsal abdominal specializations. It was received recently with Peruvian orchids and is closely related to *Dryadoblatta* Rehn, based on a species first found in Trinidad bromeliads in 1912. Both new genera are in the Blaberidae.

Roth (1970b) studied the male genitalia of the numerous species of *Epilampra* Burmeister and reviewed the validity of the genus *Audreia* (pp. 455–465). The type-species of *Audreia*, *Calolampra carinulata* Saussure, designated by Hebard (1920:92), appears generically distinct from *Epilampra*. The male genital differences are the lack of a subapical incision of the hooked sclerite of the right phallomere (R2) (fig. 11) and the relatively weak development of the dorsal sclerite (L2d) (fig. 6) of the ventromedial sclerite in *Audreia*. The L2d of *A. carinulata* (fig. 10) is a simple flattened sclerotized section of the preputial membrane, and the remainder of the prepuce is not shaped or sclerotized.

Shelford (1910) initially placed 8 species in *Audreia*. Princis (1967) added 4 others and later (1971:1157) added one more. The present generic disposition of the 12 species other than *carinulata* is as follows: *truncata* Brunner (*Calolampra* Saussure, Roth and Princis, 1973); *biolleyi* Saussure (*Litopeltis* Hebard, Rehn, 1928:179); *hamiltoni* Rehn, *heusseriana* Saussure, *exploratrix* Gurney, *bromeliadarum* Caudell, *gatunae* Hebard, and *fugax* Bonfils (*Epilampra*, Roth, 1970b); *cathar-*

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ina Shelford (*Poeciloderrhis* Stål, Roth, 1970a); *cicatricosa* Rehn (no reassignment published; male not known, type-female examined by Gurney and found not congeneric with *carinulata*); *jamaicana* Rehn and Hebard (no reassignment published; male not dissected, but females examined by Gurney and found probably to be in *Epilampra*). The type-specimens of *Audreia pulchra* have been studied recently, and we conclude that the species represents a new genus, here described. Except for *truncata* (from Australia) and *pulchra* (from India), all of the above mentioned species which were referred to *Audreia* are Neotropical, a geographic disparity which suggests that the assignment of those 2 species to *Audreia* is an unnatural one.

Princisola, Gurney and Roth, new genus

In its general appearance, this genus strongly suggests *Audreia*, which differs especially in the male subgenital plate and genitalia. *Princisola* can be separated from *Epilampra*, *Audreia*, *Calolampra*, *Calolamprodes* Bey-Bienko, and *Rhabdoblatta* Kirby by the presence of a tooth on the excavated right margin of the asymmetrical male subgenital plate. Additional differences between *Audreia* and *Princisola* are shown in Table 1. The male of *Calolamprodes*, of Burma and southern China, has fully developed tegmina and wings; the female has greatly reduced lateral tegmina and lacks wings. Unlike *Princisola* which has 2 rows of small ventral spines on tarsal segments 1 and 2 of the hind tarsus and segment 1 of the middle tarsus, *Calolamprodes* has a single ventral row of spinules on those segments (Bey-Bienko, 1969:840). During past years, a variety of species from several continents have been referred to *Calolampra*. In his catalogue, Princis (1963) placed 23 species there, some with a question. Many have since been removed, and the genus *Calolampra* is now mainly Australian (Roth and Princis, 1973). *Calolampra* differs from *Princisola*, in addition to the entire symmetrical subgenital plate which bears 2 styli of equal size, by the apparent absence of L2d and shape of L1 in the male genitalia.

Generic description: General form as in fig. 1 and 2. Interocular space about equal to distance between antennae. Pronotum wider than long, widest a little behind middle, posterior margin broadly angulate (♂) or truncate (♀). Tegmina (♂) well developed but abbreviated, and wings reduced; both completely absent in ♀. Ventro-anterior margin of front femur with 4 large spines in basal half, followed by row of minute spines, then strong terminal spine; ventro-posterior margin with 1 subapical and 1 terminal spine; no genicular spine. Front tarsus with 1 small ventral spine on metatarsus. Hind metatarsus longer than (♂) or about equal to (♀) other segments combined. Hind leg with 2 rows of ventral spines on tarsal segments 1 and 2, segment 3 with several spines, chiefly in single row. Middle leg with 2 rows of spines on metatarsus, other seg-

Table 1. Differences between 2 species representing the genera *Princisola* and *Audreia.*

Character	*Princisola pulchra*	*Audreia carinulata*
Tegmina and wings	Abbreviated, not quite reaching hind margin of fifth tergum (fig. 2); wings greatly reduced, hidden under tegmen (♂). Both absent in ♀ (fig. 1).	Abbreviated but contiguous or overlapping, reaching to about hind margin of second tergum; wings very small, hidden under tegmen (♂ ♀).
Subgenital plate (♂)	Hind margin convex, right side broadly excavate, the posterior margin of concavity curved, forming a distinct tooth. Styli slender, the right longer than left (fig. 5).	Hind margin broadly concave, sides not excavate (fig. 14). Without a left stylus; right stylus slender (fig. 14).
Supra-anal plate (hind margin)	Weakly concave (♂, fig. 4), or entire (♀).	Mesally emarginate (♂ ♀). (♂, Fig. 13).
Front femur (Postero-ventral margin)	1 distal and 1 subapical spine.	Usually with 2 or 3 spines plus a distal spine.
Male genital phallomeres		
R2 (apex of hook)	Truncate bearing a conspicuous, recurved tooth on inner margin (fig. 8).	Curved with a small non-recurved tooth. (fig. 11).
L2d	Cylindrical sclerotization at end of preputial membrane (fig. 7).	Flattened, asymmetrical, sclerotized plate (fig. 10).
Sclerotized cleft of L1	Straight (fig. 9).	Curved (fig. 12).

ments unarmed ventrally. Pulvilli apical, and minute on segments 1–4 of hind tarsus. Arolium small; claws equal. No dorsal abdominal specialization in male. Supra-anal plate (fig. 4) broadly rounded, apex weakly emarginate (♂), or entire (♀). Cerci extending well behind supra-anal plate (fig. 4, (♂) or short, trigonal, not reaching beyond supra-anal plate (fig. 1, ♀). Male subgenital plate asymmetrical, right side broadly excavated with posterior margin of concavity recurved, forming a small tooth; styli of similar shape, but right stylus much longer than left (fig. 5). Female subgenital plate symmetrical, lateral margins somewhat undulate. Male phallomeres arranged as in fig. 6; L2d (fig. 7) poorly developed, separated from L2vm, preputial membrane weakly sclerotized; R2 (fig. 8) lacking subapical incision, apex truncate with small recurved hook on inner margin; L1 (fig. 9) with deep narrow straight cleft, its inner margins darkly sclerotized, lower (lateral) lobe with few widely scattered setae.

Type-species of genus: *Audreia pulchra* Shelford, 1910 (present designation).

The name *Princisola* is chosen as a tribute to Dr. Karlis A. Princis, the patient, thorough compiler of the Blattariae sections of the *Orthopterorum Catalogus.* Because of the short "o", the name is pronounced with the accent on the antepenultimate syllable, thus Prin*ci*sola.

Princisola pulchra (Shelford), n. comb.

fig. 1–9

Male: Vertex visible from above. Tegmina reaching to anterior margin of 6th tergite; venation well marked, closely reticulated, humeral (mediastinal) area punctate. Ventro-anterior margin of middle femur with 3 large, widely spaced, spines and 1 terminal spine; long genicular spine present; ventro-posterior margin with 4–5 large, widely spaced spines and 1 terminal spine. Ventro-anterior margin of hind femur with 3 large, widely spaced spines, no apical spine; large genicular spine present.

Female: First valve of ovipositor (relaxed and exposed, now dry *in situ*) upcurved subapically, then extending posteriorly and secondarily upcurved; 3rd valve twisted and outcurved near apex. (Above-mentioned curvature of valves much more developed than in *Audreia carinulata*; structure of valves basically as illustrated for *Pycnoscelus* Scudder by McKittrick (1964:fig. 94).

Measurements (mm): Body length, 15 (♂), 19 (♀); length of tegmen, 8.4 (♂); pronotum length × width, 4.5 × 5.5 (♂), 4.5 × 7.2 (♀).

Coloration: *Male*: Head piceous, vertex and face with broad testaceous longitudinal band; genae, clypeus, and mouthparts testaceous. Pronotal disk fuscocastaneous, narrow anterior and broader lateral margins testaceous, rufo-punctate. Humeral (mediastinal) area of tegmen testaceous, remainder castaneous and with fuscous spots; bases of subcosta and radius piceous. Terga brown, laterally testaceous and fusco-punctate; Sterna dark brown. Supra-anal plate with broad testaceous margin. Cerci with longitudinal median or testaceous line of more or less uniform width. Subgenital plate broadly margined with testaceous on left side and less so on right. Legs castaneous. *Female:* Thorax margined laterally with fusco-punctate testaceous. Abdomen above fusco-marmorate, beneath brown, becoming dark gray posteriorly. Cerci with a testaceous line broad at base and tapering toward apex.

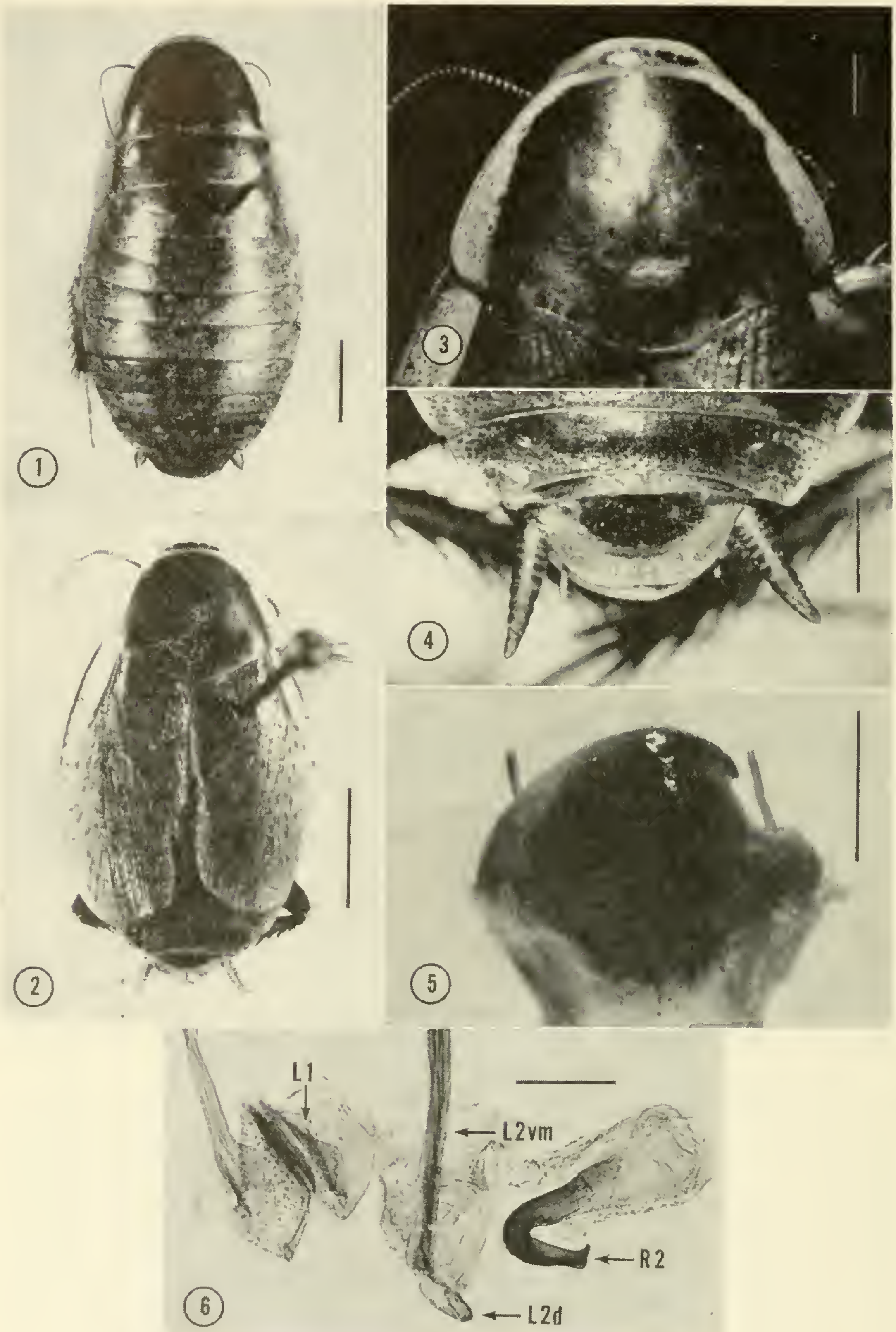

Fig. 1. *Princisola pulchra.* Female allotype (dorsal). Fig. 2–6. *P. pulchra.* Male holotype. 2, Habitus (dorsal). 3, Head, pronotum, and tegminal bases. 4, Apical portion of abdomen (dorsal). 5, Subgenital plate (ventral). 6, Male genital phallomeres (dorsal) (KOH preparation; phallomeres numbered accord-

Material examined: Male holotype, female allotype: Nilghiri, Coonoor (India) 1902. (M. Maindron). The second digit of the label date is unclear, the year is 1902. Desbordes (1912) stated that Maindron, an active collector in the Old World tropics, went to India on his last trip in 1901. Types in Muséum National d'Histoire Naturelle, Paris.

Comments: The male genital phallomere R2 of *pulchra* is reminiscent of the R2 of *Epilampra shelfordi* Hebard (fig. 357 *in* Roth, 1970b). The L2d in *shelfordi* is absent, and the unsclerotized preputial membrane is in the form of a hollow round cylinder covered with microtrichia (fig. 356 *in* Roth, 1970b); the preputial membrane in *pulchra* is also cylindrical in shape and minutely spicular, but the apex is sclerotized (fig. 7). The L1's of *shelfordi* (fig. 358 *in* Roth, 1970b) and *pulchra* (fig. 9) differ in the shape of the cleft.

Orchidoeca Gurney and Roth, new genus

This new genus is clearly recognized as a member of the Epilamprinae: Poroblattini by the male genitalia, especially the L2d and L1 as reviewed by Roth (1971). Within the Poroblattini, *Orchidoeca* approaches *Dryadoblatta* in habitus most closely, differing as follows: 1. Pronotum and tegmina deep liver brown in *Dryadoblatta*, bordered laterally with striking yellow longitudinal band; lighter general color and no such yellow band in *Orchidoeca*. 2. In *Dryadoblatta* ventroanterior margin of front femur has 3 to 5 strong spines in basal half, followed by numerous delicate spines in apical half, finally 2 distal spines; *Orchidoeca* has 5 to 6 strong spines in basal three-fourths, followed by 3 delicate apical spines and finally 2 distal spines. 3. Pulvillus of hind metatarsus of *Dryadoblatta* occupies more than one-half ventral margin of segment, about 2 to 5 pairs of weak ventral spines near base; in *Orchidoeca* pulvillus occupies apical one-third or less of ventral margin, with many strong ventral spines in double row along surface not covered by pulvillus. *Dryadoblatta* has been well characterized by Rehn (1930:56–58; 1937:230–233).

Generic description: *Male*: Surface of pronotum and tegmina moderately shiny, scarcely punctate, with very sparse tiny setae, general form rather flattened. Vertex of head visible from above; interocular space clearly wider than distance between ocellar spots, about equal to distance between antennal sockets. Pronotum as in fig. 23. Tegmina (fig. 15) covering about ⅔ of abdomen, corneous, venation distinct and prominent, anal sulcus strongly curved near apex, reaching posterior margin basad of mid-length of tegmen, a few rami anterior of subcosta weak and scarcely visible. Wing (fig. 16) somewhat parchmentlike, without apical triangle, probably nonfunctional, not quite reaching apex of teg-

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ing to McKittrick, 1964). Scale, fig. 1–2 = 4 mm, fig. 3–5 = 1 mm, fig. 6 = 0.5 mm.

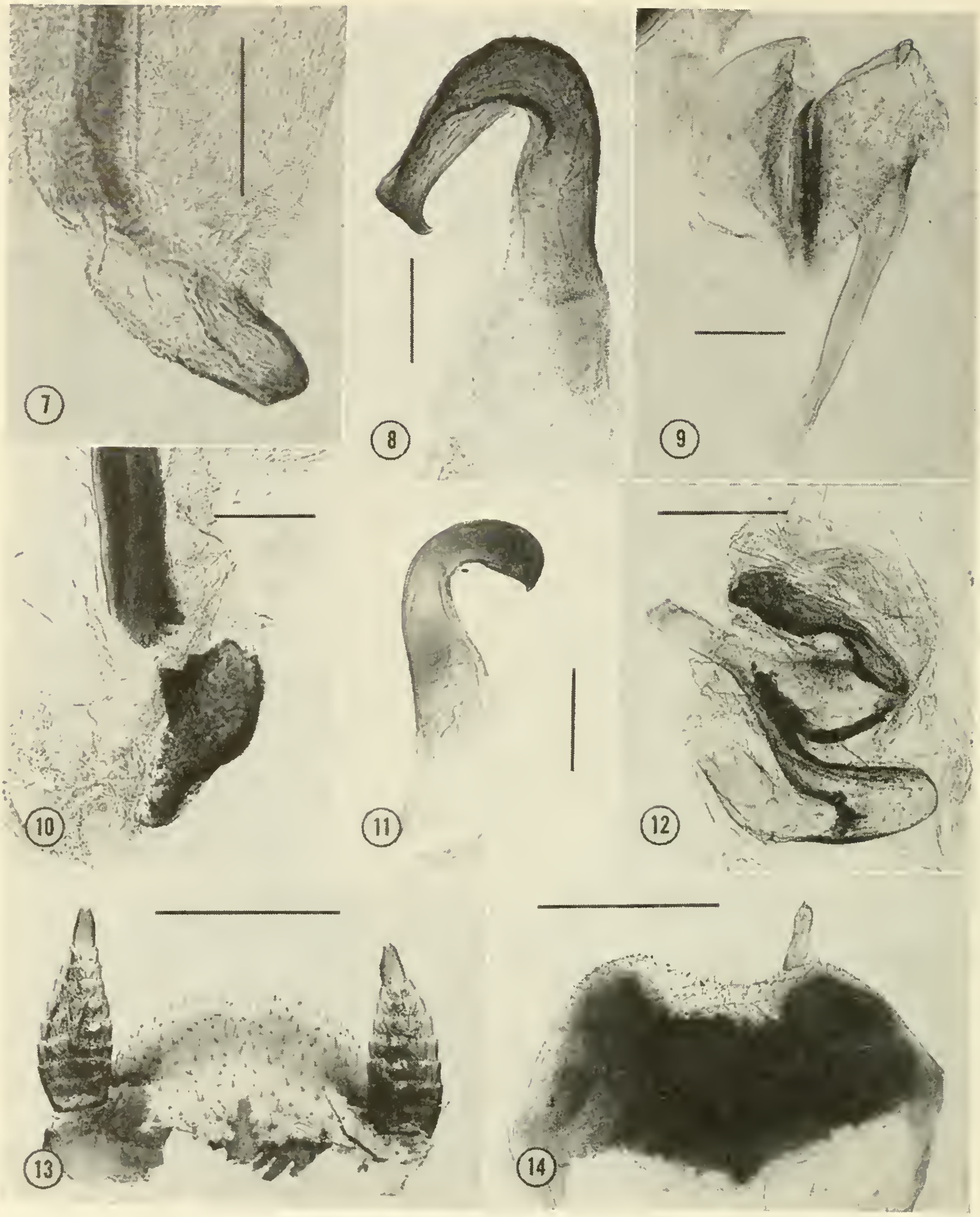

Fig. 7–9. *Princisola pulchra.* Male genital phallomeres L2d (and apex of L2vm), R2, and L1 (from fig. 6). Fig. 10–14. *Audreia carinulata* (Saussure). Male from Volcan Barba, Costa Rica. 10–12, Male genital phallomeres L2d (and apex of L2vm), R2, and L1. 13, Supra-anal plate and cerci (dorsal). 14, Subgenital plate (ventral, left stylus absent). (All figures from KOH preparations; scale, fig. 7 = 0.1 mm, fig. 8, 10, 11 = 0.2 mm, fig. 9 = 0.3 mm, fig. 12 = 0.5 mm, fig. 13–14 = 1 mm).

men. Legs well spined, front femur as noted above. Hind metatarsus a little shorter than remainder of tarsus (as 18:21), segments 1 to 4 with conspicuous pulvilli, only metatarsus with ventral spines. Arolium large; claws equal.

Dorsum of abdomen (fig. 20–21) ornately specialized; short spiracular breath-

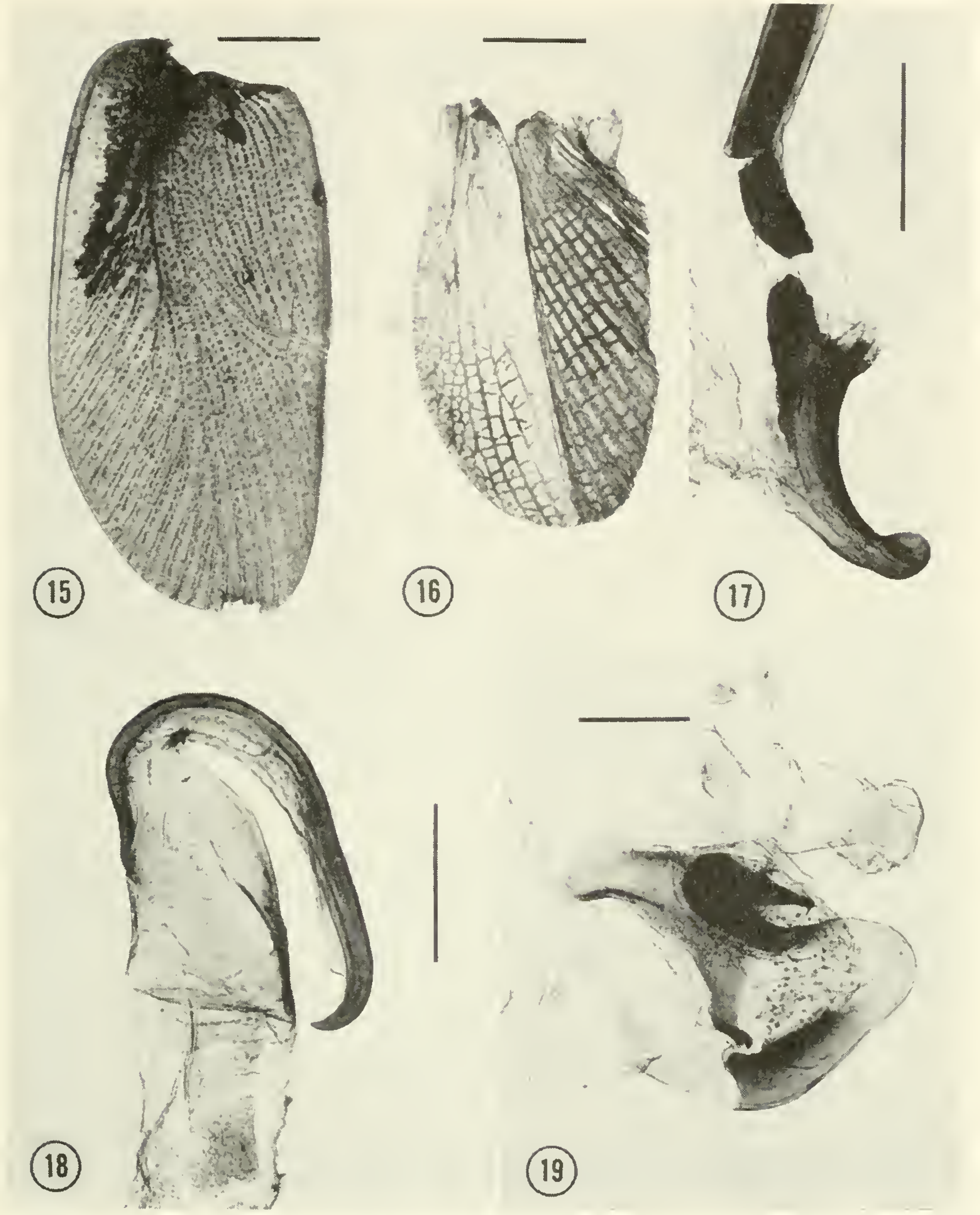

Fig. 15–19. *Orchidoeca peruvia.* Male holotype. 15, Left tegmen. 16, Left wing. 17–19, Genital phallomeres L2d (and apex of L2vm), R2, and L1. (KOH preparation; scale, fig. 15–16 = 2 mm, fig. 17–19 = 0.5 mm).

ing tubes from segment 8 beside bases of cerci; supra-anal plate broad, bilobed (fig. 20); subgenital plate (fig. 22) asymmetrical, with right stylus small, left stylus absent (?). Genitalia typical of Poroblattini; L2d elongate, curved, well sclerotized, separated from L2vm, without distinct prepuce (fig. 17); R2 (fig. 18) strongly-curved, lacking a subapical incision; L1 (fig. 19) with cleft and outer margin of lower lobe darkly sclerotized.

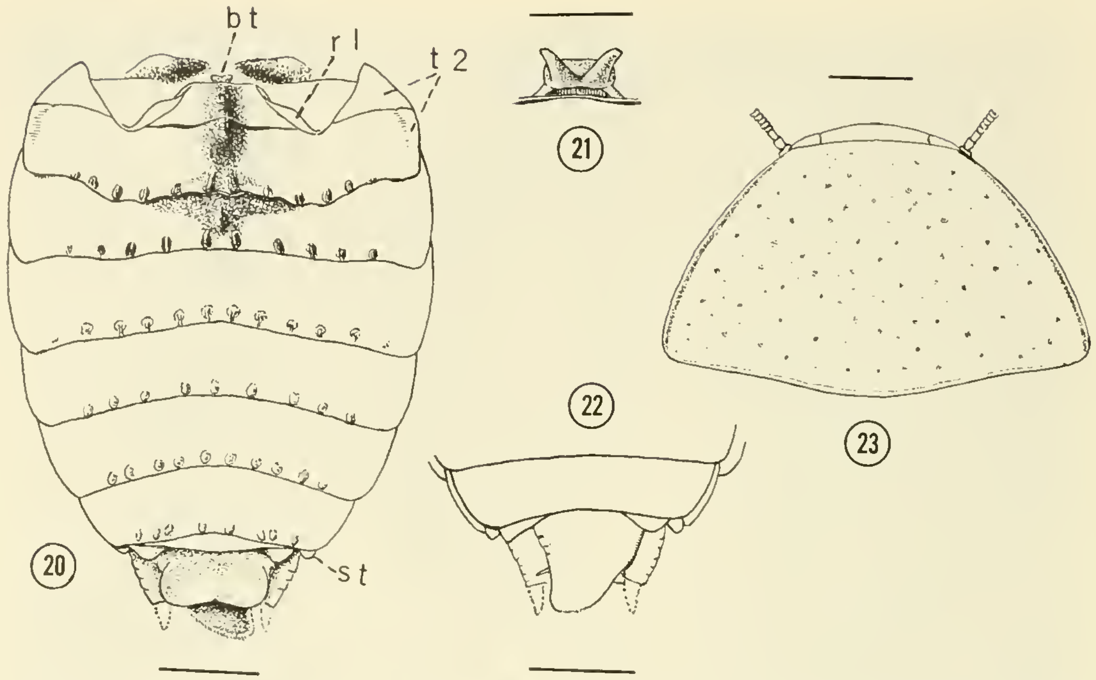

Fig. 20–23. *Orchidoeca peruvia.* Male holotype. 20, Dorsal view of abdomen. 21, Anterior view of bifurcate tubercle on first tergum. 22, Ventral view of apical portion of abdomen. 23, Dorsal view of head and pronotum. (bt = bifurcate tubercle of first tergum; rl = recurved lobe of first tergite; st = spiracular breathing tube of segment 8; t2 = second tergum showing transverse division of segment on dorsal surface. Scale, fig. 20, 22, 23 = 2 mm, fig. 21 = 1 mm).

The feminine name *Orchidoeca* is adapted from 2 Greek words which suggest living in orchids, though the single instance of the association for this species is insufficient evidence of restriction to this one plant group.

Type-species of genus: *Orchidoeca peruvia,* n. sp.

Orchidoeca peruvia Gurney and Roth, new species
fig. 15–23

Male: Vertex with 2 shallow depressions, 1 on each side of longitudinal parietal suture; compound eye extending onto gena considerably ventrad of antennal socket. First abdominal tergum nearly bisected longitudinally, a darkly sclerotized lobe near midline on each side in front, a thin recurved lobe of posterior margin (fig. 20, rl) behind; at posterior margin of 1st tergite, on midline, a small erect white bifurcate tubercle (bt), shown enlarged in anterior view in fig. 21; tergite 2 with large elongate tubercle on midline, traversing basal line of tergum, 6 tubercles of decreasing size on each side of midline along posterior margin; other terga with posterior marginal tubercles (fig. 20). Cerci extending somewhat beyond apex of supra-anal plate.

Measurements (mm): Length of body, 18; head width, 3.7; pronotum length × width, 4.7 × 8; tegmen length, 10; hind tibia length, 7.

Coloration: Pronotum pale yellow brown, darker on disk, with sparse sprinkling of small brown spots as in fig. 23. Tegmen (fig. 15) with basic ground color somewhat more chestnut brown than brought out in photo; dark spot on posterior margin of anal area an artifact; a longitudinal streak anterior to subcosta cream colored. Wing not dark as in fig. 16, instead whitish (in dry preparation originally in alcohol). Most of head dark brown; ocellar spots, occiput, most of labrum, and apical portion of clypeus pale. Legs pale brown, tarsal segments narrowly blackish at apices. Dorsum of abdomen yellowish, sprinkled with tiny brown spots except for a wide blackish longitudinal band on middle ⅓ extending with less intensity onto tergite 7; tubercles along posterior margins of terga pale. Venter of abdomen very dark brown, with more reddish hue in middle part, paler and with sprinkling of spots toward lateral margins; subgenital plate reddish dark brown.

Material examined: 1 (male holotype) (No. 73189, USNM). Peru; intercepted at Honolulu, Hawaii, April 7, 1964, alive when detected during Plant Quarantine inspection of orchids from Peru in air cargo.

Comments: The spiracular breathing tubes, borne on abdominal segment 8 and visible beside the cerci from above, are noteworthy as an adaptation for breathing when most of the body is submerged in water. Such breathing tubes were described by Shelford (1912:432) for *Homalopteryx scotti* (now *Dryadoblatta*) and earlier (Shelford, 1907:3) for certain Far Eastern Epilamprinae. Breathing tubes of this sort occur in a wide variety of Epilamprinae, even species which are not known to occur in water, but we have not made a sufficient survey to know what portion of the genera possess them. Some earlier descriptions (Shelford, 1907) relate the tubes to tergite 7, which results when the small first tergite of cockroaches is called the "median segment" rather than the first abdominal segment. Formerly, this practice was frequent among cockroach taxonomists.

Roth and Willis (1960:30–33, 151–152, 144–146) have documented records of cockroaches in aquatic habitats, those associated with orchids, and those with bromeliads, respectively. Neotropical cockroaches associated with plants which have water receptacles, as evidenced by Plant Quarantine interceptions which we have seen over a period of many years, as well as during some personal collecting, are numerous in both numbers of individuals and the variety of species encountered. Too few species of cockroaches have been recorded from orchids to indicate whether there is a significant difference in the cockroach faunas of orchids and bromeliads.

We are much indebted to Dr. M. Descamps, Muséum National d'Histoire Naturelle, Paris, for the loan of the types of *Audreia pulchra* Shelford. We thank Mr. Samuel Cohen for taking the photographs and Mr. Arthur D. Cushman for making the drawings.

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A NEW GENUS AND SPECIES OF CYLAPINAE FROM PANAMÁ (HEMIPTERA: MIRIDAE)

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ABSTRACT—A new genus and species, **Trynocoris lawrencei**, are described from Barro Colorado Island, Canal Zone, Panamá. Both adults and nymphs were taken from shelf fungi where they were apparently feeding on the larvae of ciid beetles belonging to the genera, *Ceracis* and *Cis*.

Recently, Dr. John F. Lawrence sent me a remarkable new species belonging to an undescribed genus of Miridae from Barro Colorado Island, Panamá, which apparently feeds on Ciidae larvae in fungi growing on trees in the forest. Specimens were taken from approximately a dozen species of fungi belonging to nine or more genera. Since nymphs were taken in several cases, it is probable that the species feeds and completes its life cycle in fungus. The suspected hosts are undescribed species of ciids of the genera *Ceracis* and *Cis*. The present paper has been written to supply a name for Dr. Lawrence's work on the biology and systematics of these tree-fungus beetles.

At first, this bug did not appear to belong to the family Miridae because of its two-segmented tarsi, elongate head with foliaceous antennal segments, very long rostrum, very small cuneus, atypical embolium, and supernumerary veins in the membrane below the basal cell. Although aberrant, this genus belongs in the Cylapinae, tribe Fulviini.

Trynocoris Herring, new genus

Characterized by 2-segmented tarsi, foliaceous 2nd antennal segment, structure of cuneus and embolium, length of rostrum, and presence of cuneate scales.

Head somewhat declivent, about 3/5 as long as broad, densely punctured, vertex with 3, low, oval prominences, separated centrally and bounded laterally by channels wich are obscured by cuneate white scales intermixed with abundant fine white hairs; eyes each equal to ½ width of vertex, contiguous to collar; antennae inserted approximately 1 peduncle width in front of eyes, short, segment II foliaceous, with prominent setae and cuneate dark scales, III and IV very short; bucculae prominent, just reaching anterior margin of eye; rostrum very long, surpassing apex of abdomen in male, somewhat shorter in female.

Pronotum of the Fulviini type, collar present, narrow, calli not fused or strongly convex, poorly delimited but discrete due to outlining by cuneate scales; lateral margins of pronotum carinate, dorsal surface deeply, densely punctured; scutellum tumid, mesoscutum broadly exposed, both punctate.

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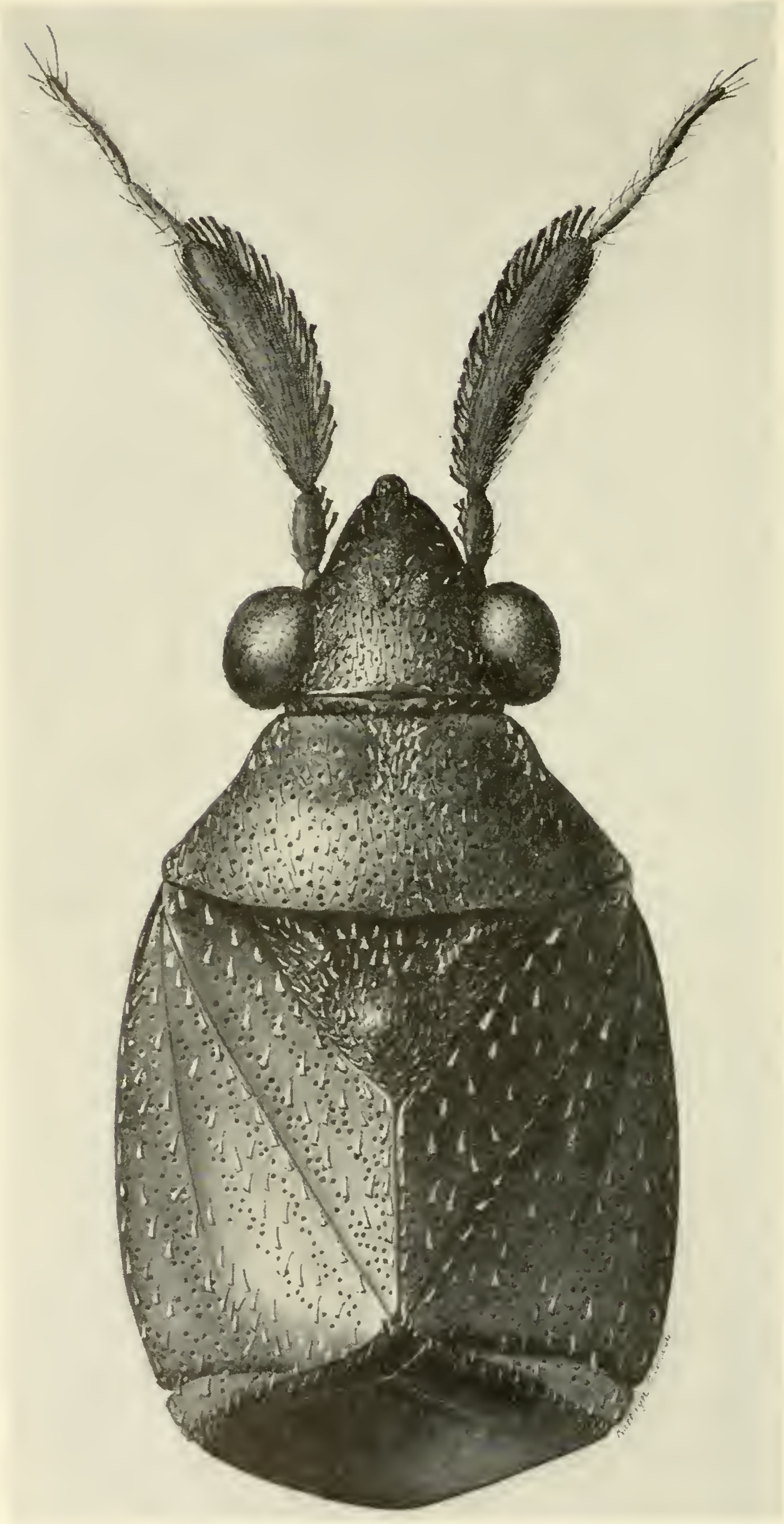

Hemelytra punctate, dull, costal area wide, especially near apex where it is equal in width to corium, costal vein absent, clavus thickly punctured, corium and embolium less so, cuneus quite short, its fracture deep. Single cell of membrane with several spurious veins leaving the margin and inner angle of cell. Apex of hemelytra at level of cuneal fracture bent abruptly downward at an angle of 45°–90°.

Legs rather short, anterior coxae much longer and stouter than others, tibiae with spines, typical hairs and rows of minute tubercles, tarsi 2-segmented, the 2nd segment very long.

Ostiole with a well-defined peritreme.

Type-species: *Trynocoris lawrencei*, n. sp.

Trynocoris runs to couplet 19 in Carvalho's (1955) key to the Fulviini genera of the world but does not fit either choice in that couplet as the frons is not depressed but striolated and punctate, and the cuneus is present. In addition, *Trynocoris* differs from all the genera following couplet 19 by its foliaceous second antennal segment and the vestiture of cuneate scales.

Trynocoris lawrencei Herring, new species

fig. 1

A very small, dark-brown species with distinctive cuneate scales and decumbent hairs, scales forming definite patterns on pronotum and scutellum.

Male: Length 2.1 mm., width 0.95 mm. *Head length*: Width[2], 17:24, vertex 11. *Antennae*: Segment I almost reaching apex of head, II foliaceous, as long as head, III and IV very short, proportion of segments I–IV, 7:22:8:11. *Pronotum*: Median length to width at base 19:35. *Rostrum*: Length 1.7 mm.

Color: Chocolate brown; last 2 segments of antennae, all tibiae and tarsi, and apices of femora, pale yellow; ill-defined bright-red ring just before apices of femora, some reddish coloration on coxae and trochanters; rostrum yellow with reddish to reddish-brown band at base, fuscous band at middle and another at apex.

Vestiture: Dorsal surface except membrane covered with mixture of cuneate scales and fine decumbent hairs, scales confined mainly to 1st 2 antennal segments, anterior ½ of pronotum around calli, 3 triangular patches on scutellum, and in rows on hemelytra, those on antennae black, those on remainder of surface ivory white to golden; scales also present on sides of pronotum and on pleura.

Other morphological characters as given for genus.

Male genitalia: Left clasper bluntly rounded at apex, right one spatulate.

Female: Larger and more robust than male. Length 2.6 mm, width 1.3 mm.

Holotype: ♂ (USNM 72986), Barro Colorado Island, Canal Zone,

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[2] The following measurements are in units, unless stated otherwise. 39 units = 1 mm.

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Fig. 1. *Trynocoris lawrencei.*

Rep. Panamá, Feb. 6, 1968, ex *Polyporus caperatus*, J. F. Lawrence, Collector. Allotype: ♀, same data except, July 3, 1969. ex *Coriolopsis crocata*. Paratypes: 10 ♂♂, 8 ♀♀, same locality and collector, March 1967 to August 1969. All in USNM.

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BOOK NOTICES

Looking at Animals. A Zoologist in Africa. 1975. By Hugh B. Cott. 221 pp., 62 pages of photos, some in color; numerous pen and ink sketches. Charles Scribner's Sons, New York. $14.95.

The author of this fine book is noted as a teacher in England and as a zoologist-explorer in many parts of the world. He has often accompanied tours to East Africa as a guest lecturer. His outstanding 1940 book, "Adaptive Coloration in Animals", established his stature in general natural history, behavior, and ecology.

Dr. Cott gives us interesting information in a most readable text, and the personally contributed illustrations (photographs and sketches) further make the book a splendid gift for anyone with either direct or peripheral interest in the subject. In the chapter on Advertising Coloration and Display numerous insects are discussed and illustrated.—A.B.G.

Insect Hormones. Fourth (second English) ed. 1975. By V. J. A. Novák. 600 pp., 37 pls., 73 figs. Halsted Press, 605 Third Ave., New York, N.Y. 10016. $49.50.

Because of the current importance of hormones, including the wide attention paid to juvenile hormones as possible control substances in applied entomology, this extensive review volume is timely. In addition to the comprehensive review aspects of the book, it also introduces the subject in a readable manner, with basic information on techniques and methods employed in research. A systematic study of hormones has been occurring only for a relatively short while and the 114 pages of references are chosen and arranged here so as not to duplicate many in earlier editions, also to emphasize papers poorly known to many western readers of this English edition. Since 1958, when the first (German) edition was ready for publication (it appeared in 1959), references on hormones have grown from 1500 to over 6,000.

The author, now head of Insect Physiology in the Entomological Institute, Czechoslovak Academy of Sciences, Prague, began his study of hormones in 1948–49 at Cambridge University under the guidance of a prominent researcher in this field, Sir Vincent Wigglesworth.—A.B.G.

NEW SPECIES IN THE GENERA BDELYROPSIS, CRYPTOCANTHON AND DREPANOCERUS (COLEOPTERA: SCARABAEIDAE)

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ABSTRACT—Four new species of Scarabaeidae are described and figured. These are *Bdelyropsis* **venezuelensis** from Venezuela, *Cryptocanthon* **altus** from Colombia, *Cryptocanthon* **newtoni** from Mexico, and *Drepanocerus* **pecki** from Jamaica.

Four new species in three scarab genera, *Bdelyropsis*, *Cryptocanthon* and *Drepanocerus* are described. All of these genera have been recently revised (Howden, 1971, 1973; Matthews, 1966) and the present species can hence be described and related to others fairly easily. All three genera are of interest since they seemingly represent relict New World groups that have only relatively recently become known.

Bdelyropsis venezuelensis Howden, new species
fig. 1–3

Holotype: Female, length 5.7 mm, greatest width 3.6 mm. Color dull black dorsally, black to brownish black ventrally with legs dark reddish brown to black. Clypeus (fig. 1) abruptly bidentate anteriorly, disc nearly smooth and shining, posterior margin delimited by a slightly tumid transverse line. Frons and vertex finely punctate, the punctures larger posteriorly. Eyes as in *bowditchi.* Pronotum finely punctate, punctures similar to those on vertex between eyes; surface between punctures granulate. Punctures (fig. 2) on head, pronotum and elytra, each with 1 central, minute, scalelike seta. Pronotal and elytral shape (fig. 3) similar to *bowditchi* (fig. 4) but slightly more convex. Scutellum absent. Elytron with 7 dorsal strial lines narrower and more conspicuous than in *bowditchi*; humeral umbone distinctly elevated, carinate as in *newtoni.* Pygidium differing from both *bowditchi* and *newtoni* by having apical area inside incised line tumid and shining. Legs and ventral surfaces generally similar to females of *bowditchi* and *newtoni* except that apical abdominal segment medially with a vague, shining, triangular area contiguous to pygidial apex.

Male: Unknown.

Type-Material: Holotype, female, Venezuela, Edo. Aragua, Cerro el Cafe, 1200 m, 10 km N. W. Valencia, 23–26 February 1971, S. Peck, forest human dung trap (Howden). Paratypes: 2 ♀♀, same data as holotype (Howden).

Variation in the three females is slight. Size ranges from 3.1 to 3.7 mm. The clypeal teeth of one female are badly worn, and in one specimen the elytral color is distinctly greenish black.

The minute scalelike setae (fig. 2) in the dorsal punctures will readily separate *venezuelensis* from either *bowditchi* Paulian (1939) or *newtoni* Howden (1971) since both have distinct, upright, dorsal setae (fig. 4).

Cryptocanthon altus Howden, new species

fig. 5–7

Holotype: Male, length 4.1 mm, greatest width 2.9 mm. Color black with head, pronotum, antennae, mouthparts, and legs very dark brown. Body oval (fig. 5), elytra conjunctly strongly convex. Head similar in shape and punctation to *C. brevisetosus* (see fig. 10, Howden, 1973); the 2 clypeal teeth well separated, anterior face of emargination between teeth broadly V-shaped, medially concave, lacking distinct fovea (fig. 6). Clypeus with lateral margins slightly arcuate; disc moderately reflexed near teeth, surface coarsely punctate, punctures separated by less than 1 diameter. Vertex with punctures smaller and more crowded; many with 1 fine, central, recumbent seta. Eye dorsally, when head retracted, covered by anterior margin of pronotum and not visible from above. Pronotum with length to width ratio 1:2.3; pronotal disc coarsely punctate, punctures separated by slightly less than 1 diameter; most punctures each with 1 fine recumbent seta, punctures not annular, margins indistinct; posterior pronotal angles abruptly rounded, not notched. Prothorax ventral to posterior angles, lacking carina. Elytral striae obsolete, each indicated by 2 feeble, wavy lines; intervals flat; each interval on each side with row of fine, pale, recumbent setae, similar in this respect to *C. brevisetosus* (see fig. 39, Howden, 1973). Lateral inflexed portion of elytron wide, at widest point approximately same width as metasternum between middle coxae; inflexed portion of elytra anteriorly lacking fovea, only epipleural line present, surface otherwise lacking indented lines or distinct punctures. Metathoracic wings greatly reduced, non-functional. Pygidium evenly convex, highest centrally, lacking deep basal indentation; pygidial surface shallowly punctate, most punctures each with 1 fine, pale, recumbent seta; surface between punctures faintly reticulate. Mesosternum and metasternum similar in shape to *C. nebulinus* (see fig. 7, Howden, 1973) but with size and number of punctures reduced. Fore tibia with inner margin expanded in apical ⅓, notched at apical ⅙, thence truncately expanded, similar in this respect to *C. nebulinus* (see fig. 25, Howden, 1973). Hind tibia with inner margin evenly arcuate, not abruptly expanded, bent, or crenulate. Genitalia as in fig. 7.

Allotype: Female, length 3.8 mm, greatest width 3.0 mm. Similar to male externally except that inner margin of fore tibia is not expanded (unmodified) apically and last abdominal sternite is narrower.

Type-Material: Holotype, ♂, Colombia, Norte de Santander, 3000 m, 35 km. S. Chinacota, 10–14 May, 1974, S. Peck, Dung Trap #12 (Howden). Allotype, ♀, same data as Holotype (Howden). Paratypes: 3 ♂♂, 2 ♀♀, same data as Holotype (Howden).

Variation in the small series is negligible; one male measures 4.3 mm in length, otherwise the measurements given for the Holotype and Allotype represent the extremes. The dorsal, recumbent setae may not be typical since all specimens were collected in fluid.

Cryptocanthon altus will key to couplet 7 in my 1973 revision. In

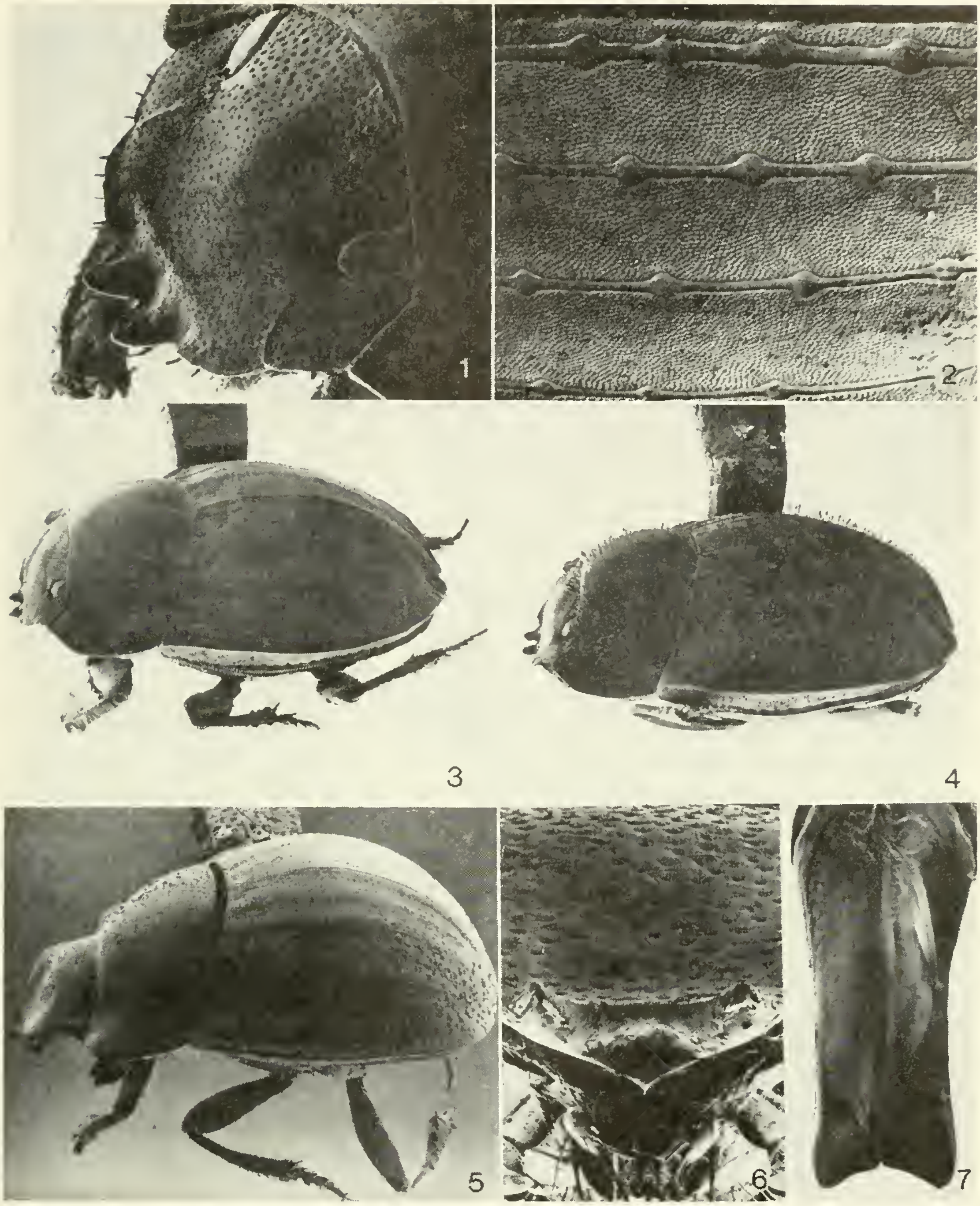

Fig. 1–3. *Bdelyropsis venezuelensis.* 1, Head. 2, Sculpture of left elytron. 3, Female. Fig. 4. *B. bowditchi*, female. Fig. 5–7. *Cryptocanthon altus.* 5, Male. 6, Apical face of clypeus. 7, Male genitalia.

the lack of a fovea in the inflexed portion of the elytron, the shape of the anterior face of the clypeus, pronotal characters and in the shape of the male genitalia, *C. altus* most closely resembles *C. nebulinus* Howden. It can be separated from *nebulinus* and other known species of *Cryptocanthon* by the following combination of characters: clypeal teeth moderately separated, anterior surface between V-shaped and concave but lacking a deep fovea; lateral clypeal margins slightly arcuate, not lobed; punctures of head and pronotum coarse, separated by less than one diameter, not annular; posterior pronotal angles abruptly rounded, not notched, carina beneath absent; elytra conjointly convex, setae inconspicuous, not erect; inflexed portion of each elytron lacking fovea near anterior margin, only epipleural line distinctly impressed; metathoracic wings greatly reduced; pygidium evenly convex, lacking a deep basal depression; male genitalia as in fig. 7.

The locality where *C. altus* was taken might best be typified as high elevation (3000 m) cloud forest. The specimens were taken in a human dung trap set within a relatively undisturbed patch of forest. The forest floor consisted of a deep mat of moss, decaying vegetation, and plant roots with no soil in evidence where the trap was set. During the period we were in the area heavy rains were frequent. The locality probably receives a high amount of moisture throughout the year.

Cryptocanthon newtoni Howden, new species

fig. 8–16

Holotype: Male, length 3.3 mm, greatest width 2.0 mm. Very dark brownish black, legs and antennae dark reddish brown. Shape elongate, oval; pronotum very convex except near margins. Head as in fig. 10, the 2 clypeal teeth (normally well developed in genus) obsolete, shallowly emarginate between obtuse angles which represent teeth. Anterior face of clypeus between angles with deep fovea (fig. 14) occupying most of surface. Clypeal margins laterally arcuate; disc coarsely, shallowly punctate, punctures mostly separated by 1 diameter or more, most with 1 fine, central seta. Pronotum (fig. 8) unusually tumid medially, length to width ratio 2 : 3.1; disc coarsely, shallowly punctate except along midline and in lateral depressions; each puncture with 1 basally thickened, apically attenuated, arched seta (fig. 9); posterior angles broadly rounded, not notched, carina present ventral to angle and extending anteriorly (fig. 9). Elytral striae obsolete, each vaguely indicated by slightly impressed, double, wavy lines; striae 1, 3, and 5 with inner adjacent rows of distinct upright setae (fig. 16), opposite side of intervals and other striae similarly delimited but with less regular spacing of setae; lateral inflexed portion of each elytron with large basal fovea adjacent to epipleuron (fig. 9); inflexed portion with scattered setae similar in shape to those on pronotum; epipleuron distinctly, abruptly elevated above plane of inflexed portion of elytron, epipleuron with fine setae forming an irregular, longitudinal, double row. Metathoracic wings reduced to elongate knobs. Pygidium (fig. 15) with conical swelling centered at median basal ⅓, deep depression present between swelling and basal margin; pygidial disc vaguely, shallowly punctate, granulate, with scattered, oppressed, whitish setae. Metasternum broadly, shallowly concave between the posterior halves of the coxal cavities; posterior half of metasternum with scattered coarse punctures and fine setae. Fore tibia (fig. 12) with an abrupt, apical, truncate, inward projection on inner

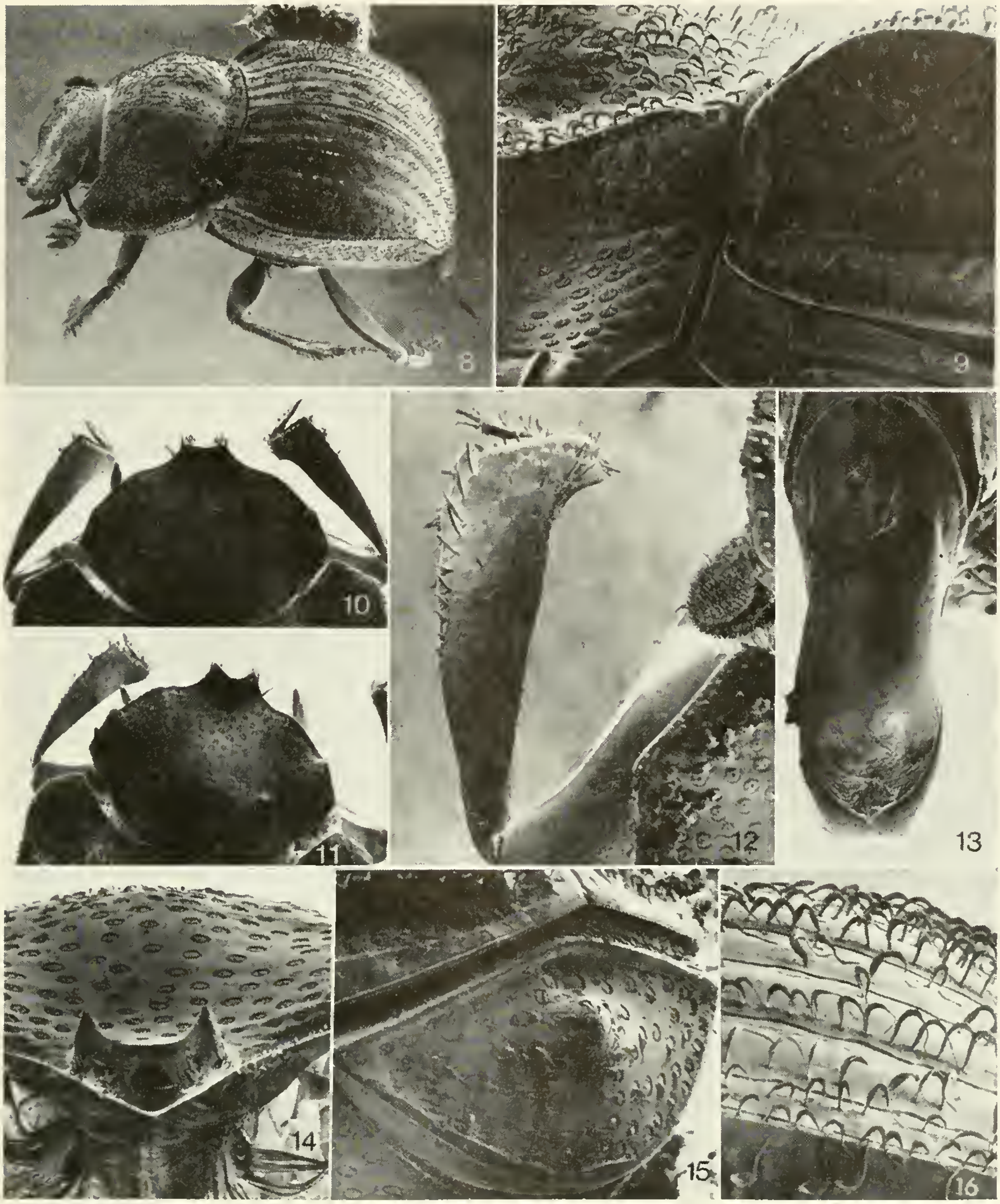

Fig. 8–16. *Cryptocanthon newtoni.* 8, Female. 9, Left side of posterior prothorax and inflexed base of left elytron showing fovea. 10, Head of male. 11, Head of female. 12, Left fore tibia of male. 13, Male genitalia. 14, Apical face of clypeus showing fovea. 15, Pygidium of male. 16, Setae on left elytron.

margin; hind tibia finely serrate on inner margin, the margin bowed and produced inwardly at apex. Male genitalia as in fig. 13.

Allotype: Female, length 3.3 mm, greatest width 2.1 mm. Differing from male in the following major respects: clypeal teeth distinct (fig. 11), apices acutely angled and distinctly reflexed; fore tibia lacking truncate inward projection at apex; hind tibia not abruptly bent and inwardly produced near apex; last abdominal sternite narrower than in male; metasternum only slightly concave medially.

Type-Material: Holotype, ♂, Mexico, Chiapas, 8 mi. N. Pueblo Nuevo S., 6000 feet, cloud forest, 26–27 August 1973, A. Newton, Dung Trap #541 (Howden). Allotype, ♀, same data as Holotype (Howden). Paratypes: 7 ♂♂, 8 ♀♀, same data as Holotype (CNC, Howden, Newton).

Variation is most evident in the characters showing sexual dimorphism, as listed in the description of the Allotype. In males the clypeal teeth are, at most, represented by obsolete angles which are slightly reflexed. In females the clypeal teeth are well developed, acutely angled and reflexed. Also in males the metasternum is more deeply concave while in females it is either flat or slightly concave. Sexual dimorphism in the characters of the tibiae and last sternite are normal for the genus. Size varies only moderately, males measuring 2.8 to 3.5 mm in length and from 1.9 to 2.3 mm in greatest width; females measure 3.0 to 3.5 mm in length and from 1.9 to 2.2 mm in greatest width. Dorsal setae vary in number but this is seemingly largely due to abrasion.

Cryptocanthon newtoni can be distinguished from other species in the genus by the following combination of characters: clypeal teeth obsolete in male, well developed in female, anterior face of clypeus at midline (in both sexes) with a deep circular fovea (fig. 14); pronotum centrally very tumid, conspiculously setose; elytra with deep fovea near anterior margin of inflexed area beside epipleuron; elytra with conspicuous arched setae; pygidium abruptly medially conical at basal third, a deep indentation present between the conical projection and the basal line; male genitalia as in fig. 13. In my 1973 key to the genus, *C. newtoni* will not key past couplet 4. The deep fovea on the anterior face of the clypeus was previously known only for some South American species. The very tumid pronotum and the odd sexual dimorphism of the clypeal teeth are not found in the other species of the genus.

The species is named for Dr. A. Newton, Museum of Comparative Zoology, Harvard, who has collected and given to me many unusual Mexican Scarabaeidae.

Drepanocerus pecki Howden, new species

fig. 17, 19, 21

Holotype: Male, length 8.1 mm, greatest width 4.4 mm. Dorsum dark brown flecked with tan spots. Body shape similar to that of *Drepanocerus reconditus* Matthews (1966, fig. 25). Head (fig. 17) with clypeus emarginate between obsolete, obtusely angled clypeal teeth; disc of clypeus with large posterior transverse carina, with 2nd transverse carina of nearly equal development and length at posterior edge of frons. Dorsal surface of head largely impunctate, few setigerous punctures widely scattered on vertex, and line of setigerous punctures present at posterior margin of vertex. Pronotum sparsely punctate, punctures separated by approximately 2 diameters, each puncture with 1 fine, inconspicu-

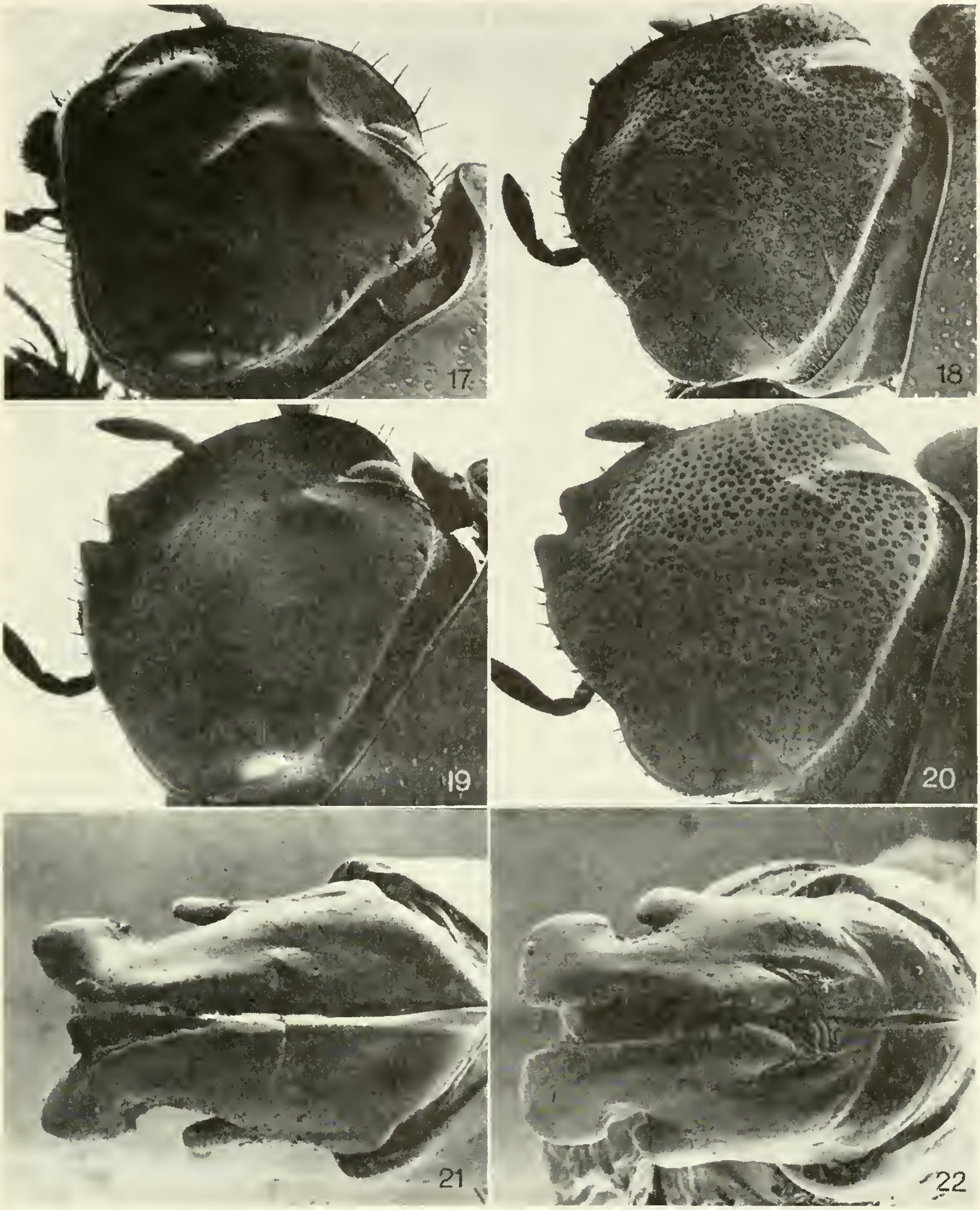

Fig. 17–22. *Drepanocerus* spp. 17, *D. pecki* n. sp., head of male. 18, *D. rereconditus*, head of male. 19, *D. pecki*, head of female. 20, *D. reconditus*, head of female. 21, *D. pecki*, male genitalia. 22, *D. reconditus*, male genitalia.

ous, central seta. Scutellum minute. Elytra with striae obsolete, each stria indicated by vague line interrupted by large, shallow punctures. Elytral intervals flat, except 3rd and 5th slightly elevated, distinctly less so than in *reconditus*; elytral setae much finer and less conspicuous than in *reconditus*. Pygidium nearly as long as wide, lacking transverse ridge before base, basal 1/7 more distinctly shining; surface of apical 3/4 largely opague, minutely punctate-setose, dark shiny spot present medially near apex. Fore tibia with 2 large teeth on outer margin in apical ½, a 3rd inconspicuous apical tooth present on anterior margin, and a 4th small tooth at middle of outer margin; in *reconditus* males, all 4 teeth are well developed, the basal 1 being the smallest. Ventral surfaces of thoracic and abdominal sterna and ventral surfaces of femora largely smooth and shining, at most few scattered setose punctures present, particularly on fore femur; in *reconditus* all sterna and femora have numerous coarse, setose punctures. Terminal abdominal sternite narrowed medially. Genitalia as in fig. 21, the apices of parameres more widely separated than in *reconditus* (fig. 22).

Allotype: Female, length 8.0 mm, greatest width 4.0 mm. Differing from male Holotype in the following major respects: clypeus shining and distinctly bidentate (fig. 19); clypeal and frontal carinae absent; frons and vertex nearly flat, opaque, and with few scattered, setigerous punctures; pygidium distinctly wider than long, median spot near apex shallowly concave; fore tibia with 4 distinct teeth, the basal 1 smaller; last abdominal segment not narrowed medially.

Type-Material: Holotype, ♂, Jamaica, St. Thomas, 2100 ft., Corn Puss Gap, 4 mi. N. Bath, 3–8 August 1974, S. Peck, Dung Traps #16–20 (Howden). Allotype, ♀, same data as Holotype (Howden). Paratypes: 246 ♂♂, 117 ♀♀. 117 ♂♂, 51 ♀♀, same data as Holotype; 129 ♂♂, 66 ♀♀, Jamaica, St. Andrew, Hermitage Dam, 1750 ft., 10–14 August 1974, S. Peck, Dung Traps #33–35. Paratypes will be deposited in a number of collections including the CNC, USNM, and Howden.

Variation in the series is mainly evident in size and associated heterogonic development of the carinae on the heads of the males. There are also slight average differences in the shape, particularly the width, of the carinae on the heads between males taken at Corn Puss Gap and ones taken at the Hermitage Dam. Males from Hermitage Dam often have the relative width of the anterior carina somewhat reduced. However, small males from either locality may have the anterior carina reduced to a median tubercle and the posterior carina only vaguely indicated by an indistinct transverse swelling. The size ranges in males from 7.0 to 10.0 mm in length and from 3.5 to 4.5 mm in greatest width; in females size varies from 7.3 to 9.8 mm in length and from 3.6 to 4.6 mm in greatest width. Color also varies, particularly in the degree of mottling. Seemingly older (more worn) specimens are usually darker, often almost black dorsally.

Drepanocerus pecki and *D. reconditus* Matthews are the only known New World representatives of *Drepanocerus*. Both are known only from Jamaica, *D. reconditus* seemingly occurring at higher elevations (4–5000 ft.) from Hardwar Gap to Portland Gap and *D. pecki* at lower elevations (1500–2500 ft.) from Hermitage Dam to Corn Puss Gap. The two species are easily separated. *Drepanocerus reconditus* has a heavily punctate head (fig. 20) with no obvious carinae in males (fig. 18), thoracic and abdominal sterna and femora are heavily punctate and the male genitalia (fig. 22) are distinctive; *Drepanocerus pecki* lacks the heavy punctation on the head (fig. 19), sterna and femora; males usually have two transverse carinae on the head (fig. 17) and the male genitalia is characteristic.

The species is named for my colleague, Dr. Stewart Peck, who discovered the species.

Acknowledgments

I am indebted to Dr. Stewart Peck, Carleton University, and Dr. A. Newton, Harvard University, for giving me the specimens on which this paper is based. I also would like to acknowledge Mr. L. E. C. Ling who took the SEM pictures used herein. The laboratory portion of this work has been supported by an operating grant from the National Research Council of Canada.

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BOOK NOTICES

Insect Biochemistry and Function. 1975. D. J. Candy and B. A. Kilby (Eds.). 314 pp., illus. Halsted Press, 605 3rd Avenue, New York, N.Y. 10016. $25.00.

The 4 chapters and their contributors are: 1. Biochemistry of insect flight, Part 1; B. Sacktor, Baltimore, Maryland. 2. Same, Part 2; E. Bailey, Yorkshire, England. 3. Excretion in insects; D. G. Cochran, Blacksburg, Virginia. 4. Synaptic transmission in insects; G. G. Lunt, Somerset, England. A review of this book has been published by Sir Vincent Wigglesworth (Entomologists' Record, vol. 87:208, 1975).—A.B.G.

California Wasps of the Subfamily Philanthinae (Hymenoptera: Sphecidae). 1975. By R. M. Bohart and E. E. Grissell. Bulletin of the California Insect Survey, vol. 19: pp. 1–92, 151 figs., 46 maps. University of California Press. $3.50.

This important bulletin concerns one of the largest subfamilies of the Sphecidae, containing over 1,000 world species. In California 6 genera and 65 species are recorded, chiefly in *Cerceris* and *Philanthus*. All of the species are predaceous and nest in the ground, provisioning their nests with bees, other wasps, ants and beetles (especially weevils). Conditions found in and near deserts are especially suitable for them.—A.B.G.

DESCRIPTION OF A NEW SPECIES OF LACE BUG ATTACKING THE OIL PALM IN COLOMBIA (HEMIPTERA: TINGIDAE)

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ABSTRACT—Two species of lace bugs are reported as feeding upon the oil palm, *Elaeis guineensis* Jacquin in Colombia: *Corythucha gossypii* (Fabricius) and a new species, *Leptopharsa* **gibbicarina** Froeschner. Literature records are cited for two other lace bugs on palms: *Allotingis binotata* (Drake and Bruner) from *Thrinax wendlandiana* Beccari; and *Stephanitis typica* (Distant) from oil palm and from the coconut palm. *Stephantis typica* is a vector of root wilt of the coconut palm.

Several colleagues have submitted for identification specimens of an apparently undescribed lace bug which is damaging the economically important oil palm, *Elaeis guineensis* Jacquin, in Columbia. A name and definition are needed for storing and communicating information about it.

The lace bug, in general appearances, looks very much like some members of the genus *Gargaphia* but lacks the diagnostic feature of that genus—that is, it has no transverse carina to interrupt the median sternal groove between the meso- and metasterna. Morphologically it belongs to the genus *Leptopharsa* as currently catalogued, but that genus is in serious need of redefinition and revision.

Two other species of lace bugs attack oil palms. One of the Colombian collections marked "feeding on oil palm foliage" also contained numerous individuals of the widely ranging polyphagous species *Corythucha gossypii* (Fabricius), a lace bug reported from a royal palm, *Roystonea regia* O. F. Cook by Drake and Ruhoff (1965:150). In India Joseph and Shanta (1968:19) reported a banana lace bug, *Stephanitis typica* (Distant), as expanding its taste to include the oil palm which had recently been introduced. *Stephanitis typica* is also known to feed on coconut palms where Shanta and Menon (1960:309) and Joseph, Shanta and Lal (1972:414) showed it to be an efficient vector of a root wilt of that palm. The only other palm with records of an associated lace bug is *Thrinax wendlandiana* Beccari from which Drake and Bruner (1924:155) described *Allotingis binotata*.

Leptopharsa gibbicarina Froeschner, new species

fig. 1

Diagnosis: The strong, subtriangular elevation of the median carina rising higher than the anteromedian cyst coupled with the strongly coarctate costal margins permit easy recognition of this species within the genus.

Fig. 1. *Leptopharsa gibbicarina* new species. Dorsal view and lateral view of head and thorax.

Length 2.69–2.91.

Head, pronotal surface, and body ventrally black, mostly pruinose. Antennal segments I and IV, except base, black; II brown, noticeably darker than III, latter and base of IV tan to yellow. Bucculae yellowed, more noticeably so along lower margin. Femora, extreme bases of tibiae, and tarsi black; most of tibia yellow. Pronotal outgrowths (paranota, longitudinal carinae, and anteromedian cyst) mostly yellow veined with milky hyaline cells. Median carina with broken stripe vertically traversing tallest part. Discoidal and subcostal areas appearing fuscous, latter often with black veins; costal area in basal half with 1 to 4 black crossveins and no fuscous cross band; apical third of elytron with distinct fuscous stripe between most of length of 2 blackened veins extending from apex of subcostal area.

Head vertically deflexed, with 3 long cephalic spines, 1 decumbent occipital pair and 1 horizontal or obliquely elevated median spine above base of clypeus. Antennal segment I about as long as width of head across vertex and part of 1 eye, slightly more than 2 times as long as II, III almost 3 times as long as I plus II or as IV. Labium reaching posterior coxae.

Pronotum with somewhat compressed anteromedian cyst about as tall as head, anteriorly extended over head almost to its apex, posteriorly not extended up pronotal convexity. Median carina with 2 irregular rows of large tall cells; dorsal margin projecting higher than anteromedian cyst, gently concave on posterior slope. Lateral carinae low, uniseriate, not higher than a femoral diameter. Paranota biseriate, sometimes with partial third row in 1 or both sides, combined width greatest caudad of midlength.

Elytron with costal margins distinctly coarctate on apical ⅔; apical margins distinctly divaricate, lateral apical angle acutely rounded. Discoidal area 4 cells wide, confined to basal ⅖, slightly elevated apically. Subcostal area regularly biseriate along most of discoidal area, thence triseriate for very short distance at its apex. Costal area triseriate opposite discoidal area, becoming uniseriate apically. Hypocostal lamina uniseriate.

Peritreme transversely auriculate. Sternal laminae present on all 3 sterna, on pro- and mesosterna subparallel, on metasternum a little more separated, slightly out bowed but still subparallel; sternal groove not interrupted by transverse carina at base of metasternum. Abdomen convex, impunctate.

Variations are evident in number of blackened cross-veins in costal area (1–4); in rows of cells in the paranota (2, sometimes with partial third row in one or both paranota); and in amount of fuscous clouding associated with blackened veins below the high point of median carina. One male paratype has median cephalic spine reduced to very short tubercle.

Holotype ♂, Colombia, San Alberto, March 1, 1975, Reynaldo Garcia, on *Elaeis guineensis*, deposited in the United States National Museum of Natural History, type number 73497.

Paratypes: taken with holotype, 13 ♂♂, 18 ♀♀. Same locality, February 1975, Ph. Genty, attacking *Elaeis guineensis*, 15 ♂♂, 17 ♀♀. Puerto Wilchez, Colombia, May 29, 1973, O. D. Jiminez, on *Elaeis guineensis*, 10 ♂♂, 5 ♀♀. Colombia, 6 ♂♂, 5 ♀♀. Paratypes will be sent to: Instituto Colombiano Agropecuario, Bogota, Colombia; British Museum (Natural History), London, England; Station de Recherches de Lutte Biologique, La Miniere, France; Landbouwhogeschool, Wangeninhen, Netherlands; Museum National d'Histoire Naturelle, Paris, France.

Superficially *L. gibbicarina* looks much like *L. pensa* Drake and Hambleton because that species is also mostly milky hyaline, has a distinct black line along the two veins extending from the apex of the subcostal area, and, at least in some specimens, has black femora; but the low, uniseriate median carina, greatly elongate erect occiptial spines, or the parallel costal margins of *L. pensa* will permit its ready separation from *L. gibbicarina.* In details *L. gibbicarina* is most similar to *L. distinconis* Drake in the strongly elevated median carina, the decumbent occipital cephalic spines, the blackened transverse veins in the basal third of the costal area, and the oblique fuscous line following the 2 veins extending from the apex of the subcostal area; but the 2 species can be easily separated by any one of 3 features because *L. distinconis* has the first antennal segment nearly 1½ times as long as width of head across both eyes (not only as long as width of vertex plus 1 eye), the costal margins straight (not coarctate), and the femora virtually wholly yellow (not black).

The fact that *L. pensa* occurs with the femora black or yellow led to the consideration that the present species might represent such a color form of some other species known only with yellow femora. Investigation of all the other species found none with the combination of the greatly elevated median carina and the coarctate costal margins.

The species name is from the Latin *gibbus*, humped, and *carina*, a ridge, in reference to the elevated dorsal outline of the median carina.

Dr. Ph. Genty, who sent one of the series of specimens, reported in a letter that the insect was moving from the foliage of a species of *Pestalozzia* (Cucurbitaceae) into the plantations of African or oil palms where it was causing economic losses.

I wish to thank the following persons for sending specimens: J. Carayon, R. Cobben, R. Carcia, Ph. Genty, B. Hurpin, L. Posada O., and G. Sanchez.

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DICYPHUS RHODODENDRI DOLLING, FIRST RECORDS FROM NORTH AMERICA (HEMIPTERA: MIRIDAE)

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Harrisburg 17120

ABSTRACT—*Dicyphus rhododendri* Dolling (Hemiptera: Miridae) was described from England in 1972 and here is reported as new to North America. In Pennsylvania populations were found breeding on cultivated and native rhododendron and mountain laurel during June–July 1974 and 1975. Two specimens were found in the U.S. National Museum of Natural History collection; they were collected at Cleveland, Ohio in 1933 but were misidentified. A description of the adult is provided.

Dolling (1972) described *Dicyphus rhododendri* from specimens collected on *Rhododendron* spp. at London's Kew Gardens and elsewhere in southern England. He reported that reddish nymphs appeared in June and that adults were present from late June to early August. This mirid was commonly associated with an aphid, *Masonaphis* sp., on which it was observed to feed. Since *D. rhododendri* is most closely related to the New World *D. cucurbitaceus* (Spinola) [= *agilis* (Uhler)] group of the genus, Dolling believed *D. rhododendri* to be a Nearctic species that only recently had been introduced into England.

In a letter dated 24 January 1974, Mr. Dolling encouraged us to look for *D. rhododendri* in Pennsylvania. We immediately examined specimens of *D. cucurbitaceus* that we had collected in previous seasons and found two specimens taken on rhododendron during July 1974 that fitted Dolling's description of *rhododendri*. These were determined tentatively as *D. rhododendri* by the senior author.

In 1975 we found populations of *Dicyphus* breeding on flowers of native and cultivated *Rhododendron maximum* L. and mountain laurel, *Kalmia latifolia* L. (detailed biological observations will be included in a forthcoming paper on the mirid fauna of ericaceous shrubs). Specimens sent to Mr. Dolling were pronounced to be "undoubtedly *D. rhododendri*." The collection of this mirid from Pennsylvania essentially confirms Dolling's hypothesis that *D. rhododendri*, although described from England, originated in the Nearctic.

We now have examined specimens from the following localities: OHIO: Cleveland, 24 June 1933, C. F. Irish, on foliage rhododendron (2 specimens det. as *D. cucurbitaceus*, NMNH collection). PENNSYLVANIA: Centre Co., Rt. 322 at Krise Valley Rd., 8 July 1975, K. Valley, on *R. maximum*; Dauphin Co., E. Harrisburg Cemetery, 9 July 1974, B. R. Stinner, on *R. maximum*; Dauphin Co., Indian Face nr. Dauphin, 6 June 1975, T. J. Henry and A. G. Wheeler, Jr., on *K. latifolia*; Luzerne Co., Glenburn, Rankin's Nursery, 4 June 1975, A. G. W., on *K. latifolia*; Philadelphia Co., Morris Arboretum, 11 July 1974, A. G. W., on *Rhododendron* sp.; Schuylkill Co., Rt. 81, 1 mi. S. of Rt. 443, 4 June 1974, on *K. latifolia* (all specimens in Pa. Dept. Agriculture collection).

Dicyphus rhododendri Dolling

Male: length 4.24–4.48 mm, width 1.12–1.20 mm (n = 4). Generally shiny black with hemelytra transparent. Head: width 0.64 mm; vertex 0.20 mm. Rostrum: length 1.44 mm, reaching middle of mesocoxae. Antennae: I, length 0.34 mm, pale yellowish to white, often lightly infuscated at apex; II, 1.34 mm, black; III, subequal to 2nd, fuscous on basal ⅓ to ½, pale yellow beyond; IV, 0.50 mm, yellowish. Pronotum: length 0.55 mm, width at base 0.94 mm; shiny black, collar white, a distinct elongate yellow triangle present along median line; mesoscutum and scutellum black. Hemelytra: lateral margins, veins and apex of corium distinctly infuscated, cuneus yellow, apex fuscous. Membrane: fumate, veins fuscous. Venter: sternum, base and apex of abdomen fuscous, sides of abdomen greenish to yellow. Legs: testaceous to yellowish; anterior aspect of hind femora with single row of fuscous spots, posterior aspect with group of spots on apical half.

Female: length 4.40–4.64 mm, width 1.16–1.24 mm (n = 5). Head: width 0.64 mm, vertex 0.28 mm. Rostrum: 1.46 mm. Antennae: I, 0.34 mm; II, 1.09 mm; III, subequal to 2nd; IV, 0.51 mm. Pronotum: length 0.61 mm, width at base 1.00 mm. Similar to male in color and markings.

Remarks: *Dicyphus rhododendri* very closely resembles *D. cucurbitaceus*, but may be separated by the pale yellow triangle on the pronotum, the lack of reddish markings on the hemelytra (some specimens of *D. cucurbitaceus* lack red), the more distinctly yellow cuneus, the male genitalia, and the reddish nymphs.

ACKNOWLEDGMENT

We are grateful to Mr. W. R. Dolling, British Museum (Natural History), for encouraging us to look for *D. rhododendri* in Pennsylvania and for sharing with us some of his observations on this mirid. Dr. K. Valley, Pa. Dept. Agric., kindly criticized the manuscript.

REFERENCE

Dolling, W. R. 1972. A new species of *Dicyphus Fieber* (Hem., Miridae) from southern England. Entomol. Mon. Mag. 107:244–245.

SOCIETY MEETINGS

824th Regular Meeting—May 1, 1975

The 824th Regular Meeting of the Entomological Society of Washington was called to order by President-elect Steyskal at 8 P.M., May 1, 1975 in the Lecture Room of the National Museum of Natural History. Thirty members and 15 guests were present. The minutes of the previous meeting were read and approved.

Membership Chairman Kingsolver read for the first time the name of the following new applicant for membership:

David W. Moss, Jr., San Jose, California

Jack Lipes discussed the status of the Mediterranean Fruit Fly in Central America and noted that it has now been detected in Nicaragua and Guatemala. William E. Bickley displayed a copy of a report on the insects of fresh and salt marshes in Maryland. Bob Nelson displayed a copy of a book titled *The Great Wine Blight* by George Ordish and remarked about its treatment of C. V. Riley. Lou Davis mentioned visiting the Armitages in California and that Mort was in good health; the United Presbyterian Church's One Great Hour of Sharing Program this year contributed money for the control of Date Insects; he also displayed a book on Washington, D.C., its past and present, which included pictures of the old USDA Entomology Building. Curt Sabrosky showed some specimens depicting the life-history of a tachinid fly, *Trichopoda* sp., which is parasitic on the squash bug, *Leptoglossus* sp.

President-elect Steyskal read a note from Frank Campbell expressing his regrets on not being able to attend the night's meeting and noting the passing of Josef Knull, the former Curator of the Insect Collections at Ohio State University.

Ted and Rosa Ella Spilman spoke of their recent trip to Puerto Rico and illustrated their comments with many kodachrome slides.

The principal speaker for the evening was Dr. Neal Weber of Florida State University, who gave an informative talk on the natural history of the fungus growing ants. The talk was well illustrated with kodachrome slides. A lively discussion period followed the talk.

The meeting was adjourned at 9:50 p.m. Punch and cookies were served following the meeting.

F. C. THOMPSON, *Recording Secretary*

825th Regular Meeting—June 5, 1975

The Entomological Society of Washington and Insecticide Society of Washington Joint Banquet was held on June 5, 1975, at the Chief Petty Officer's Club, Washington Navy Yard. The evening began with cocktails and was followed by a buffet.

Bob Nelson was Master of Ceremonies. The main speaker of the evening was Jack Coulson of the Beneficial Insect Introduction Laboratory, IIBIII, USDA, who spoke about biological control of weeds. Afterward, George Steyskal showed slides of Dominica, British West Indies, taken by the various scientists who participated in the Bredin-Archbold-Smithsonian Biological Survey of that island.

F. C. THOMPSON, *Recording Secretary*

826th Regular Meeting—October 2, 1975

The 826th Regular Meeting of the Entomological Society of Washington was called to order by President Rainwater at 8 P.M. on October 2, 1975 in the Lecture Room of the National Museum of Natural History. Thirteen members and 8 guests were present. The minutes of the previous meetings were read and approved with 1 correction.

Membership Chairman Kingsolver read for the first time the names of the following new applicants for membership:

Gisela Rack, Zoologisches Institut und Zoologisches Museum, Hamburg, Germany.
John K. Bouseman, Department of Entomology, Illinois Natural History Survey, Urbana, Illinois.
William E. Gavin, Department of Entomology, Oregon State University, Corvalis, Oregon.
Stephen L. Arnold, Department of Entomology, Cornell University, Ithaca, New York.
Rafael Inglés, Agricultural Experiment Station, Rio Piedras, Puerto Rico.
Paul Kittle, Department of Zoology, University of Arkanasas, Fayetteville, Arkansas.
Ronald A. Ward, Medical Entomology Project, Department of Entomology, Smithsonian Institution, Washington, D.C.
Nancy T. Kuenzel, College Park, Maryland.
Jack S. Lesshafft, Jr., Department of Biology, University of Louisville, Louisville, Kentucky.

President Rainwater read a proposal for a change in the Bylaws. The proposal, to be voted on at the November meeting, was to insert the words "Emeritus Members" into Article III, Section 5, in place of the word "member" where the article now reads ". . . as members without further payment of dues."

Jack Lipes reported for Maynard Ramsey, our Representative to the Washington of Sciences, on the current activities of the Academy.

Frank Campbell, who had just returned from the Eastern Branch Meeting of the Entomological Society of America, discussed a highlight of that meeting, the presentation of the L. O. Howard Award for Distinguished Achievement.

President Rainwater noted the passing of Honorary Member Mortimer D. Leonard. Louise Russell spoke on Dr. Leonard's life and achievements; a more detailed obituary appeared in the December, 1975 issue of the *Proceedings*. President Rainwater also mentioned the passing of William B. Wood, a member since 1912 and a retired USDA entomologist.

President Rainwater announced that Raymond A. St. George had been unanimously proposed for Honorary Membership by the Executive Committee and asked for a vote on this nomination. Ray Gagné moved that the Secretary record an unanimous ballot for the election. The motion was seconded and carried without dissent. The President then brought up the subject of affiliation with the Entomological Society of America, noting that the Executive Committee was in favor of such affiliation. There was unanimous approval for affiliation with the Entomological Society of America. Then President Rainwater announced the appointment of the Auditing and Nominating Committees.

Notes and Exhibitions: Ted Bissell displayed some larvae of the Pecan Weevil, *Curculio caryae* (Horn), which he had reared from shagbark hickory nuts. Dick Newkirk called attention to the new book, *Mites Injurious to Economic Plants* by Jeppson, Keifer, and Baker. Louise Russell introduced a book entitled *Aphids* by Blackman. She recommended this book as an excellent basic source of information on aphids. Ted Spilman announced that an Emeritus member of the Society, Botha deMeillon, had been awarded a silver medal by the Medical Association of South Africa for his valuable contributions, through original research, to the advancement of medical science and the art of healing.

The principal speaker for the evening was Dr. Robert Whitcomb of the Plant Protection Institute, USDA, who gave a very informative talk on "Island Biogeography, a limiting factor in the distribution of insects and birds." The talk was illustrated with kodachrome slides.

The meeting was adjourned at 9:50 P.M. Cider and cookies were served following the meeting.

F. C. Thompson, *Recording Secretary*

NOTE

PEPONAPIS CITRULLINA (COCKERELL) IN THE ORINOCO BASIN (HYMENOPTERA: APOIDEA)

On August 1, 1975, while collecting along a weedy roadside eleven kilometers southwest of San Fernando de Apure, Venezuela (ca. 7°53′N., 67°28′W., 73 m.), I took 12 male *Peponapis citrullina* (Cockerell) from open blossoms of *Cucurbita moschata* Duch. ex Poir. and another from a yellow malvaceous flower. The specimens were collected between 1035 and 1110 under a completely overcast sky following heavy rains which had left many of the squash blossoms filled with water. I returned to the locality on August 4, 1975, and between 0630 and 0708 (first sun on blossoms at 0640) I collected nine female and two male *P. citrullina* from open blossoms of *C. moschata*. During this time I also took one male *P. citrullina* from an open blossom of a dishcloth gourd (*Luffa* sp.) which was growing in a roadside dump near the *Cucurbita* site.

While the presence of *Peponapis citrullina* in Venezuela and Colombia has been well documented by Hurd and Linsley in their treatment of the South American squash and gourd bees (1967, Ann. Entomol. Soc. Amer. 60:647–661), their records for the species pertain to the Pacific and Caribbean slopes. My records are of interest because they are the first for *P. citrullina* in the basin of the Orinoco River.

The specimens cited herein will be deposited in the collection of the Section of Faunistic Surveys and Insect Identification of the Illinois Natural History Survey at Urbana, Illinois. Thanks are due to the following for their aid: Wallace E. LaBerge, Illinois Natural History Survey, for verifying the determinations of the bees; Ashby M. Rhodes, University of Illinois, for identifying the cucurbitaceous hosts of the bees; and Richard B. Selander, University of Illinois, for making the trip possible.

John K. Bouseman, *Agricultural Entomology, Illinois Agricultural Experiment Station and Section of Economic Entomology, Illinois Natural History Survey, Urbana, Illinois 61801*

NOTE

HUMAN MYIASIS IN VIRGINIA CAUSED BY PHAENICIA SERICATA (MEIGEN) (DIPTERA: CALLIPHORIDAE)

The green bottle fly, *Phaenicia sericata* (Meigen), is common throughout the U.S. during summer months. Hall indicated this species is one of the first of an ecological succession of saprophagous insects to attack dead animals (1948, Entomol. Soc. Amer., Thomas Say Found. Publ. 4, 477 p.). James (1947, USDA Misc. Publ. 631, 175 p.) reported the occurrence of larvae in garbage and manure. *Phaenicia sericata* is attracted also to malodorous wounds and sores. Consequently, Hall stated that cases of human myiasis attributable to this species may arise from almost the entire range of its distribution.

Pratt (1956, Proc. Entomol. Soc. Wash. 58:14) encouraged documentation of unquestionable instances of human myiasis. Two cases involving *P. sericata* have been reported from Virginia: one by Pratt, the massive infestation of the navel of a baby boy and a case of aural myiasis (Morris, 1957, Coop. Econ. Insect Rpt. 7:607). Scott (1963, U.S. Dept. HEW, PHS, CDC, Atlanta, 14 p.) cataloged 102 instances of human myiasis of all kinds in the U.S. for the period 1952–62 and estimated that about 7,000 cases occur annually in this area. He noted additionally that the incidence is difficult to assess accurately with the superficial data generally available.

Mr. Stuart McCausland (Bureau of Solid Waste and Vector Control, Virginia State Department of Health in Norfolk) advised us of myiasis in a patient admitted to Norfolk General Hospital. A total of eight second-instar larvae were collected and two successfully reared on clean ground beef. We identified the adult flies as *P. sericata.*

The case history is as follows:

> A 54-year-old female was admitted to Norfolk General Hospital on July 26, 1975. The patient was in a diabetic coma of undetermined length. An ulcer containing maggots was observed on the upper inner thigh region of one leg. Maggots were noted also in the lower vaginal canal. Larvae were removed by mechanical means and the afflicted areas irrigated with a topical antiseptic on July 27. No additional larvae were observed after that time.

Melvin determined that the egg stage of *P. sericata* requires approximately eight hours at 94°F (1934, Ann. Entomol. Soc. Amer. 27:406–10). The first-instar is a non-feeding period terminated by a molt two or three hours after hatching (Wardle, 1930, ex Hall, 1948). The presence of larvae and their stage of development could be of value to physicians in such a case in approximating the length of exposure or duration of unconsciousness. This information would require careful interpretation and should be used with discretion.

Voucher specimens of *P. sericata*, adult females and larvae, were designated and deposited in the Insect Collection of the Department of Entomology at Virginia Polytechnic Institute and State University.

Dr. R. J. Gagné, Systematic Entomology Laboratory, U.S. Department of Agriculture, confirmed the identification of specimens. Dr. W. H Robinson, Department of Entomology, VPI & SU, offered valuable criticism of this manuscript.

L. H. Townsend, Jr. and R. D. Hall, *Department of Entomology, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.*

BOOK REVIEW

Classification of the Acridomorphoid Insects. 1975. By V. M. Dirsh. 171 pp., 74 figs. E. W. Classey, Ltd., Park Road, Oxon, SN7 7DR, England ($23.50).

For anyone, student and specialist alike, interested in the classification of grasshoppers, this book is valuable, as it presents an arrangement of the world fauna in all categories from subfamily to order. It is well illustrated and has ample keys and a glossary of terms.

The classification offered, due to the large number of families and subfamilies, is in contrast with the classification of cockroaches, comprising five families, as the latter are now regarded by most current workers, though a more expansive classification has been used by some specialists. This reviewer endorses a conservative classification, with fewer orders and families for the now divided old order Orthoptera than frequently are advocated by some writers.

Among the numerous subfamilies recognized by Dirsh, it is not always clear which ones are proposed here for the first time. No reference is made to an important paper on the classification of Neotropical acridians published by C. Amedegnato of France in July 1974, and resolving the names and priority of several higher categories may be necessary. Another point at issue is the formation of suprageneric names which in several cases do not conform to the International Code. My colleague G. C. Steyskal has examined the book and given me the following comments: "The following taxa at the subfamily rank should have the following forms—Anamesacridinae, Atacamacridinae, Aucacridinae, Chilacridinae, Conophymatinae, Cyrtacanthacridinae, Echinotropidinae, Eyprepocnemidinae, Hyalopteryginae, Illapeliinae, Leptacridinae, Leptysmatinae, Parabullacridinae, Paraconophymatinae, Parginae, Phlaeobidinae, Podismatinae, Porthetidinae, Pyrgacridinae, Thericlidae. Most of these are cited with -acrinae, although from names ending with *-acris*, which has the stem *acrid-* and would therefore be similar to Acridinae, Acrididae, and Acridoidea (from the genus-name Acrida). Superfamily names are given the ending -oidea, as recommended by the Code, but names of orders and superorders are given the same ending, though most ordinal names now end in -optera."

In the characterization of subfamilies and other categories, many traditional external characters are used, but for numerous divisions great reliance is placed on the male genitalia. Only future experience will show how basic the genitalia are in this instance. We may hope that the exploration of genital details will not prove to be a Pandora's box to justify the naming of an unnecessary number of families and subfamilies.

In spite of the foregoing comments, this book can be truly useful if readers realize that certain inconsistencies in spelling, problems of nomenclature and priority, and a tendency to recognize too many orders and families occur. The author, Dr. V. M. Dirsh, who retired recently from the Centre for Overseas Pest Research, London, has had a wealth of experience in grasshopper classification and identification.

Ashley B. Gurney, *Cooperating Scientist,*
Systematic Entomology Laboratory, IIBIII,
Agr. Res. Serv., USDA, c/o U.S. National Museum, Washington, D.C. 20560

OBITUARY

Photo by Frank W. Mead, Fla. Dept. Agr. and Consumer Services, Div. Pl. Ind., Gainesville.

JOSEF NISSLEY KNULL
1891–1975

Josef N. Knull, Professor Emeritus of Entomology at the Ohio State University, died at the age of 83 on April 24, 1975, in Columbus, Ohio. He was well known in entomology as a curator, taxonomist on Coleoptera, economic entomologist, and illustrator.

Professor Knull was born at Harrisburg, Pa., on October 12, 1891. He was educated in the public schools of that city, and went to college at Pennsylvania State College (now University) where he graduated in 1915 with a B. Sc. in biology. His first entomological position was with the Pennsylvania State Bureau of Plant Industry. The work resulted in formation of his interest in forest insects, and particularly in certain families of Coleoptera. He went on to graduate work in entomology at the Ohio State University where he received the M. Sc. degree in 1924. In 1930 he became research entomologist with the Forest Research Institute of the Pennsylvania State Department of Forests and Waters. During 1933 he worked with the Forest Insect Investigations Division of the U.S. Dept. of Agriculture. In 1934 he became Curator of Insects and Assistant Professor of Zoology and Entomology at the Ohio State University, where he remained until his retirement in 1962.

The very well-prepared and well-curated Henry Wenzel collection formed the nucleus of the beetle collection in the Zoology-Entomology Department at the Ohio State University, and the high standards of this collection were maintained by Professor Knull. Over the years he and his wife Dorothy (who survives him and is an entomologist of note in the Cicadellidae) in their collecting trips added greatly to the collection, and largely through their efforts this has become a major insect collection with over 3 million specimens. A large number of new species have been described by various workers from the beetles collected by the Knulls.

During Professor Knull's career in economic entomology and taxonomy he produced about 200 publications. The economic papers dealt largely with forest insects, and the taxonomic papers mostly with descriptions of new species with an emphasis on beetles of the families Cerambycidae, Buprestidae, Elateridae, Cleridae, and Eucnemidae. Many of the publications were illustrated with Professor Knull's excellent drawings.

Professor Knull was advisor to comparatively few students at the Ohio State University; the writer has the distinction of being the last. His meticulous attention to detail in curating and high standards in all work set an example for his students and those who assisted in the museum. He made it a point to introduce his students to illustrative techniques, and many of us today in our own taxonomic work continue to use these skills he assisted in developing. Professor Knull will be long remembered by those of us who worked most closely with him, for we learned much and profited greatly from the association.

RICHARD E. WHITE, *Systematic Entomology Laboratory, IIBIII, Agr. Res. Serv., USDA, c/o U.S. National Museum, Washington, D.C. 20560.*

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A REVISION OF THE NEW NEOTROPICAL LEAFHOPPER SUBFAMILY PHEREURHININAE (HOMOPTERA: CICADELLIDAE)

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ABSTRACT—A new subfamily, **Phereurhininae**, of leafhoppers from the American tropics is described and discussed. Three genera are included: *Phereurhinus* Jacobi, *Clydacha* Melichar, and **Dayoungia** Kramer, new genus. In the genus *Phereurhinus*, two new species are described from Peru, *P.* **hoplon** and *P.* **sosanion**, and one new species from Brazil, *P.* **enteon**. In the genus *Clydacha*, three new species are described from Peru, *C.* **ballista**, *C.* **condylura**, and *C.* **catapulta**. In the genus *Dayoungia*, one new species is described from Argentina, *D.* **magister**, and two new species are described from Brazil, *D.* **virescens** and *D.* **metron**.

The Neotropical genera discussed in this paper appear to form a natural group, but their assignment to any existing subfamily of leafhoppers is questionable. Their affinities seem to be closest to the Cicadellinae, but Young (1968) deliberately excluded them from his massive report on the Proconiini. Young (personal communication) is not including these genera in his future papers on the Cicadellini, the only other tribe he is recognizing in the Cicadellinae. Hence, I am establishing a new subfamily for their reception.

Phereurhininae Kramer, new subfamily

Type-genus *Phereurhinus* Jacobi

Head produced with median length greater, usually more than 2½ times greater, than length next to eyes; distal midline of crown often elevated as carina; ocelli on crown; frontal sutures reaching coronal surface and usually touching ocelli; pronotum large with lateral margins long, carinate, and flared; scutellum large; appendix of forewing minute or absent; surfaces of crown, pronotum, and scutellum variously punctate, striate and/or rugulose; face tumid and without median longitudinal carina on clypeus; posterior legs at rest not attaining posterior proepimeral margins; apex of hind femur with pair of slender

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setae; male plates and pygofer with randomly arranged hairlike setae. Females unknown.

The subfamily Phereurhininae is closest to the Cicadellinae on the basis of the frontal sutures reaching or nearly reaching the coronally positioned ocelli and the tumid face. The best character for separating the two subfamilies is the flared, and at times almost foliaceous, lateral margins of the pronotum. This character is present in the Phereurhininae and absent in the Cicadellinae.

KEY TO GENERA OF PHEREURHININAE

1. Head greatly prolonged and distally spatulate (fig. 4) .... *Clydacha* Melichar
— Head triangular 2
2. Distal midline of crown elevated as carina (fig. 1); antennal ledges triangularly produced; face with vestiture .... *Phereurhinus* Jacobi
— Distal midline of crown not elevated (fig. 43, 47); antennal ledges not triangularly produced; face without vestiture .... *Dayoungia* Kramer, n.g.

Clydacha Melichar

Clydacha Melichar 1926:345. (without species)
Phereurhinus cochlear Jacobi, type-species by China 1938:184.

Large (12–13.8 mm), elongated, parallel-sided, flattened leafhoppers; head greatly prolonged apically and thickly spatulate; midline of crown elevated and carinate before ocelli to near extreme apex; lateral edges of head sharp and carinate; portion of margins near eyes often flared and slightly elevated above level of eye; portion of crown on each side of coronal suture in approximately basal ⅓, tumid and rugulose; antennal ledges protruding, triangular and carinate; face with variable covering of scattered hairlike setae; surface of pronotum punctate rugulose, often with traces of median longitudinal carina, hind margin of pronotum indented; surface of scutellum finely scaly to rugulose, rarely with slight trace of median longitudinal carina; forewing elongate and lacking distinct appendix, with 4 apical and 3 closed preapical cells, all veins well delineated; legs slender, with spinelike setae on hind tibiae mainly short and fine. *Male genitalia*: Pygofer without appendages or processes; valve narrow; plates and styles elongate, slender, and variously modified; connective short and H-shaped; aedeagus heavily membranous, especially apically, with sclerotized dorsocentral rod bearing appendages; aedeagus dorsally connected to pygofer and base of anal tube by sclerotized apodeme; gonopore not clearly delimited. *Female genitalia*: Female unknown.

KEY TO SPECIES OF CLYDACHA MELICHAR

1. Aedeagus in ventral view with 3 pairs of processes arising in distal ¼ (fig. 5); apex of style consisting of 2 overlapping, rounded lobes (fig. 7, 8) .... *cochlear* (Jacobi)
— Aedeagus in ventral view with no more than 2 pairs of processes arising in distal ¼; apex of style hooked 2

2. Aedeagus in ventral view with pair of long, straight processes originating near middle of shaft and extending beyond lateral margins in distal ⅓ (fig. 10); apex of style in dorsal view weakly hooked, with angular projection on preapical outer margin (fig. 11) .... *ballista*, new species
— Aedeagus in ventral view not as above; apex of style in dorsal view weakly or strongly hooked, with preapical lobelike expansion 3
3. Aedeagus in ventral view with pair of contiguous, slender processes on midline in distal ⅓ (fig. 15); hook at apex of style slender in lateral view (fig. 17) .... *condylura*, new species
— Aedeagus in ventral view without processes on midline in distal ⅓ (fig. 22); hook at apex of style stout in lateral view (fig. 24) .... *catapulta*, new species

Clydacha cochlear (Jacobi)

fig. 5–8

Phereurhinus cochlear Jacobi 1905:169.
Clydacha cochlear (Jacobi); China 1938:184.

Length of male: 12.5 mm. *Structure*: Cephalic extension at apex gradually expanded and rounded distally; surface of crown weakly and irregularly rugulose; surface of pronotum uneven in anterior ½ with poorly defined callosities, posterior ½ weakly reticulately rugulose, suggestion of longitudinal carina on midline; lateral edges of pronotum declivent; lower portion of face, except middle portions of clypellus and clypeus, thinly covered with pale, moderately short hairlike setae; traces of similar covering on thoracic venter. *Coloration*: Ground color of crown, pronotum, and scutellum brownish yellow; most of crown, including central carina, lightly infuscated; pronotum lightly infuscated on outer ⅓ in anterior ½; scutellum with anterior angles darkened; forewing hyaline with veins brownish yellow and large brownish yellow, transparent patch at middle; patch fading in claval area; face and thoracic venter with same ground color as crown, lightly infuscated except for intervals between clypeal arcs, portions of genae, sides of pronotum below carina, and irregular portions of thoracic sclerites; legs with all femora fuscus except at apices, anterior tibiae largely fuscus, mid- and hind tibiae darkened at bases and apices, 1st tarsal segment of all legs darkened apically, rest of tarsal segments largely fuscus. *Male genitalia*: Aedeagus in ventral view (fig. 5) with lateral margins indented and 3 pairs of processes in distal ¼ as apical branches of dorsocentral rod; sclerotized apodeme attached to base of dorsocentral rod, its shape like that shown in fig. 14; valve and plates like those shown in fig. 21; style in dorsal view (fig. 7) elongate, sides slightly wrinkled preapically, apex consisting of 2 overlapping lobes; apex of style in lateral view (fig. 8) concave before apex on dorsal margin.

Type: A ♂ lectotype is here selected with the labels "Peru N Rioja, Garlepp c." (light green label) and "Coll. A. Jacobi, 1913–9" (dark green label—this label added later) and "A. Jacobi, Typus" (pink label with black frame) and "Staatl. Museum für Tierkunde, Dresden". The lectotype is in the entomological collections of the Museum für Tierkunde, Dresden, D. D. R.

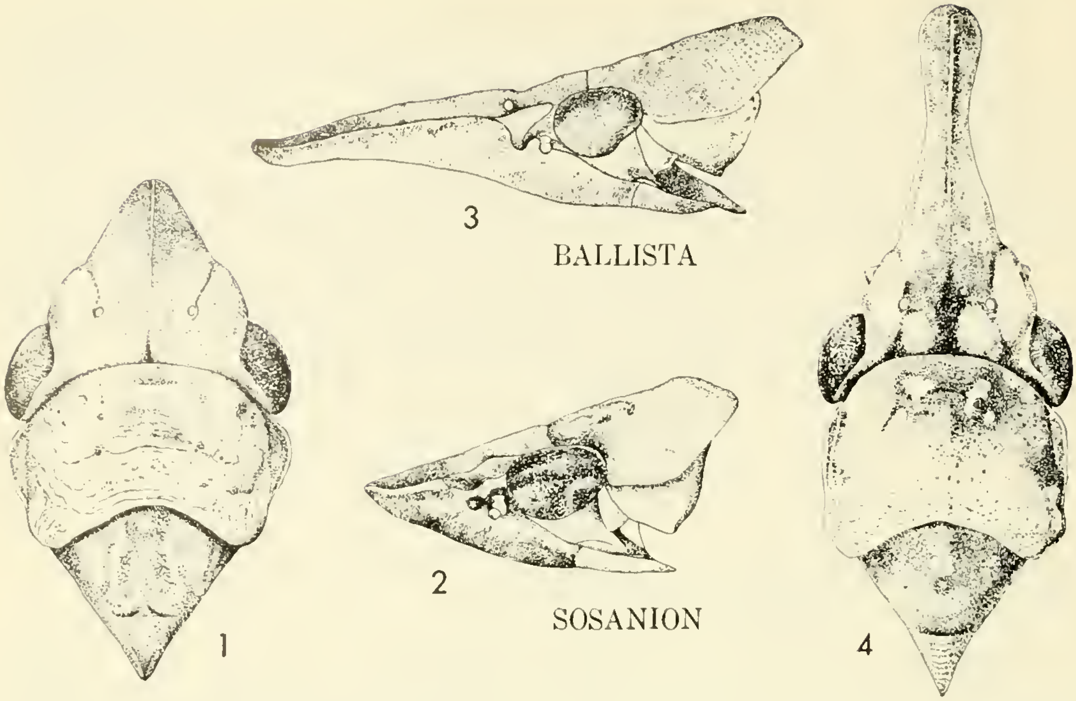


Fig. 1–2. *Phereurhinus sosanion.* 1, head and thorax in dorsal view. 2, same in lateral view. Fig. 3–4. *Clydacha ballista.* 3, head and thorax in lateral view. 4, same in dorsal view.

Notes: The characters noted in the key distinguish *C. cochlear* from its congeners. The lectotype male is the only specimen known to me.

Clydacha ballista Kramer, new species

fig. 3–4, 9–14

Length of male: 12–12.5 mm. *Structure*: Like that of *C. cochlear* except as follows: rugulose surfaces of crown and pronotum more clearly defined; surface of scutellum rugulose, anterior angles finely granular, sometimes with vague carina on midline. *Coloration*: Variable, ground color of crown and pronotum ochreous and only darkened at extreme coronal apex and on coronal carina to entirely black except for 2 pale spots behind ocelli which touch posterior margin of head; scutellum with same ground color and only darkened at anterior angles to entirely black; forewing varying from that of *C. cochlear* to heavily infuscated or blackened at base and middle with veins darkly fuscus to black; ground color of face and thoracic venter stramineous with clypellus, central portion of clypeus, clypeal arcs, and extreme facial apex fuscus to black; thoracic sclerites with anepisternum 2 broadly banded with black and katepisternum 2 black except at margins, pattern similar to that of *C. cochlear*; legs with femora fuscus except basally and apically, 1st and 3rd tibiae darkened distally, 2nd tibiae uniformly lightly embrowned, tarsi like those of *C. cochlear*. *Male genitalia*: Aedeagus in ventral view (fig. 10) with lobelike expansion of lateral margins in basal ½, central rod forked at middle, each fork branched apically (fig. 12) or not and

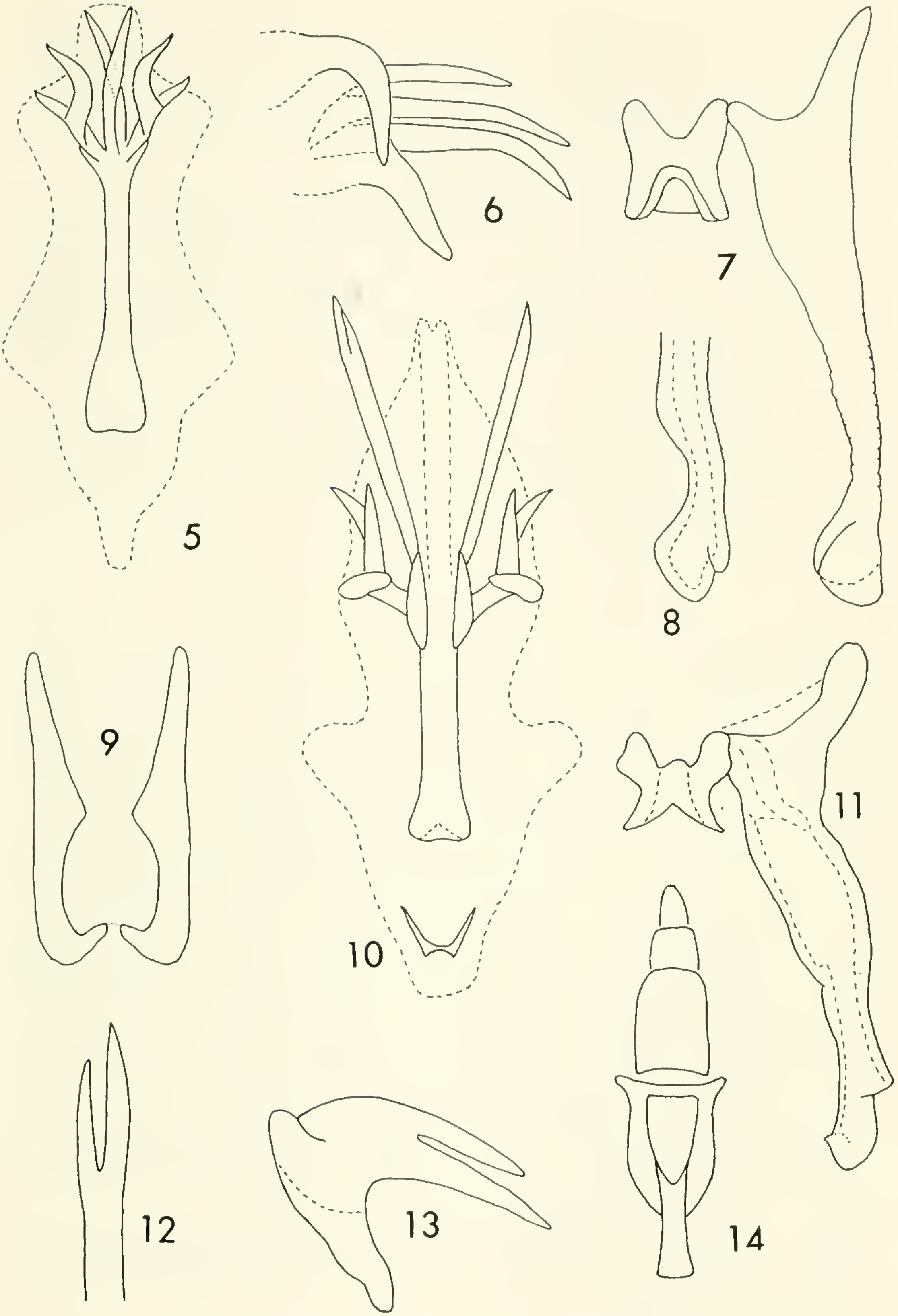


Fig. 5–8. *Clydacha cochlear.* 5, aedeagus in ventral view. 6, distal processes of aedeagus in lateral view. 7, connective and style in dorsal view. 8, apical portion of style in lateral view. Fig. 9–14. *Clydacha ballista.* 9, plates in ventral view. 10, aedeagus in ventral view. 11, connective and style in dorsal view. 12, forked apex of longest aedeagal process in broad view. 13, shorter aedeagal processes in lateral view. 14, sclerotized apodeme and anal tube in posterior view.

extending beyond lateral margins in distal ⅓, apically acute processes arising laterally near distal portion of rod, in lateral view processes form single structure (fig. 13); sclerotized apodeme in posterior view (fig. 14) basally stalked; plates elongate and slender, gradually produced on inner margins from bases and apices (fig. 9); style in dorsal view (fig. 11) elongate, weakly hooked apically with angular projection on preapical outer margin.

Types: Holotype ♂, Monson Valley, Tingo Maria, Peru, 10 November 1954, E. I. Schlinger and E. S. Ross in collection of California Academy of Sciences. Paratypes, ♂♂; 9 with same data as holotype; rest with same data except collection dates—36, 29 November 1954; 2, 2 December 1954; 65, 9 December 1954; 16, 23 December 1954. Total 129 specimens.

Notes: The long pair of processes originating near the middle of the aedeagus at once distinguish this species. The coloration varies considerably and all sorts of intermediates exist between the extremes noted in the description.

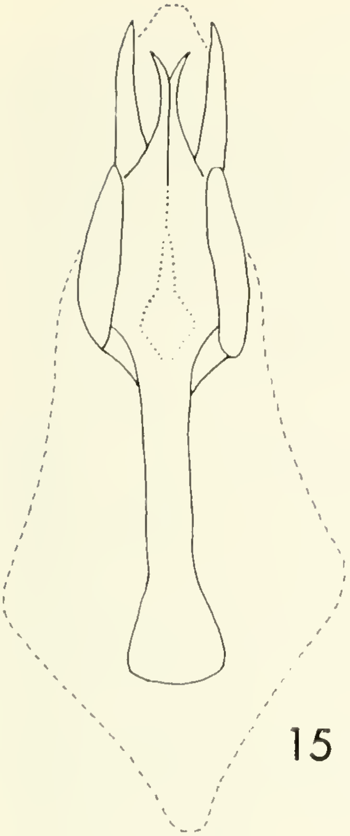
Clydacha condylura Kramer, new species

fig. 15–19

Length of male: 13.5 mm. *Structure*: Like that of *C. cochlear* except as follows: spatulate portion of crown with rugulae transverse, surface of apical portion on each side of carina finely granular, surface of crown between ocelli and on each side of carinal base punctate rugulose, surface of crown between basal tumid areas longitudinally rugulose with rugulae converging basally; posterior ⅔ of pronotum punctate–rugulose; scutellum like that of *C. ballista*. *Coloration*: Crown black except for ochreous portions as follows: round spots on each side of midline at base, areas laterad of frontal sutures to lateral margins, edges of spatulate portion in proximal ⅗; central ½ of pronotum infuscated or blackened, lateral portions brownish orange; scutellum fuscus or black; forewing brownish orange hyaline in basal ⅓, fuscus hyaline in middle ⅓, and hyaline in distal ⅓; veins similarly colored, but veins in distal ⅓ brownish yellow; face and thoracic venter marked like those of *C. ballista*; legs marked like those of *C. cochlear*. *Male genitalia*: Aedeagus in ventral view (fig. 15) broadest in basal ⅓, rod elaborated distally, with 2 pairs of processes in distal ¼, central pair narrower and on midline; apex of aedeagus in lateral view (fig. 19) with lateral processes decurved and mesal processes upturned; sclerotized apodeme, valve, and plates similar to those of *C. ballista*; shank of style slender and wrinkled, with preapical lobe and apical hook (fig. 16–18).

Type: Holotype ♂, Monson Valley, Tingo Maria, Peru, 29 November 1954, E. I. Schlinger and E. S. Ross in collection of California Academy of Sciences.

Notes: The slender pair of processes on the midline of the aedeagus distinguishes this species. The tricolored forewings and larger size also appear distinctive.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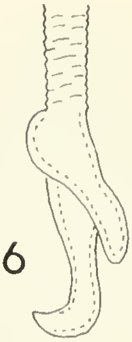
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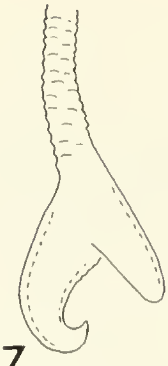
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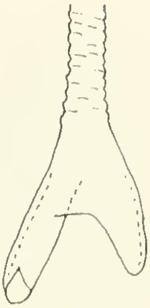
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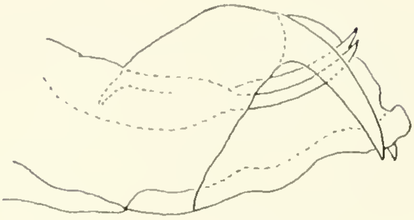
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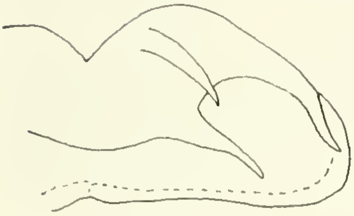
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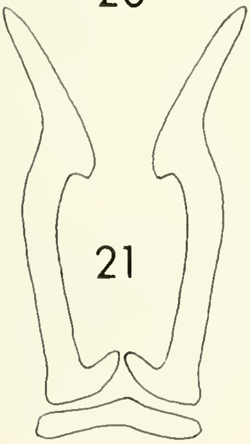
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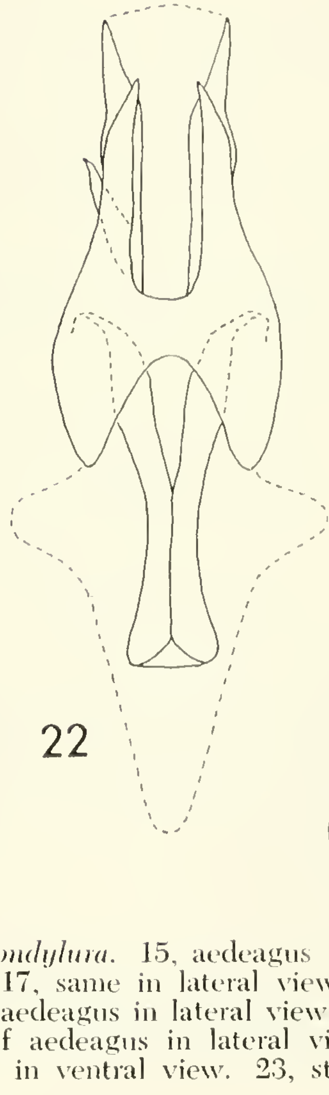
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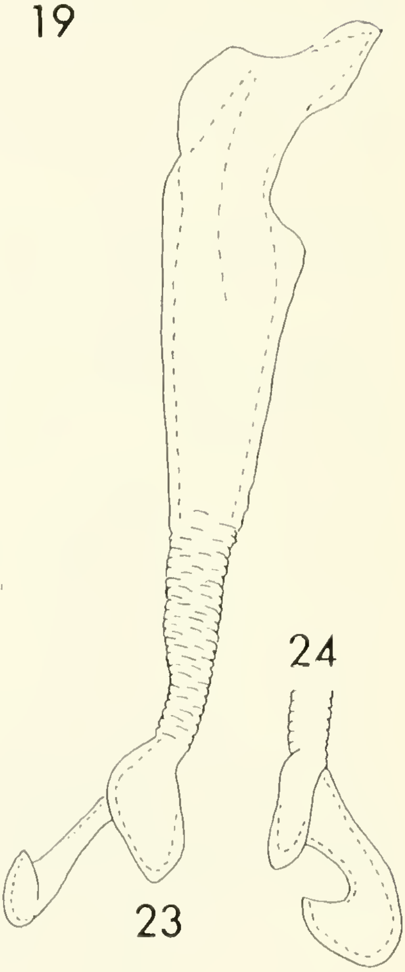

Fig. 15–19. *Clydacha condylura.* 15, aedeagus in ventral view. 16, apex of style in dorsolateral view. 17, same in lateral view. 18, same in broad ventral view. 19, apical portion of aedeagus in lateral view. Fig. 20–24. *Clydacha catapulta.* 20, apical portion of aedeagus in lateral view. 21, valve and plates in ventral view. 22, aedeagus in ventral view. 23, style in dorsal view. 24, apex of style in lateral view.

Clydacha catapulta Kramer, new species
fig. 20–24

Length of male: 12.5–13.8 mm. *Structure*: Like that of *C. cochlear* except as follows: spatulate portion of crown stouter and usually longer; surface of crown with rugulae more distinct; posterior portion of pronotal surface sharply punctate–rugulose; scutellum like that of *C. ballista*, but always with vague carina on midline; hairlike setae covering all of face and more abundant on thoracic venter than in congeners. *Coloration*: Most of crown fuscus to black with lateral margins variably ochreous and pair of light spots on posterior margin like those found in darker specimens of *C. ballista*; ground color of pronotum ochreous, dark brownish orange, or almost fuscus with variable blackened areas in anterior ½; scutellum fuscus to black with angles at times paler; forewing hyaline, veins fuscus, dark transparent patch at middle like that of *C. cochlear*, at times with suggestion of similar patch at base; face marked like darker forms of *C. ballista* but antennal ledges, genae below antennae, and lora also black; thoracic sclerites with anepisternum 2 and katepisternum 2 largely black, but irregularly yellow on their tangent margins; legs marked like those of *C. ballista*. *Male genitalia*: Aedeagus in ventral view (fig. 22) more heavily sclerotized than that of congeners, central rod split distally, lateral edges of aedeagus sclerotized in distal ½, 2 pairs of processes arising in distal ½, sometimes extra process present basad of these; apex of aedeagus in lateral view (fig. 20) with all processes decurved; sclerotized apodeme like that of *C. ballista*; valve and plates in ventral view (fig. 21) with valve simple and each plate produced at base on inner margin and distally curved obliquely laterad to form footlike outline; style in dorsal view (fig. 23) with portion before apex wrinkled, large preapical lobe, and distinct apical hook (fig. 24).

Types: Holotype ♂, Monson Valley, Tingo Maria, Peru, 29 November 1954, E. I. Schlinger and E. S. Ross in collection of California Academy of Sciences. Paratypes, ♂♂; 4 with same data as type; 1 with same data except 26 October 1954.

Notes: In addition to the features of the male genitalia mentioned in the key, the stouter spatulate portion of the head and generally darker color will help to distinguish this species.

Phereurhinus Jacobi

Phereurhinus batillus Jacobi 1905:168, type-species.

This genus is only distinct from *Clydacha* Melichar on the basis of head shape. In *Phereurhinus* the heads are triangularly produced and shorter than the spatulate heads found in *Clydacha*. In all other characters the two genera are essentially alike. I consider head shape, when as spectacularly different as it is in the case at hand, sufficient grounds for generic separation.

KEY TO SPECIES OF PHEREURHINUS JACOBI

1. Crown longer at middle, 2 mm or slightly more; style with a distinct tooth on apical hook (fig. 26) .... *hoplon*, new species

— Crown shorter at middle, 1.8 mm or less; style without a tooth on apical hook 2

2. Apex of style reaching distal ¼ of plate .... *enteon*, new species

— Apex of style reaching beyond apex of plate 3

3. Plates forming a distinct open oval area between their bases (fig. 34); apical hook of style sharply turned mesad (fig. 35) .... *sosanion*, new species

— Plates not forming an open oval area between their bases (fig. 37); apical hook of style broadly turned mesad (fig. 36) .... *batillus* Jacobi

Phereurhinus hoplon Kramer, new species

fig. 25–28

Length of male: 11–11.5 mm. *Structure*: Like that of *P. batillus* except as follows: crown well produced with median length clearly exceeding greatest width; forewing with punctures between veins in basal ¼ usually poorly defined. *Coloration*: Like that of *P. batillus* except as follows: forewing infuscated and pigmented to or nearly to bases of preapical cells, hyaline beyond; costal vein not darker than other veins. *Male genitalia*: Aedeagus in lateral and ventral views (fig. 27, 28) similar to that of *P. batillus* but apical processes more slender and differently bent, without preapical processes; valve and plates similar to those of *P. batillus*; style in broad ventral view (fig. 26) only about ½ as long as plate, shank wrinkled but comparatively short and stout, apical hook with subapical tooth (fig. 25).

Types: Holotype ♂, Monson Valley, Tingo Maria, Peru, 29 November 1954, E. I. Schlinger and E. S. Ross in collection of California Academy of Sciences. Paratype ♂ with same data.

Notes: The longer head, more extensively darkened forewings, and toothed stylar hooks make *P. hoplon* the most distinctive species in *Phereurhinus*.

Phereurhinus enteon Kramer, new species

fig. 29–31

Length of male: 9.75–10 mm. *Structure*: Like that of *P. batillus* except as follows: crown well produced with median length slightly exceeding greatest width; forewing with punctures between veins in basal ¼ like that of *P. hoplon*. *Coloration*: Like that of *P. batillus* except as follows: ground color lighter; slightly more than basal ¼ of forewing deep dark red with some additional grayish-yellow pigmentation near claval base. *Male genitalia*: Like that of *P. sosanion* except as follows: apical aedeagal processes in lateral view (fig. 31) crossed to form open oval area between them basally; same processes in ventral view (fig. 30) as shown; style only about ¾ as long as plate with apical hook nearly identical (fig. 29).

Types: Holotype ♂, Itaituba, Brazil (USNM 73370). Paratype ♂ with same data.

Notes: The relatively long head, deep dark reddish basal ¼ of the forewings, and short style are the distinguishing features of *P. enteon*.

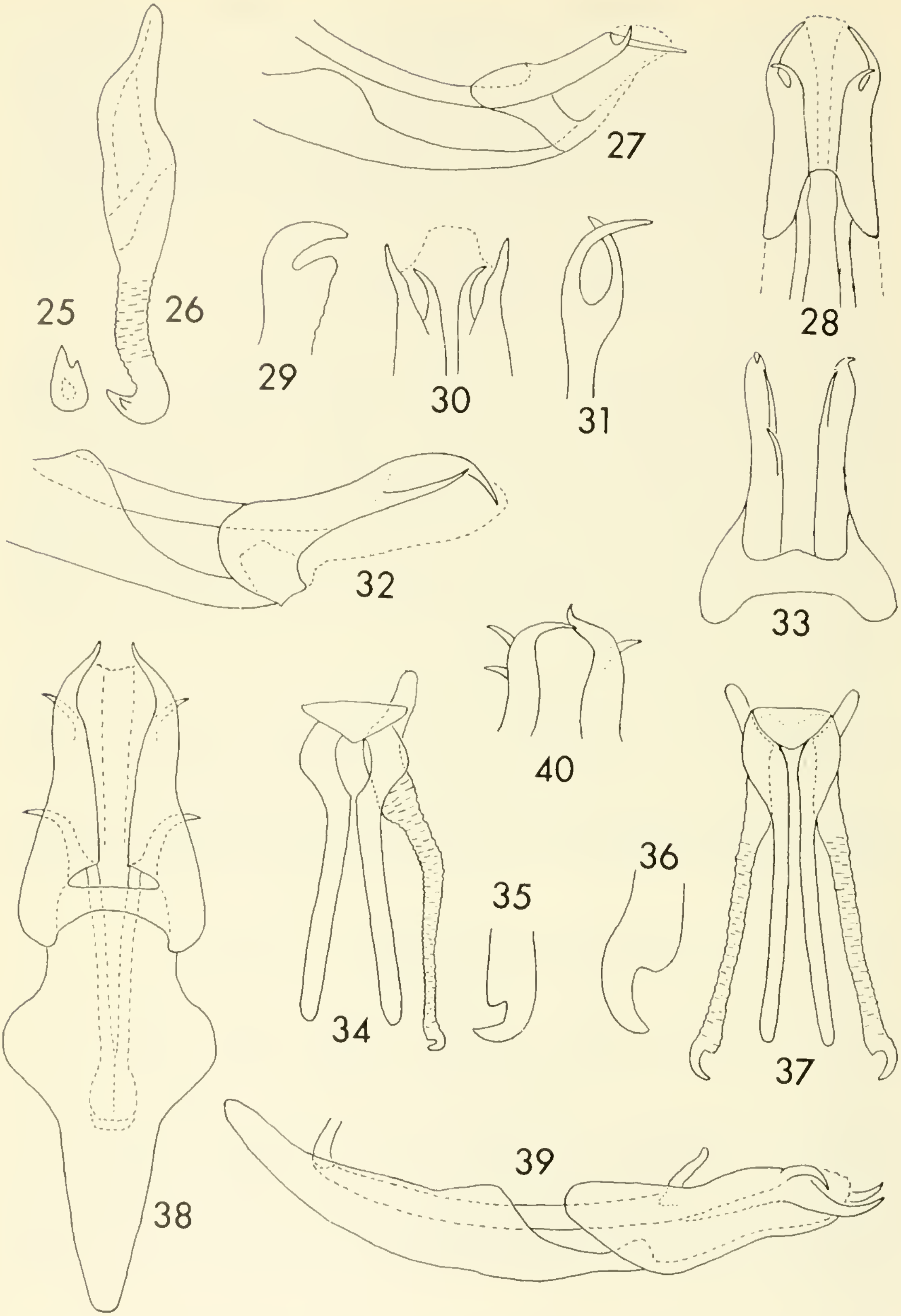

Fig. 25–28. *Phereurhinus hoplon.* 25, apex of style in posterior view. 26, style in dorsal view. 27, distal portion of aedeagus in lateral view. 28, same in ventral view. Fig. 29–31. *Phereurhinus euteon.* 29, apex of style in ventral view. 30, apex of aedeagus in ventral view. 31, distal aedeagal processes in lateral view. Fig. 32–35. *Phereurhinus sosanion.* 32, distal portion of aedeagus in lateral view.

Phereurhinus sosanion Kramer, new species

fig. 1–2, 32–35

Length of male: 10.5–11 mm. *Structure*: Like that of *P. batillus* except crown well produced with median length slightly less than greatest width. *Coloration*: Like that of *P. batillus*. *Male genitalia*: Aedeagus in lateral view (fig. 32) similar to that of *P. batillus* except distal processes more slender with dorsal process exceeding ventral process distally; aedeagal apex in anterioventral view (fig. 33) with apical processes shorter than preapical processes, at times with extra process basad of preapical process; plates and styles in ventral view (fig. 34) with basal portions of plates curved to form distinct open oval area between them, plates distally narrowed and attenuated, shank of style wrinkled and extended beyond apex of plate, apical hook of style sharply turned mesad (fig. 35).

Types: Holotype ♂, Monson Valley, Tingo Maria, Peru, 29 November 1954, E. I. Schlinger and E. S. Ross in collection of California Academy of Sciences. Paratype ♂♂, 4 with same data.

Notes: *Phereurhinus sosanion* is closest to *P. batillus* and can be separated from that species only by the features mentioned in the key.

Phereurhinus batillus Jacobi

fig. 36–40

Phereurhinus batillus Jacobi 1905:168.

Length of male: 9.5–10.5 mm. *Structure*: Crown well produced with median length and greatest width subequal; coronal surface rugulose, rugulae most distinct and longitudinal on portion between ocelli and base; pronotum like that of *C. cochlear* except posterior portion more clearly rugulose–punctate; scutellum like that of *C. ballista*; face and thoracic venter with hairlike setal covering like that of *C. cochlear*; forewing with punctures between veins in basal ¼. *Coloration*: Ground color of crown, pronotum, and scutellum ochreous to reddish brown; coronal apex, frontal sutures, and carina at middle usually darker; pronotum with irregular fuscus to black dots and dashes on anterior ½, lateral margins and punctures in distal portion darkened; scutellum with anterior angles darkened, posterior angle sometimes paler; forewing hyaline except for infuscated basal ¼, base of clavus with some additional grayish-yellow pigmentation, veins ochreous to fuscus, costal vein darkest; face and thoracic venter with ground color stramineous; clypeus except laterally, antennal ledges, upper portion of genae, and lora blackened or infuscated; at times clypellus and inner edges of genae similarly darkened; portion of pronotum below lateral carina darkened, rest of sclerites on venter variably darkened; legs yellow to pale brown, femora either ringed with

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33, apex of aedeagus in anterior ventral view. 34, valve, plates, and style in ventral view. 35, apex of style in ventral view. Fig. 36–40. *Phereurhinus batillus*. 36, apex of style in ventral view. 37, valve, plates, and styles in ventral view. 38, aedeagus in ventral view. 39, aedeagus in lateral view. 40, apex of aedeagus in ventral view.

brown or not, tibial and tarsal segments darkest distally. *Male genitalia*: Aedeagus in lateral view (fig. 39) elongate with 2 pairs of processes at or near apex and 1 pair distinctly preapical; aedeagus in ventral view (fig. 38) moderately broad with rod forked near base, 1 pair of apical processes and 2 pairs of preapical processes; plates and styles in ventral view (fig. 37) with basal portions of plates oval and distal portions attenuated and narrow, styles with shanks long and wrinkled, apical hook broadly turned mesad (fig. 36).

Type: A ♂ lectotype is here selected with the labels "Peru N Rioja, Garlepp c." (light green label) and "Coll. A. Jacobi, 1913–9" (dark green label—this label added later) and "A. Jacobi, Typus" (pink label with black frame) and "Staatl. Museum für Tierkunde, Dresden". The lectotype is in the entomological collections of the Museum für Tierkunde, Dresden, D. D. R. A second ♂ with same labels from Dresden was also studied.

Notes: In addition to the features noted in the key, this species has narrow pigmented areas at the bases of the forewings. In *P. batillus* the basal ¼ is not entirely pigmented, whereas its congeners, except *P. sosanion*, have at least most of the basal ¼ pigmented. A specimen from Rurrenabaque, Beni, Bolivia agrees with the lectotype except for the apical aedeagal processes, which are somewhat differently bent and have an extra process on one side (fig. 40).

Dayoungia Kramer, new genus

Type-species: *Dayoungia magister* Kramer, new species.

Moderately large (9–10.5 mm) somewhat flattened leafhoppers; head triangularly produced apically; coronal suture normal; midline beyond coronal suture often depressed or shallowly excavated; coronal margins carinate near eyes and at apex; portions of margins near eyes somewhat elevated and flared; antennal ledges carinate but not strongly protruding; face without vestiture; pronotum at least partly transversely rugulose; forewing with appendix narrow, with 4 apical and 3 closed preapical cells, veins usually well delineated; legs normal, with spinelike setae on hind tibiae both of the normal and shortened types. *Male genitalia*: Pygofer without appendages or processes; valve narrow; plates elongate and bluntly subtriangular; styles elongate and broadened distally; connective barlike and transverse; aedeagus well sclerotized with long paired basal processes and massive sheath; sheath dorsally connected to pygofer and base of anal tube by sclerotized apodeme; gonopore apical. *Female genitalia*: Female unknown.

This genus is named for Professor D. A. Young in recognition of his outstanding contributions to the classification of the Cicadellidae.

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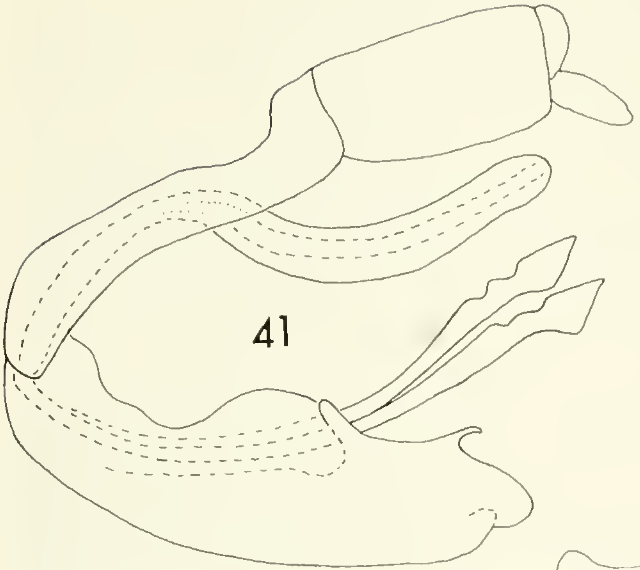
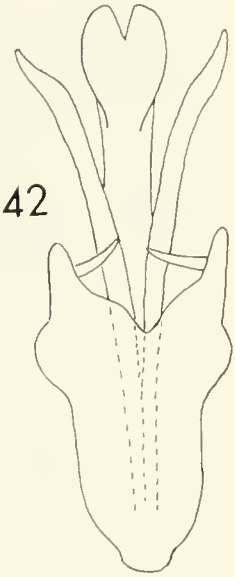
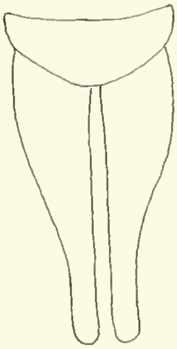
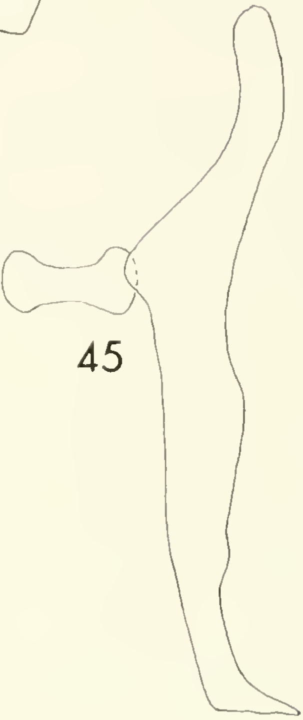
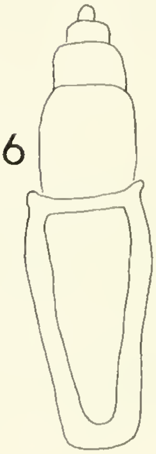
Fig. 41–45. *Dayoungia metron*. 41, aedeagus, sclerotized apodeme, and anal tube in lateral view. 42, aedeagus in ventral view. 43, head and thorax in dorsal view. 44, valve and plates in ventral view. 45, connective and style in dorsal

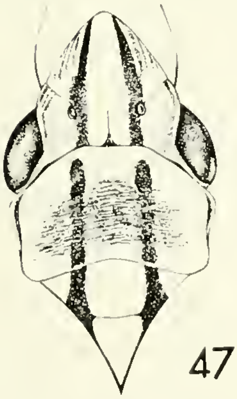


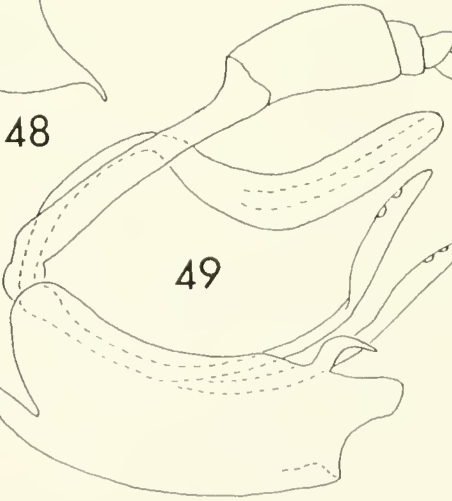


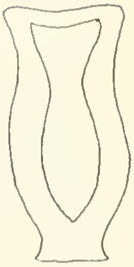












view. Fig. 46–49. *Dayoungia magister.* 46, sclerotized apodeme and anal tube in posterior view. 47, head and thorax in dorsal view. 48, apex of style in dorsal view. 49, aedeagus, sclerotized apodeme, and anal tube in lateral view. Fig. 50–51. *Dayoungia virescens.* 50, avicephaliform process in lateral view. 51, sclerotized apodeme in posterior view.

KEY TO SPECIES OF DAYOUNGIA KRAMER

1. Forewings hyaline with broad fuscus band across middle and fuscus patch at each base .... *metron*, new species
— Forewings largely opaque with only portions beyond claval apex hyaline 2
2. Forewings largely dark red or reddish fuscus; crown with median length and greatest width subequal .... *magister*, new species
— Forewings largely green or fuscus washed with green; crown with median length exceeding greatest width .... *virescens*, new species

Dayoungia metron Kramer, new species
fig. 41–45

Length of male: 9–9.5 mm. *Structure*: Like that of *D. magister* except less robust; crown narrowly and triangularly produced with median length clearly exceeding greatest width (fig. 43). *Coloration*: Like that of *D. magister* except: area between black dorsal stripes, especially on crown, partly or entirely blackened; forewing hyaline with small fuscus patch at base and larger one at middle; upper submargin of clypeus with solid or broken transverse black band, band follows contour of head. *Male genitalia*: Aedeagal complex in lateral view (fig. 41): sheath broadly oval, rounded basally, bluntly produced at middle distally; dorsal margin irregularly undulate, slender and simple process on dorsal margin near apex; aedeagal processes slender and subtriangular apically, their dorsal submargins broadly undulate; rest of complex like that of *D. magister*; aedeagal complex in posterior ventral view as in fig. 42; connective and style in dorsal view (fig. 45), connective rounded on each side, apex of style tapering to outwardly directed sharp tip; valve and plates in ventral view as in fig. 44.

Types: Holotype ♂ (USNM 73371), Chapada, [Brazil], March, Collection C. F. Baker. Paratype ♂♂, 1 same as type except "November"; 1 same as type but without month.

Notes: *Dayoungia metron* is easily separated from its congeners by the distinctive coloration of the forewings. In general body form, it is less robust than other members of the genus.

Dayoungia magister Kramer, new species
fig. 46–49

Length of male: 10–10.5 mm. *Structure*: Crown broadly and triangularly produced with median length and greatest width subequal (fig. 47); apical carina of crown extending basad on each side to point short of frontal sutures; laterad of carina on each side some clypeal arcs clearly visible as part of dorsal surface; midline beyond coronal suture usually slightly depressed; portion of crown between ocellus and eye at times similarly depressed; surface of crown weakly rugulose and somewhat granular; pronotum declivent laterally; anterior portion of pronotum with vague, irregular, shallow depressions and surface similar to crown; posterior portion of pronotum transversely rugulose; scutellum with anterior angles finely scaly, rest granular. *Coloration*: Ground color of crown, pronotum, and scutellum yellow to ochreous; with pair of black, irregular and at times broken longitudinal stripes, 1 stripe of pair on each side of midline and transversing crown, pronotum, and scutellum; pronotum with lateral submargins blackened; forewing dark red or reddish fuscus except for hyaline portion beyond claval apex; face yellowish with clypellus, basal ½ of clypeus, and often lora, basal portion of genae, and antennal bases blackened; thoracic sclerites with same ground color, and variably blackened; legs ochreous with or without variable darkened areas. *Male genitalia*: Aedeagal complex in lateral view (fig. 49): sheath subquadrate, ventral margin at base narrowly produced, dorsal margin at apex quadrately produced, avicephaliform process on dorsal margin near apex; aedeagus simple, tubelike, and basally attenuated; aedeagal processes slender and expanded distally, their dorsal margins irregular; sclerotized apodeme joined distally to base of anal tube; apodeme in posterior view (fig. 46) subquadrate and narrowest at base; apex of style in broad ventral view (fig. 48) with outer edge produced as slender, bent extension; rest of structures like those of *D. metron.*

Types: Holotype ♂, Puerto Bember, Misiones, Argentina, March 1945, Golbach, Willink, Hayward in collection of the Miguel Lillo Foundation, Tucuman, Argentina. Paratypes, 15 ♂♂, Independencia, Paraguay, 10 October 1951, from Bavarian State Zoological Collections, Munich, Federal Republic of Germany.

Notes: The features noted in the key readily distinguish this species.

Dayoungia virescens Kramer, new species
fig. 50–51

Length of male: 9.5 mm. *Structure*: Like that of *D. magister* except crown broadly and triangularly produced with median length clearly exceeding greatest width. *Coloration*: Like that of *D. magister* except: ground color of crown, pronotum, and scutellum brighter yellow to greenish yellow; forewing green or fuscus washed with green, except for hyaline portion beyond claval apex. *Male genitalia*: Like that of *D. magister* except: avicephaliform process of sheath (fig. 50) stouter and blunter; apodeme in posterior view (fig. 51) indented at base and near apex.

Type: Holotype ♂ (USNM 73372), Rio de Janeiro, Corcovado, D. F., Brazil, November 1958, Seabra and Alvarenga.

Notes: *Dayoungia virescens* is exceedingly close to *D. magister* and may prove to be no more than a subspecies of it. However, it is easily separated from *D. magister* by both color and head shape.

For the generous loan of types vital to this study, I wish to express special thanks to Dr. R. Hertel of the Museum für Tierkunde, Dresden, D. D. R.

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BIOLOGICAL STUDIES OF PLAGIOMERUS DIASPIDIS CRAWFORD, A PRIMARY INTERNAL PARASITE OF DIASPIDID SCALE INSECTS (HYMENOPTERA: ENCYRTIDAE: HOMOPTERA: DIASPIDIDAE)

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ABSTRACT—Studies of *Plagiomerus diaspidis* Crawford indicate that it is a solitary internal parasite of *Diaspis echinocacti* (Bouché). When tested against third instar scales of six other species of diaspidid scale insects, the parasite was host specific and also exhibited ovipositional site preference, ovipositing in the prosoma and depositing eggs on the ventral surface of the scale body. Although thelytokous, males were produced by subjecting immature females to high temperatures (29.5°C or above). Male courtship is described, but copulation was not observed. As the male has an unusual habitus and the systematic placement of *Plagiomerus* is questionable, the male is described in detail. The taxonomic and biological relationships of the three described species of *Plagiomerus* are discussed.

The genus *Plagiomerus* Crawford consists of three described species: *P. diaspidis* Crawford, *P. cyaneus* (Ashmead) and *P. hospes* Timberlake. The latter species was described from material collected on Oahu, Hawaii, but Timberlake (1920) writes that the species was probably an immigrant from North America. Ferriere (1953) records *P. diaspidis* in Italy (on *D. calypteroides* Costa = *D. echinocacti*) and Trjapitzin (1968) reports that *Plagiomerus* sp. was accidentally introduced into the Soviet Union at Baku with its host *D. echinocacti*. Trjapitzin (1968) was unable to determine the identity of *Plagiomerus* sp. because of the brevity of the original descriptions and a lack of comparative material. There are also six female specimens in the USNM of an undescribed species of *Plagiomerus* taken on Taiwan from *Aulacaspis murryae* Takahashi.

The systematic placement of *Plagiomerus* is unsettled. Hoffer (1955) places it in the Cercobelini with *Cercobelus* Walker. According to Hoffer (1960) *Cercobelus* is characterized by a four-segmented funicle in both sexes, and the hosts are *Psyllopsis* spp.; *Plagiomerus* males have a two-segmented funicle and a banana-shaped clavus; females parasitize armored scale insects. Compere and Annecke (1961) note that the genera *Anabrolepis* Timberlake, *Habrolepis* Förster and *Adelencyrtus* Ashmead are related based on

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mandible dentition and presence of lamelliform setae on the apex of the female scutellum. Trjapitzin (1973) places *Plagiomerus* in the Habrolepidini, subtribe Habrolepidini, including the genera mentioned by Compere and Annecke, *Homalopoda* Howard, *Pseudhomalopoda* Girault, *Parahomalopoda* Girault and *Adelencyrtoides* Tachikawa and Valentine.

MATERIALS AND METHODS

Plagiomerus diaspidis was detected as a contaminant of an *Aphytis* nr. *linguanensis* Compere culture maintained on *D. echinocacti* in the University of California, Riverside, insectary. After isolation, *P. diaspidis* was reared in a one-hole sleeve cage on cactus pads (*Opuntia* spp.) infested with 3rd instar *D. echinocacti*. Pads were added to the culture weekly, and pads in the culture more than 1 month were discarded.

Material used in behavior studies was obtained by removing pads from the culture, examining the scales under a dissecting microscope and isolating parasitized scales in ¼ dram vials with a drop of honey added as nutrition. Daily observations were made for adult parasite emergence, and the age of each female parasite was recorded. Morphological studies on immature parasites were performed in several ways. Parasitized scales from the culture were removed from the pads, immersed in 30% ETOH for several hours and the scale bodies teased apart with forceps and dissecting needles. Next the material was mounted in glycerine or stained with acid fuchsin and mounted in Hoyer's medium. Permanent mounts were made by killing in 30% ETOH, running the specimen up through alcohol to 100% ETOH, through clove oil and mounting in Canada balsam.

Ovarian eggs were removed from 4 day old female parasites that had been continually deprived of hosts. Eggs were observed by killing the female parasite in 30% ETOH, holding the body with a pair of forceps and grasping the base of the ovipositor with another pair of forceps and tugging gently. In so doing the reproductive system was often removed intact. Next the ovaries were placed in acid fuchsin for several minutes, washed in distilled water and then slide mounted in glycerine.

Voucher specimens of the material studied have been deposited in the following institutions: Plant Protection Research Institute, Pretoria, South Africa; British Museum (Natural History); U. S. National Museum; Zoological Institute, Soviet Academy of Science, Leningrad; and the Canadian National Collection, Ottawa.

In the following discussion the term "scale" is intended to mean the scale cover and the scale insect body together.

RESULTS

Female search and oviposition behavior:

Female parasites lived up to 35 days. Three to five day old nulliparous parasites were released on cactus pads infested with *D. echinocacti* in all stages of development and observed under a dissecting microscope. Search of a seemingly non-systematic or random nature, characterized by antennal drumming of the substrate, proceeded immediately. Mature female scales, both gravid and ovipositing, were most attractive to the searching parasites; crawlers, white caps, and second instars were generally ignored. Second instar female and male scales seemed attractive to older *Plagiomerus* females that had been deprived of hosts for more than ten days after emergence, but after extensive examination with the antennae they were not attacked. Antennal drumming on the scale covers found to be attractive ranged from less than ten seconds to several minutes (n = 32 observations). Females that had been allowed contact with hosts since emergence would often spontaneously abandon antennal drumming and move to another scale or begin grooming activity. Upon again coming in contact with the scale cover a second time, most females were observed to have little interest in it.

If the scale cover was found suitable for attack, the female moved off the scale, assumed a position perpendicular to a tangent to the cover margin, lowered her body and inserted the ovipositor shaft into the scale by a backward movement of the body (fig. 1). One to several insertions of the ovipositor into the scale body preceded oviposition. Sometimes the scale was abandoned after insertion of the ovipositor but before an egg was deposited. Females deprived of hosts for five to eight days after emergence oviposited in up to ten scales in rapid succession. Unoccupied scale covers were found to be more attractive to searching females than exposed mature scale bodies. A nulliparous female was observed to insert her ovipositor through an unoccupied cover, but eggs were not deposited.

Host feeding was noted in a few instances but was not an apparent prerequisite for oviposition. Feeding consisted of the female thrusting her ovipositor through the scale cover and into the scale body several times then backing up to feed on the exudate welling up at the point of ovipositor penetration.

Oviposition site preference and egg dispersion:

To determine female oviposition site preference several females were allowed to parasitize scales and egg position was tabulated. (Eggs were noted by the conspicuous stalk projecting through the host's integument—see below). Figure 2 indicates the position of 98 eggs with respect to four quadrants of the scale body. There was no significant difference between the number of eggs laid in quadrants one and four or two and three, suggesting that there was no bilateral oviposition site preference. There was a highly significant difference between the number of eggs laid in quadrants one plus four (69 eggs) and two plus three (29 eggs) ($\chi^2 = 8.16$, $p < 0.005\%$), indicating that females oviposited more frequently in the prosoma than in the pygidium.

Eggs were also scored with respect to the vertical, counted as

Fig. 1. Female *Plagiomerus diaspidis* ovipositing into *D. echinocacti.*

upper surface, midline and lower surface. Thus nine eggs were laid on the upper surface of the scale body, 21 eggs were laid on the midline and 68 eggs were deposited on the ventral surface of the scale body. All eggs were deposited near the lateral margin of the scale body. Combining the eggs scored as midline or above, a highly significant difference was noted between the number of eggs deposited above and below the midline ($\chi^2 = 13.97$, $p < 0.005\%$), suggesting that the female preferred to oviposit on the ventral surface of adult female scales.

Informal observations of the stock culture showed that only a single parasite emerged from each parasitized host. Several scales from the stock culture were dissected from the cactus pads during the period when new material was added when the parasite population was exceptionally high and numerous females were actively ovipositing. (Because population structure was such that distinct peaks were noted and adult emergence was largely synchronous, it was believed that these conditions approximated a highly competitive situation in nature.) A random sample of the scales removed and examined revealed that 38 scales had one parasite egg, 22 scales had two parasite eggs, 2 scales had three parasite eggs and 1 scale had four parasite eggs. The pads were then returned to the culture (because the scale population on the pad was high and many scales were still not parasitized). Examination of the host population from the same ovipositional episode a week later revealed numerous instances of more than one parasite larva in individual scales. However, in nearly two years of observation we did not notice more

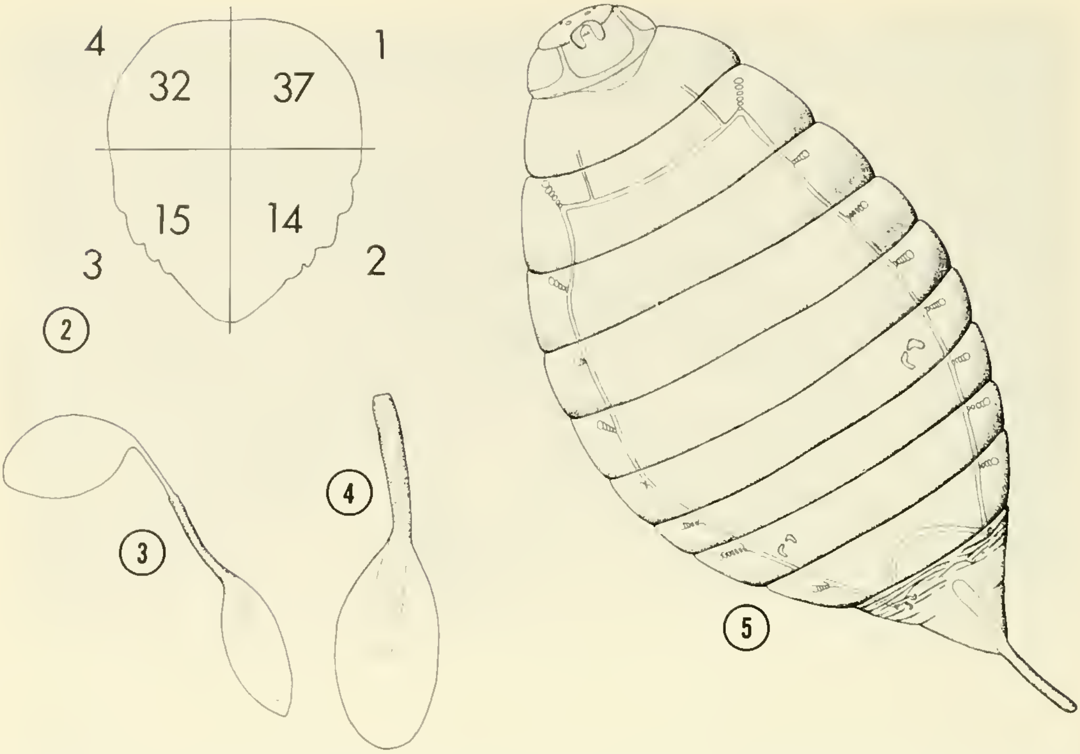

Fig. 2. Schematic diagram illustrating number of parasite eggs deposited in each quadrant of host body. (Quadrants indicated outside the body margin, number of eggs deposited inside body quadrant.) Fig. 3–5. *Plagiomerus diaspidis.* 3, ovarian egg. 4, deposited egg. 5, mature larva.

than one pupa develop or adult parasite emerge from an individual scale insect. Presumably larval combat occurs.

Immature development and stages:

The ovarian egg of *P. diaspidis* is encyrtiform (fig. 3). After deposition the bulb collapses at the stalk apex (fig. 4). The stalk of the deposited egg projects through the host integument and serves as an anchor for the egg body. The stalk is uniform in diameter and approximately half as long as the egg body. Eggs are the banded type with the aeroscopic plate reticulation pattern completely surrounding the stalk and forming a peninsula approximately halfway down the egg body (fig. 3, 4). The reticulation pattern is uniform, and the remainder of the chorion is smooth. Respiration is thought to occur through the stalk reticulation pattern.

The exact duration of egg incubation after oviposition was not determined but required one to three days at the temperatures indicated.

Larval development required seven to nine days at 26.7° ± 1.5°C. The mature larva (fig. 5) is 13 segmented, lacks setae and is attached to the host cuticle via the stalk. The anterior-most body segment of the larva bears two pairs of sensilla. Cast exuviae of earlier instars accumulate around the base of the stalk and as determined by the

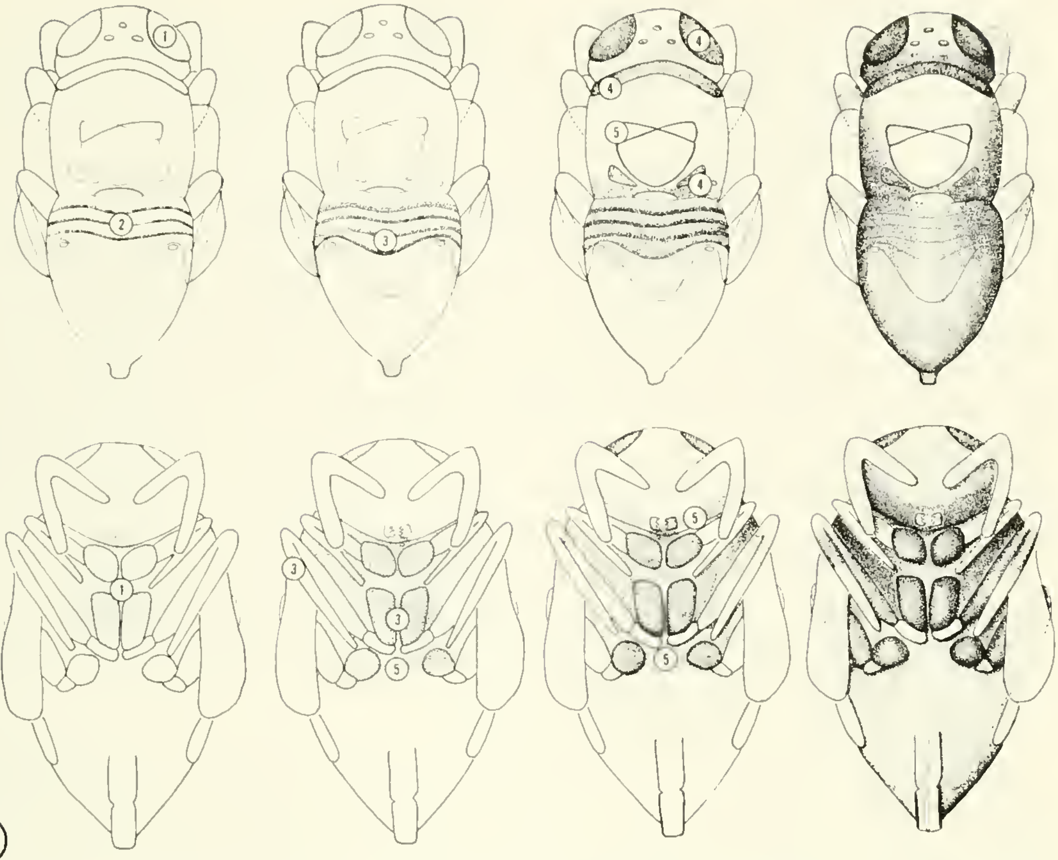

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Fig. 6. Schematic diagram illustrating the sequential pattern of pupal pigmentation of *Plagiomerus diaspidis.*

number of mandibular exuvia *P. diaspidis* apparently has four feeding instars. The tracheole network is an open system with the spiracle aperture and tracheole diameter uniform throughout the system. The mature larva has nine pairs of spiracles on segments 4–12 and a parallel longitudinal tracheole system which connects transversely in segments four and twelve. Spiracles connect to the tracheoles via loosely spiraled taenidia.

The host's body contents are completely consumed by the parasite larva and only the transparent, parchmentlike host integument remains.

Initially, the prepupa becomes dorsoventrally flattened and transformed into a form with seven pairs of lateral lobes. The body color changes from pale white to light yellow, and meconial pellets are deposited on both sides about halfway between the anterior and posterior ends of the body.

The pupal stage lasts five to seven days. After assuming the pupal shape the body is translucent peripherally and white centrally. The sequential deposition of pigmentation is stereotyped and complicated (fig. 6, numbers indicate the order in which parts become pigmented).

Pigmentation begins with the compound eyes turning faintly pink and the mesopleuron and coxae turning dusky. Next, the posterior margins of terga one thru three become dusky. Shortly afterwards, the banding pattern appears on the middle and hind tibiae and the pleuron and coxae darken. Concomitantly, the posterior margin of tergum four darkens and the entire surface area of terga one thru three darkened (although the posterior margins remain noticeably darker). Later the compound eyes and ocelli turn red, and the pronotum and lateral margins of the propodeum become dusky. Next, there seems to be a general darkening of the body parts indicated above, but the head, dorsal region of the thorax and body appendages remain translucent or opaque. After considerable darkening of the parts mentioned above, the metanotum and thoracic notal sutures become dark. As the first and second sterna become dusky so do the gena and apical terga. Later the remaining sterna become uniformly dusky and the remainder of the thoracic notum (scutum and scutellum) darken. The antennae become dark shortly before emergence.

Adult emergence and host preference:

Adults emerged by chewing their way through the host's integument and the scale cover. Newly emerged female parasites were quiescent for two or three days or at least ovipositional activity was not observed during that period.

Studies were conducted with adult parasites to determine the host specificity of *P. diaspidis*. Individual five day old female parasites were placed in one pint mason jars with lemons or potatoes infested with third instar scales of the following species: latania scale (*Hemiberlesia lataniae* (Signoret)), California red scale (*Aonidiella aurantii* (Maskell)), purple scale (*Lepidosaphes beckii* (Newman)), yellow scale (*Aonidiella citrina* (Coquillett)), dictyospermum scale (*Chrysomphalus dictyospermi* (Morgan)) and oleander scale (*Aspidiotus nerii* Bouché), in addition to *D. echinocacti*. Ten replicates of each group were used and each experimental cell was maintained at 26.7° ± 1.5°C and 50 ± 10% RH for ten days, then the females were removed. Cells were then maintained at the temperature and relative humidity indicated for an additional 15 days, and then the cells were examined for parasite development, activity or emergence. Parasite progeny emerged only from cactus scale. Examination of the scales did not reveal sting marks or indication of parasite-induced moribund scales other than for *D. echinocacti*. When host-deprived female parasites were offered the above mentioned scale species and then observed under a dissecting microscope, the parasites drummed the scales but oviposition or drilling was not observed in any scale species except *D. echinocacti*.

Production of males, courtship behavior and descriptive notes:

Field recoveries of *P. diaspidis* from *Opuntia* sp. infested with *D. echinocacti* at Irvine, California by Walter White revealed that encyrtid males were associated with *P. diaspidis* females. Two collections made by White during August showed males were present in low numbers (less than five males per several hundred females). However, in collections made at the same locality during other times of the year males of what was provisionally thought to be *P. diaspidis* were not recovered. As we knew that males of other thelytokous species of parasitic Hymenoptera produced males when subjected to high temperatures, the following experiment was conducted. Females were allowed to oviposit at 26.7°C and immatures were incubated at 32°C for the entire duration of development. In addition a control group was used in which eggs were deposited, hatched and immatures developed at 26.7°C.

All adults of both groups were female. These females were allowed to oviposit in cactus scale, and their F_1 progeny developed at 80°F. All F_1 progeny of the heat-treated parental generation were males; all progeny of the parental generation subjected to 26.7°C were females.

Studies to establish the exact temperature at which the sex shift occurred suggested that 29.5°C was apparently the critical temperature, but because of temperature fluctuations (± 1.5°C) this is only an approximation.

To determine the duration of exposure responsible for the temperature-induced shift, eggs were deposited by females at 26.7°C and then incubated at 32°C. Pads were removed from the high temperature cabinet during the early and late larval stages, prepupa and pupal stages. Only parasites subjected to high temperature during their entire development produced male progeny. Further studies indicated that the temperature-sensitive period was restricted to the pupal stage and that this is the period during which ovarian development occurs.

To determine male functionality, pairs of males and females were placed in quarter dram vials and observed with a dissecting microscope. Courtship behavior of the males resembled that of another encyrtid (*Comperiella bifasciata* Howard), but copulation was not observed. Males approached quiescent females and when one came within 8–15 mm of a female he began to sway from side-to-side while still approaching her. When the male's head was approximately two to three mm from the female's gaster, he would stop, begin to vibrate his antennae slowly, and attempt to touch the female's wings (folded over her gaster), or possibly the gaster itself, near the pygostyle with his antennal clubs. Female response to this behavior was either to remain quiescent or move quickly. If the female moved, the male attempted to chase the female for a distance of six to eight cm but was eventually evaded. If the female remained quiescent while the male attempted to antennate the female's gaster or wings, after several seconds of this behavior the male would slowly move into a face-to-face position with the female. Male movement to a face-to-face position was such that his body was oriented with his head nearest the female and as he moved laterally the longitudinal axis of his body approximated a perpendicular to a line tangent to the closest point to her body. Concomitantly the antennae of the male still vibrated and there was some side-to-side swaying. When the male assumed a face-to-face position the female invariably moved away quickly. The above observations were made for males and females of ages ranging from newly emerged to senescent. In no instance was copulation observed, but this is not to infer males were non-functional. Rather, it suggests that the conditions for copulation were not appropriate.

The male resembles the female in habitus, but differs by having a five-segemented antenna (1, 1, 2, 1) (fig. 7) with scape slightly dilated ventrally, funicular segments nearly anelliform and a banana-shaped club longer than all other segments combined. The apex of the scutellum bears two long, non-lamelliform setae. The pygostyli are situated just anterior to an imaginary transverse line bisecting the gaster, and all sterna are mesally setose. The mandible is four toothed (fig. 11); maxillary-palpus four segmented (fig. 9), labial-palpus three segmented (fig. 10), and the genitalia are as shown (fig. 8).

Discussion

Taxonomically, *Plagiomerus* is puzzling. Crawford (1910) designated *P. diaspidis* type-species from material collected in New Mexico (host, *D. echinocacti*). Subsequently, Girault (1915) indicated that Ashmead's (1888) *Comys cyanea* from Florida was in fact a *Plagiomerus* (as determined by P. H. Timberlake). Later Timberlake (1920) described a third species, *P. hospes*, from material taken on Oahu, Hawaii. Material in the USNM indicates that *P. diaspidis* has been recovered in Maryland (on *H. lataniae*), Texas (on *D. echinocacti*), Washington, D.C. (on *D. echinocacti*), Florida ("Scale on cactus", *D. echinocacti*), Virginia (on *Chionaspis americana* Johnson), México (*D. echinocacti*) and Colombia (on *Clovastis* sp.). *P. cyaneus* has been recovered from México, (Morelos—on *H. diffinis* (Newstead); Matamoros and Cuernavaca—hosts unknown) and Trinidad (on *Ceroplastes cirripediformis* Comstock). *Plagiomerus hospes* has been recovered on Bermuda ("Scale on Melia") and Trinidad (on *D. bromiliae* (Kerner)). Timberlake (1920) reported that *P.*

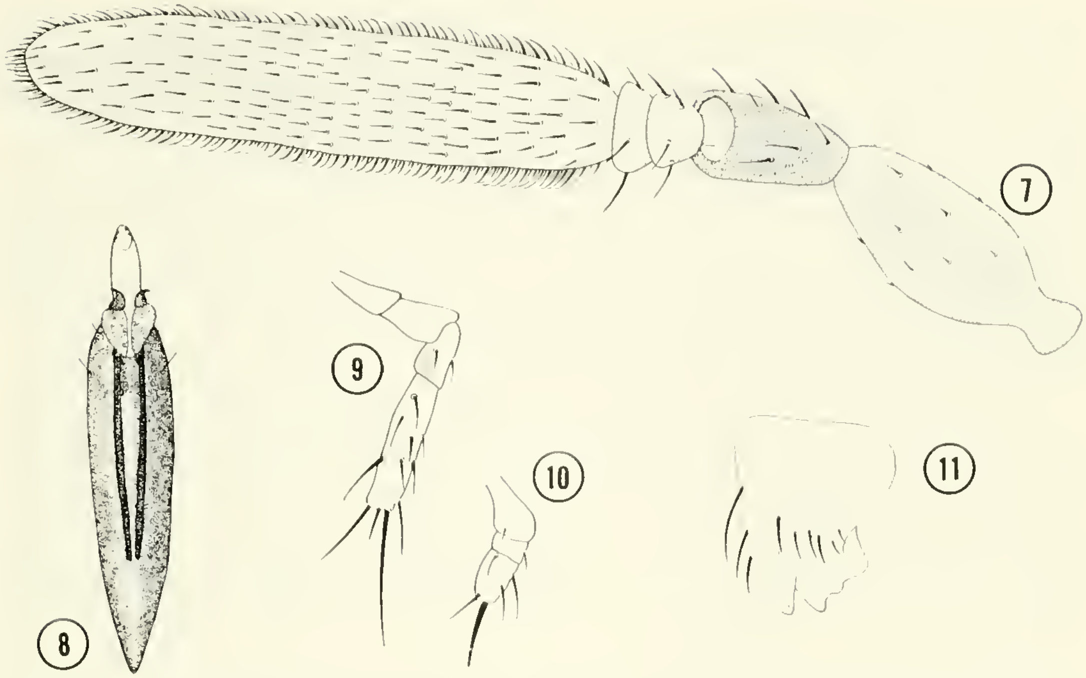

Fig. 7–11. *Plagiomerus diaspidis*. 7, male antenna. 8, male genitalia. 9, maxillary palpus. 10, labial palpus. 11, male right mandible, inner aspect.

hospes was probably thelytokous. Males of *P. cyaneus* are unknown, but several males identified as *P. diaspidis* were reared from *H. lataniae* by H. S. McConnell during 1928.

The characters used to separate the three species are variable. *Plagiomerus hospes* is distinguished from the others on the basis of the narrow lamelliform setae on the apex of the scutellum and the relatively short black band at the base of the middle tibia. Girault (1915) reports that *P. cyaneus* can be distinguished from *P. diaspidis* on the basis of the former species having funicular segments three and four white and the mesoscutum more hairy. Ashmead (1888) describes *P. cyaneus* on the basis of a unique female whose host is unknown. Dozier (1926) redescribed *P. cyaneus* from material he reared on Puerto Rico.

Study by one of us (GG) of the material in the USNM and additional material reared from *D. echinocacti* collected in California suggests that there can be variation in the characters used by others to separate *P. cyaneus* from *P. diaspidis*, namely the number of mesoscutal setae and antennal coloration. There also seems to be some variation in the width of the apical scutellar setae. However, because males of *P. cyaneus* are not known and the males of *P. diaspidis* produced did not mate, it is difficult to determine the reproductive status of the species involved. It seems undesirable to synonymize *P. cyaneus* and *P. diaspidis* at this time, although such a decision may be justified when the species are better known. Perhaps an appreciation for species limits may be obtained by critical examination of immature stages, development and female behavior.

In a comprehensive analysis of encyrtid egg and larva morphology, Maple (1947) reported that encyrtid eggs were of three types: banded, unbanded and intermediate. In Maple's classification *P. diaspidis* eggs are banded. Maple also noted that size, shape, composition and extent of banding varies among species but is consistent within a species. His observations are consistent with the findings for the population of *P. diaspidis* studied.

Encyrtid larvae are classified as having closed or open tracheal systems. Closed systems form a loop within the body, and the open systems bear two or four caudal spiracles. Larvae that hatch from unbanded and intermediate egg types are apneustic; larvae that hatch from banded eggs are metapneustic. According to Maple (1947) metapneustic larvae remain attached to egg shells "so that the spiracles are in position to gain contact with the air-bearing structures of the egg proper."

Plagiomerus diaspidis remains attached to the egg shell throughout larval development, and mature larvae have nine pairs of spiracles. It is not known whether all pairs of spiracles are functional, but this seems questionable because of the taenidia which connect the spiracle to the tracheole are loosely coiled. Maple also notes that encyrtid larvae have cephalic branches at the point of union with the main trunk and two were noted in *P. diaspidis.*

The genetic mechanism responsible for the sequential deposition of pigmentation and its significance have not been studied in the parasitic Hymenoptera. However, informal studies by one of us (GG) have revealed that the pattern is constant in several species. Unknown is whether this constancy is a species or population phenomenon. The pattern is constant in *P. diaspidis* from California although genetic contact between individuals of the same generation of a population is restricted because *P. diaspidis* is thelytokous. The observed uniformity in the sequential pattern may suggest a functional necessity or a position effect may be influencing the pattern. Critical comparative study of pupal pigmentation in *Plagiomerus* may provide insight into the problems of delimiting species.

It is interesting to note that *P. diaspidis* was reared from *H. lataniae* in Maryland and *C. americana* in Virginia. It was not possible to obtain progeny from any scale species except *D. echinocacti* in the present study. This suggests perhaps that populations of *P. diaspidis* have adopted different host exploitation strategies in different areas.

Preferring to oviposit in the prosoma may indicate that nourishment is more easily obtained there because the third instar female has her prosoma filled with eggs. Feeding would conceivably be more difficult in the pygidial area. Preference for a ventral egg deposition site may afford more protection for the stalk and aeroscopic plate. Undetermined as yet, however, are the modalities used to perceive front from rear and top from bottom of the scale body.

Production of males is noteworthy. Studies with other members of the Encyrtidae (Wilson, 1962; Wilson and Woolcock, 1960; Flanders, 1945), Signiphoridae (Quezada *et al.* 1973) and Trichogrammatidae (Bowen and Stern, 1966) have also shown that male chalcidoids can be produced with high temperatures. We hypothesize that the genetic manipulation of sex determination by high temperatures is not a laboratory artifact and that it is probably widespread in the parasitic Hymenoptera and that it has some adaptive advantage in that the otherwise thelytokous population produces males for genetic recombination during environmentally adverse periods. In so doing, a population may maximize its genetic fitness while not overtaxing a limited resource (superfluous males feeding on hosts).

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ETHOLOGY OF EFFERIA BENEDICTI (DIPTERA: ASILIDAE) IN WYOMING[1,2]

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ABSTRACT—The eastern limits for the distribution of *Efferia benedicti* (Bromley) are extended to include the western third of Wyoming. This species captures its prey in the air and manipulates it with all six tarsi while hovering above the feeding site. The preferred prey belong to the orders Diptera, Homoptera, Orthoptera and Hymenoptera; but prey selection differed between sexes. No courtship occurs in this species and males take a simple male over female mating position which is maintained for approximately 104 seconds.

Efferia benedicti (Bromley), a late spring species, was described in 1940 from specimens collected in Arizona. Wilcox (1966) reported that "The range is then from the western slopes of the Rocky Mountains to the eastern slopes of the Sierra and the Cascade Mountains, and southern California extending as far north as Fresno County in the San Joaquin Valley." This species was subsequently collected by Horning and Barr (1970) in the Craters of the Moon National Monument, one specimen being captured while feeding on the membracid, *Tortistillus wickhami* Van Duzee.

In Wyoming, populations of *E. benedicti* have been located in two open rangeland sites in the western third of the state, i.e. Shoshoni (4820′) and Greybull (3788′). Morphologically, it closely resembles *Efferia pallidula* (Hine) which occupies a similar rangeland habitat in Eastern Wyoming. *Efferia benedicti* has been collected from June 12 through July 18; *pallidula* appears later, having been collected from July 1 through September 8. It is probable that the ancestral stock of *pallidula* and *benedicti* became separated and that speciation occurred when the Rocky Mountains were formed. Subsequently, *benedicti* has been able to cross the Rocky Mountains and establish itself on the eastern slopes.

On the rangelands where *benedicti* occur, the dominant vegetation is *Artemisia tridentata* Nutt., *Bouteloua gracilis* (H. B. K.) Lag. and *Opuntia polyacantha* Haw. An additional population of *benedicti* was locally abundant in an *Atriplex confertifolia* (Torr. and Frem.)

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Wats., *Bromus* sp. and *Sarcobatus vermiculatus* (Hook.) Torr. community, northwest of Bruneau, Idaho in mid-June.

Like other species of robber flies, such as *Efferia helenae* (Bromley) (Lavigne and Holland, 1969), which tend to initiate attacks from the soil, this species responds to the changes in soil surface temperatures. Thus, when the surface temperature is below 37°C the asilids land broadside to the sun. Between that temperature and 45°C, they land facing the sun, but with bodies held off the soil. When the surface temperatures exceed 48°C, all tend to land on vegetation. Almost all foraging during the mid-part of sunny days is initiated from dead roots or live sagebrush plants.

All prey captures take place in the air. Attacks are initiated towards most potential prey flying within ½ meter, but when the insect was large, prey strikes as long as 1½ meters have been observed. Before the attack is initiated, the whole body is turned to face the organism. Once collected, the prey is impaled during a short hover just before the asilid lands. The usual point of insertion of the predator's proboscis is dorsally or dorsolaterally in the thorax, although occasionally, as in the case of tiny wasps, the tip of the abdomen is utilized first (fig. 1). When the prey is almost as large as the predator, as in the case with the asilid, *Heteropogon wilcoxi* James, the pair will fall to earth grappling as the predator attempts to impale the prey. In one instance, a male *benedicti* picked off a tiny hymenopteran, but was unable to penetrate its armour and dropped it after hovering twice and manipulating it several times.

As is the case with *Efferia staminea* (Williston) (Lavigne and Holland, 1969), foraging efficiency appears to be very poor. It is not unusual to observe one of these predators making 15 unsuccessful attack flights in a row. In one instance, a male *benedicti* made over 40 unsuccessful attack flights between 12 noon and 12:40, a time of day when its high body heat presumably would permit the greatest activity and mobility.

Prey may be manipulated several times while feeding takes place. The asilid will rise above the feeding site, approximately four to five centimeters and manipulate the prey using all of its six tarsi. This behavior has been observed in all five species of *Efferia* studied. During feeding, small prey may be observed periodically ballooning and collapsing on the predator's proboscis as described for *staminea*, *pallidula* and *helenae* (Lavigne and Holland, 1969), in response to the pumping in of the salivary fluids and the subsequent sucking up of the digested internal prey contents.

Upon completion of feeding, the predator may push the prey off its proboscis with its fore tarsi, may leave the feeding site and hover briefly, dropping the prey, or may push the prey off the proboscis in flight as it launches an attack on a new potential prey. Out of

Fig. 1. *Efferia benedicti* female with *Mallophorina guildiana* (Diptera: Asilidae) as prey.

61 cases where the culmination of feeding was observed, 61% of the prey were discarded on site, 34% were dropped as the asilid made a forage flight and 5% were discarded while the predator was hovering above the feeding site.

All prey records were collected 10 miles south of Shoshoni, Wyoming unless otherwise noted. The sex of the predator is indicated in parentheses following the prey record.

Prey taken by *Efferia benedicti*: COLEOPTERA Chrysomelidae: *Chaetocnema cribrifrons* LeConte, VI-21-71 (♀); *Chaetocnema* sp., nr. *denticulata* (Illiger), VI-24-71 (♂); *Phyllotreta* sp. (♂). Melyridae: unidentified (♂ ♀). Nitidulidae: *Carpophilus pallipennis* (Say), VII-17-69 (2 records, ♂ ♀), VI-22-71 (♂), VI-23-71 (♂). Scarabaeidae: *Aphodius vittatus* Say, VII-14-64 (♀), VI-16-72 (♂). Staphylinidae: unidentified (♀). DIPTERA Agromyzidae: *Phytomyza* sp. (♀). Anthomyiidae: *Hylemya cinerella* (Fallen), VI-21-71 (♂), VI-22-71 (♂), VI-23-71 (♂, 3 records), *H. neomexicana* Malloch, VI-28-71 (♂), *H. platura* (Meigen), VI-23-71 (♂), *Hylemya* sp. (♂, 2 records). Asilidae: *Asilus mesae* (Tucker), VI-22-71 (♀), VI-23-71 (♀), VI-24-71 (♂ ♀, 2 records), VI-16-72 (♂), VI-21-74 (♂); *Efferia benedicti* (Bromley), VII-10-69 (♀), VII-17-69 (♀), VI-23-71 (♀, 2 records), VI-21-74 (♂); *E. costalis* (Williston), VI-23-71 (♀), VI-24-71 (♂, 3 records); *Heteropogon wilcoxi* James, VII-2-65, VII-16-69 (♂), VII-17-69 (♂, 2 records), VI-22-71 (♂, 4 records), VI-23-71 (♂, 3 records), VI-24-71 (6 records, 5♂, 1♀), VI-25-71 (9 records, 7♂, 2♀), VI-21-74 (♂); *Mallophorina guildiana* Williston, VII-17-69 (♀). Bombyliidae: *Aphoebantus* sp., nr. *marginatus* Cole, (3 records, 1♂, 2♀); *Geron* sp. (♂); *Mythicomyia* sp. (♂), *Phthiria* sp. (♂); *Villa* (*Chrysanthrax*) sp. (♂); *Villa* (*Paravilla*) sp. (♂). Calliphoridae: *Phormia regina* (Meigen), VI-21-74 (♀). Cecidomyiidae: *Anarete* sp. (3 records, ♂, 2♀); *Lestremia* sp. (♂). Chironomidae: unidentified (♂). Chloropidae: *Oscinella* sp. (♀). Culicidae: *Aedes idahoensis* (Theobald), VI-22-71 (♀), Aedes sp. (♂). Dolichopodidae: *Medetera veles* Loew, VII-10-69 (♂), VII-16-69 (♂), VII-17-69 (♀, 2 records), *Medetera* sp. (♂). Milichiidae: *Leptometopa halteralis* (Coquillett), VII-9-69 (♀). Pipunculidae: *Tomosvaryella coquilletti* (Kertesz), VII-17-69, *T. lepidipes* Hardy, VII-11-69 (♀); *T. similis* (Hough), VII-9-69 (♀). Sarcophagidae: *Blaesoxipha* sp., prob. *reperta* (Reinhard) (2 records, ♂ ♀); *Ravinia planifrons* (Aldrich), VII-9-69 (♂); *R. querula* (Walker), VII-18-69 (♂); *Senotainia trilineata* (Wulp), VI-6-72 (♂). Scenopinidae: *Brevitrichia* sp. (♀), *Scenopinus cochise* Kelsey, VII-16-69 (♀), *Scenopinus* sp. (7 records, 3♂, 4♀). Sepsidae: *Sepsis neocynipsea* Melander and Spuler, VI-24-71 (♀). Sphaeroceridae: *Leptocera* sp. (♂). Syrphidae: *Volucella* (*Copestylum*) *caudata* (Curran), VII-17-69 (♀). Tachinidae: *Euthersia* sp. (♂); *Paradidyma* sp. (♂); *Spathidexia reinhardi* Arnaud, VII-17-69 (♂). Trixoscelididae: *Trixoscelis flavens* Melander, Gas Hills Rd., Riverton, VI-17-62. HEMIPTERA Alydidae: *Alydus* sp. (♂); *Stachyocnemus apicalis* (Dallas), VII-11-69 (♂). Coreidae: *Chelinidea vittiger* Uhler, VII-9-69 (♀, 2 records), VII-17-69 (2 records, ♂ ♀). Miridae: unidentified (♀). Reduviidae: unidentified. HOMOPTERA Aphididae: *Pemphigus* sp. (winged reproductive) (♂). Cicadellidae: *Athysanella magdalena* Baker, VII-14-64 (♀, 2 records); *Athysanella* sp. (♂); *Ballana* sp. (♀); *Commellus sexvittatus* (Van Duzee), VI-23-71 (♂); *Empoasca aspersa* complex (♀, 5 records); *E. decora* DeLong and Davidson, VI-22-71 (♂, 2 records), VI-24-71 (♀); *E. neaspersa* Oman and Wheeler, VII-9-10-69 (5 records, ♂, 4♀); *E. nigra*, var. *typhlocyboides* Gillette and Baker, VII-22-71 (♂); *Empoasca* sp. (♂); *Flexamia abbreviata* (Osborn and Ball), VI-21-71 (♂); *Flexamia* sp. (♀); *Frigartus frigidus* (Ball), VII-16-69 (♀, 3 records), VII-17-69 (♀, 3 records); *Hardya dentata* (Osborn and Ball), VII-9-69 (♀), VII-16-69 (♀); *Laevicephalus tantalus* Knull, VI-24-71 (♂); *Laevicephalus* sp., prob. *tantalus* Knull, VI-23-71 (♂); *Laevicephalus* sp. (♀); *Macrosteles fascifrons* (Stal), VI-22-71 (♂); unidentified nymphs (3 records, 2♂, ♀). Issidae: *Bruchomorpha suturalis* Melichar, VI-5-72 (♀). Margarodidae: *Margarodes* sp. (♀). Psyllidae: *Aphalara* (*Anomocera*) *minutissima* Crawford, VI-23-71 (♂). HYMENOPTERA Braconidae: *Apanteles* sp. (♀); *Chelonus* sp. (♀); *Microplitis* sp. (♂); *Orgilus* sp. (♀). Eumenidae: *Pterocheilus morrisoni* Cresson, VI-25-71 (♂). Figitidae: *Trischiza* sp. (♂). Formicidae (winged reproductives): *Formica* sp. (♀, ♂); *Lasius* sp. (♀, 3 records); *Myrmica* sp. (♀). Halictidae: *Dialictus* sp. (♂). Ichneumonidae: *Centeterus* sp. (♂). Pompilidae: *Anoplius* sp. (♀, 2 records); *Evagetes padrinus* (Viereck), VII-17-69 (2 records, ♂, ♀); *Pompilus* sp. (♀). Proctotrupidae: *Proctotrupes florissantensis* Rohwer, VI-29-65. Sphecidae: *Prionyx canadensis* (Provancher), VII-9-69 (♀); *Solierella* sp. (♀) (♂, 2 records); *Tachysphex* sp. (2 records, ♀). Tiphiidae: *Brachycistis* sp. (2 records, ♂, ♀); *Tiphia* sp. (2 records, ♂, ♀). LEPIDOPTERA Acrolophidae: *Acrolophus* *cockerelli* (Dyar), VII-10-69 (♂), VII-17-69 (♀, 2 records). Coleophoridae: *Coleophora* sp. (♂). Gelechiidae: *Gnorimoschema* sp. (♀). Hesperiidae: *Hesperia nevada* (Scudder), VI-22-71 (♂). Noctuidae: *Pseudaletia unipuncta* (Haw.), VII-18-69 (♀); *Therasea flavicosta* (Sm.), Gas Hills Rd., Riverton, VII-17-62 (♀). Oecophoridae: *Semioscopis* sp. (♀). Olethreutidae: *Eucosma* sp. (8 records, ♀, 7♂); *Eucosma* sp., prob. *argenteana* (Wlsm.) (♂, ♀); *Eucosma* sp., prob. *serpentana* (Wlsm) (♀). Pyralidae: *Homoeosoma* sp. (♀); *Loxostege indentalis* (Grote), 3.2 mi. N.W. of Bruneau, Idaho, VI-12-64 (♂); *Loxostege* sp. (♀). Scythridae: *Scythris* sp. (♀). Torticidae: *Choristoneura conflictana* (Wlsm), VII-18-69 (♀). NEUROPTERA Chrysopidae: *Chrysopiella* sp. Myrmeleontidae: *Hesperoleon blandis* (Hagen), VII-17-18-69 (♀, 2 records), VI-23-71 (♂), VI-25-71 (♂), VI-21-74 (♀). ORTHOPTERA Acrididae: unidentified nymphs (11♀, 1♂); *Ageneotettix deorum* (Scudder) nymphs, VII-18-69 (2♂, 2♀); *Cordillacris crenulata* (Bruner), VII-11-69 (♂); *Cordillacris occipitalis* (Thomas) (♀) VII-11-69; *Melanoplus* sp. nymphs VII-10-18-69, (1♂, 8♀, 1?); *Phlibostroma quadrimaculatum* (Thomas) nymphs, VII-10-17-69 (3♀); *Psoloessa delicatula* (Scudder), VII-16-17-69 (1♂, 2♀), nymphs (1♀).

This species, like its relative *pallidula*, is euryphagic. The prey taken represent 8 orders, including 56 families and 92 genera. Of the 256 recorded prey, 38% belong to the order Diptera, 16% to the order Homoptera, 14% to the order Orthoptera, 12% to the order Hymenoptera, 10% to the order Lepidoptera, 5% to the order Coleoptera, 3% to the order Hemiptera and 2% to the order Neuroptera.

When prey records are separated at the order level on the basis of sex of the predator, there appears to be some difference in preference by sex (Table 1). Females show about equal preference for Diptera, Homoptera and Orthoptera, but males overwhelmingly chose Diptera. Anthomyiids, tachinids and sarcophagids were largely ignored by females; whereas males showed little interest in grasshoppers. Only slightly fewer males (119) were captured with prey than females (131) over the five year period. The prey of *benedicti* males represented 34 families and 59 genera; those of the females represented 38 families and 64 genera. Twenty-two of the families, but only 29 of the genera, captured by males were the same as those captured by females. It should be pointed out that *Efferia benedicti* is cannibalistic, both males and females attacking members of their own species.

Although the predators are fairly uniform in size, time spent feeding on various prey varies somewhat with the size of the prey. For ten leafhoppers of varying sizes, the time for a complete feeding varied from four to fifteen minutes. As would be expected, since the size variation of grasshopper nymphs is greater, the total feeding time on these insects varied from seven to 60 minutes. Two *Heteropogon wilcoxi*, which served as prey were discarded after 84 and 91

Table 1. Insects, by order, preyed upon by *Efferia benedicti* (%) based on sex of the predator.

	Prey								
Predator	Coleoptera	Diptera	Hemiptera	Homoptera	Hymenoptera	Lepidoptera	Neuroptera	Orthoptera	Total No. Prey captured
male	6	53	2	13	9	10	2	5	119
female	4	26	3	20	14	10	2	21	131
Total	5	38	3	16	12	10	2	14	256

minutes, respectively, while a smaller species of asilid, *Asilus mesae* (Tucker), provided food for only 39 minutes.

Additionally, the time between feedings appears correlated with the size of the prey, i.e. the smaller the prey, the less time between feedings.

In one instance, a female *benedicti* fed upon six prey in 93 minutes; in another, a male devoured five insects in 81 minutes, while a third specimen, a male, dispatched four insects in 95 minutes. The following sequence is typical of those where small insects serve as prey:

3:54—Male *E. benedicti* observed making forage flights.
4:03—picked tiny green leafhopper (*Empoasca aspera* complex) out of air after making six previous forage flights.
4:14—prey pushed off proboscis on site by fore tarsi of asilid.
4:39—after seven forage flights, a small flea beetle (*Phyllotreta* sp.) was captured.
5:05—pushed prey off proboscis on site and cleaned proboscis and fore tarsi.
5:14—after several unsuccessful forage flights, returned with a small dipteran.
5:20.5—prey was discarded on site and more forage flights were initiated.
5:40—captured a tiny dipteran.

A survey of the area on the date of our arrival at the study site 10 miles south of Shoshoni, on June 21, 1971, revealed an absence of female *benedicti*. Surveys of the area at various times of the day on June 23 provided a combined ratio of five males to every female observed. The following day, the ratio had fallen to four males per female; and on June 25, it was approximately 2 males to each female. No further surveys were conducted, since the investigators had to

Fig. 2. Mating pair of *Efferia benedicti.*

depart. However, surveys conducted on two successive days, July 17 and 18, 1969 showed a ratio of almost two to one in favor of the females on both days. On this basis, we believe that, although males initially outnumber females, the reverse is probably normal throughout most of the time the species is present. The first mated pair was observed in late afternoon (3:27) on June 23, 1971; and it was not until the morning of June 25 that matings were commonly observed.

Mating behavior among the males and females of *benedicti* is very simple. There is no courtship, although the males, like those of *pallidula*, perform a peculiar undulating "searching" flight, which covers fairly long distances. With one exception, all matings where the initiation was observed occurred in the air almost immediately after a female had taken flight. In that one instance, the male landed beside the female and immediately mounted. Another female had prey when she was accosted; while in one case, the male had a tiny insect impaled on his beak, which he promptly dropped during the initial flight *in copula.*

Efferia benedicti matings last slightly longer than those of *pallidula*, averaging 104 seconds. Like *pallidula*, the complete mating may occur

Fig. 3. Female *Efferia benedicti* with tip of ovipositor inserted beneath bank of dead limb of *Artemesia tridentata.*

on the grass mat or soil or the pair may immediately seek a position on vegetation, probably responding to ambient temperatures. Unlike *pallidula*, where matings appear to be limited to early morning and late afternoon, those of *benedicti* may occur at any time of day, having been observed as early as 8:35 a.m. and as late as 6:01 p.m. Temperatures taken at the sites on which the mated pairs have settled vary from 27°C to 38°C.

During copulation, the male rests atop the female with his fore tarsi directly on her eyes. Several times during a mating, he forces her head back and forth. In between times, he occasionally opens and closes his wings, but with no apparent pattern (fig. 2). Like *pallidula*, and unlike *helenae* and *staminea*, the male at no time buzzes his wings while *in copula*. He also occasionally moves his hind tarsi back and forth along the sides of the female's abdomen; but again, with no apparent pattern, although the frequency increases towards the end of copulation. The male initiates separation by rising into the air and fluttering his wings while releasing his claspers.

Like females of other species of robber flies, *benedicti* females probe the substrate in various places prior to actual oviposition. Probing behavior by this species occurs on the limbs of sagebrush, *Artemisia tridentata.* The female moves vertically up and down the limbs, both live and dead, thrusting the tip of her ovipositor in cracks and crannies where the bark has separated from the limb (fig. 3). During the process, her ovipositor is curved forward between her hind legs. In one instance, a female making probes had a tiny leafhopper impaled on her proboscis which she carried around for six minutes before flying seven cm away from the limb to discard the prey. Temperatures in the bushes at the heights probing was observed varied from 28°C to 37°C. All probing was observed between 10 a.m. and 1:30 p.m. All attempts to recover eggs from points where individual females kept the tip of their ovipositors under the bark for 2½ to 3 minutes were unsuccessful.

We should like to express our appreciation to the following taxonomists of the Systematic Entomology Laboratory, USDA, for identifying most of the varied insects used as prey by this species of asilid: S. W. T. Batra, R. W. Carlson, D. C. Ferguson, R. J. Gagné, R. D. Gordon, J. L. Herring, R. W. Hodges, J. M. Kingsolver, L. Knutson, J. P. Kramer, P. M. Marsh, A. S. Menke, D. R. Miller, L. M. Russell, C. W. Sabrosky, D. R. Smith, G. C. Steyskal, M. B. Stoetzel, F. C. Thompson, R. E. White and W. W. Wirth. Identifications also were provided by D. R. Davis, D. Duckworth, R. Ward, and O. S. Flint of the Department of Entomology, Smithsonian Institution, and W. A. Connell, University of Delaware.

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EIGHT NEW NORTH AMERICAN SPECIES OF ANOBIIDAE WITH KEYS AND NOTES (COLEOPTERA)

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ABSTRACT—The 8 new species described are *Oligomerus* **angusticollis**, *O.* **cylindricus**, *O.* **enervatus**, *O.* **grossus**, *O.* **priapus**, *O.* **texanus**, *Euvrilletta* **arizonica** and *Utobium* **granulatum**. A discussion of the characters of *Oligomerus* includes a new diagnosis for it; a key including the new species is provided for the North American species. *Hemicoelus nelsoni* (Hatch) is revalidated, and a key to North American *Hemicoelus* is given. *Oligomerus arbuti* Fisher is transferred to *Xyletomerus*, and *Oligomerus oregonensis* Hatch is synonymized with *arbuti*. The 29 illustrations are of the new species, their near relatives, and the male antenna of *Eucrada robusta* VanDyke.

The following descriptions and notes result largely from my examination of collections recently sent to me.

Oligomerus Redtenbacher

Oligomerus Redtenbacher, 1849:347.

During this work I have seen the holotype of *Oligomerodes delicatulus* Fall (MCZ type number 2464) and have concluded that it belongs in *Oligomerus* NEW COMBINATION.

I have examined the male genitalia of most species of *Oligomerus* (only those of *brevipilis* Fall, *californicus* Fall, and *delicatulus* (Fall) not seen) and found strong generic similarities (below). Characters of the new species below differ somewhat from those of old species of *Oligomerus*, so I here give diagnostic characters for *Oligomerus* (including notes on male genitalia) as follows: antenna 9–11 segmented, intermediate segments not over ½ as wide as segments of club; pronotum produced medially before base into a more or less distinct crest and with other evident to quite distinct irregularities, lateral margin moderately broadly explanate (crest, irregularities, and margin least developed in *sericans*), surface distinctly granulate throughout; elytral striae distinctly punctured (except in *enervatus*, n. sp.); median lobe of male genitalia (fig. 20–26) with a longitudinal ridge (most strongly developed in new species), palplike process of each lateral lobe elongated, narrow, and curving, lateral lobe at apex acute and pointed inward (except in *alternans* Lec.).

For notes on the status of *Oligomerus arbuti* Fisher and of *O. oregonensis* Hatch see below under *Xyletomerus*.

During construction of the key below I examined members of all species.

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Key to the North American Species of Oligomerus

1\. Front coxae separated by about ½ transverse coxal diameter; hairs of dorsal surface distinctly bristling (fig. 7); northeast U.S. to Minnesota ...... *sericans* (Melsheimer)

— Front coxae touching to separated by not over ⅓ transverse coxal diameter; hairs of dorsal surface appressed or weakly bristling (fig. 8, 9), rarely moderately bristling; various localities 2

2(1). Length 2.3–2.9 mm; California and Arizona 3

— Length 3.7–7.2 mm; various localities 4

3(2). Antenna of 9 or 10 segments; front and middle coxae separated ...... *tenellus* Fall

— Antenna of 11 segments; front and middle coxae touching ...... *delicatulus* Fall

4(2). Middle coxal cavities confluent, not separated by meso- and metasternal processes 5

— Middle coxal cavities separated by meso- and metasternal processes 9

5(4). Pronotum 0.8 times as wide as elytra; punctures of elytral striae lacking distinct granules; male genitalia as in fig. 26; New Mexico ...... *angusticollis*, new species

— Pronotum 0.9 times as wide as elytra to fully as wide; punctures of elytral striae usually finely granulate; male genitalia as in fig. 20, 21, 23, 24, 25; Texas, Arizona, New Mexico, and Oregon 6

6(5). Ninth antennal segment of male about 1.2 times as long as all preceding segments united; Arizona and New Mexico; male genitalia as in fig. 25 ...... *cylindricus*, new species

— Ninth antennal segment of male never longer than all preceding segments united; Texas and Oregon 7

7(6). Length 7.2 mm; Oregon; male genitalia as in fig. 23 ...... *grossus*, new species

— Length 3.8–5.2 mm; Texas; male genitalia as in fig. 20, 21, 24 8

8(7). Male genitalia with median lobe much elongated, fig. 20, 21; 3.8–4.8 mm ...... *priapus*, new species

— Male genitalia not as above, as in fig. 24; 5.2 mm ...... *texanus*, new species

9(4). Pubescence of head and thorax moderately bristling (nearly as strongly as in fig. 7); eastern U.S. to Wisconsin and Louisiana ...... *brevipilis* Fall

— Pubescence of head and thorax not to weakly bristling (fig. 8, 9); various localities 10

10(9). Length about 4.1 mm; slender, about 2.8 times as long as wide; California ...... *californicus* Fall

— Length 3.7–7.2 mm; robust, 2.6–2.7 times as long as wide; Oregon and northeastern U.S. 11

11(10). Metasternal intercoxal process angulate, acute 12

— Metasternal intercoxal process obtuse to arcuate 13

12(11). Elytral intervals distinctly convex; northeastern U.S. ...... *alternans* Leconte

— Elytral intervals weakly convex; Oregon to British Columbia ...... *crestonensis* Hatch

13(11). Pronotum at base with depression each side of median crest (fig. 12); elytral striae obsolete; Oregon .... *enervatus*, new species

— Pronotum nearly evenly rounded throughout; elytral striae distinct; northeastern U.S. .... *obtusus* Leconte

Oligomerus angusticollis White, new species

fig. 26

General: Body elongate, cylindrical, a little over 3× as long as wide, sides of elytra subparallel for about basal ¾; body red brown, antenna brown, head, pronotum, legs and ventral surface clouded with or predominantly brown; pubescence very short, sparse, with a dull yellow luster, that on head and pronotum bristling, that on elytra appressed.

Head: Surface with fine, not dense granules on minutely granulate background; eyes separated by 1.5× vertical diameter of eye. Antenna 11 segmented, roughly 0.8× as long as body in male (last segment absent), 1st segment arcuate, more than 2× as long as wide, 2nd segment widest near apex, a little longer than wide, 3rd through 8th segments weakly serrate, 3rd segment a little longer than wide, segments 4 through 8 transverse, terminal ones most distinctly so, 9th segment longer than all preceding united, sides subparallel, 6× as long as wide, 10th segment similar in shape, 8× as long as wide, (11th segment missing). Last segment of maxillary palpus subfusiform, about 2.5× as long as wide; last segment of labial palpus subfusiform, apex pointed, a little over 2× as long as wide.

Dorsal surface: Pronotum narrow, sides concave in dorsal view, 0.8× as wide as elytra at base, disk with longitudinal crest before base that is weakly compressed, with fine, longitudinal impression from crest to apex; lateral margin sharp, complete, explanate, at extreme side surface concave; sculpture of fine granules, moderate to sparse in density, on finely punctate, moderately shiny background. Scutellum a little wider than long, narrowed to apex. Elytra with distinct, even striae, formed of round to elongate punctures clearly but not precisely aligned in rows, intervals weakly convex, surface minutely granulate–punctate.

Ventral surface: Prosternum before coxae about ⅓ length of a coxa; anterior coxae elongated, subconical, approximate. Middle coxae touching, subconical. Metasternal intercoxal process angulate, obtuse, surface near middle punctate, at sides granulate–punctate. Abdominal surface finely, densely punctate, 5th segment of male shallowly depressed before apex.

Length: 5.3 mm.

The ♂ holotype (no. 72669 in USNM) and only specimen, bears the data "Cloudcroft, New Mex., Wickham; Wickham Collection 1933".

In addition to the characters given in the key this species differs from *cylindricus* (to which it is most closely allied) in that the lateral lobes of the male genitalia have the apices less strongly produced inwardly.

The specific name, meaning narrow neck, refers to the narrow prothorax.

Oligomerus cylindricus White, new species

fig. 25

General: Body elongate, cylindrical, 2.9× as long as wide, elytral sides subparallel for about basal ¾; body and appendages brown to red brown, elytra often a little lighter than remainder; pubescence short, moderately dense, dull tan, largely appressed, that on head and pronotum minutely bristling.

Head: Surface with fine, moderately dense granules on minutely granulate background; eyes separated by 1.6–1.8× vertical diameter of eye. Antenna 11 segmented, 0.8× as long as body in male, 1st segment arcuate, about 2× as long as wide, 2nd segment widest near apex, a little longer than wide, 3rd through 8th segments weakly serrate, 3rd segment a little longer than wide, segments 4 through 8 transverse, 9th segment a little longer than all preceding segments united and with sides subparallel, about 5× as long as wide, 10th segment similar in shape, about 6× as long as wide, 11th segment 10× or more as long as wide. Last segment of maxillary palpus subfusiform, about 2× as long as wide; last segment of labial palpus similar except apex more pointed.

Dorsal surface: Pronotum about 0.9× as wide as elytra at base, sides as seen from above nearly straight, disk with moderately produced, weakly compressed crest before base, with longitudinal impression from crest to apex; lateral margin sharp, complete, explanate, at extreme side surface nearly flat to weakly concave; sculpture of distinct, moderately dense granules on finely granulate background. Scutellum a little wider than long, apex rounded. Elytra with more or less distinct striae, punctures sometimes in poor alignment, often distinctly granulate, intervals usually convex, surface minutely, transversely rugose.

Ventral surface: Prosternum before coxae nearly ½ length of a coxa; anterior coxae elongate, subconical, narrowly separated. Middle coxae narrowly separated. Metasternal intercoxal process arcuate to weakly angulate, most of surface finely, densely granulate, granulate–punctate near middle. Abdominal surface finely, densely punctate, 5th segment of male depressed before apex.

Length: 4.5–5.9 mm.

The ♂ holotype (in OSU) and 9 ♂ paratypes bear the following "Chiricahua M., VII-26-52. Ar., D.J. & J.N. Knull Collrs." (6 in OSU, 3 in USNM). Seven additional ♂ paratypes have essentially the same data but differ as follows: "VIII-2-52", 1 in OSU; "VII-12-52", 3 in OSU; "VII-29-55", 1 in OSU, 1 in USNM; "VII-22-53", 1 in OSU. Finally a ♂ paratype (in OSU) bears "Sacramento M., VII-29-37, N.M.; D.J. & J.N. Knull Collrs."

For a discussion of a character in addition to that given in the key for separation of this species from *angusticollis* (its nearest relative) see under the latter species.

The specific name refers to the cylindrical body shape.

Oligomerus enervatus White, new species

fig. 12

General: Body elongate–cylindrical, 2.8× as long as wide, elytral sides subparallel for about basal ⅗; ground color red brown nearly throughout, antennae slightly lighter and body margins darker, pronotum irregularly, vaguely darkened; pubescence very short, fine, sparse, appressed, with yellow luster, that on pronotum difficult to detect.

Head: Surface with fine, dense granules on minutely granulate background; eyes small, bulging, separated by 2× vertical diameter of an eye. Antenna 11 segmented, 0.3× as long as body in female, last 3 segments a little longer than all preceding united, 1st segment broad, arcuate, 2nd and 3rd segments elongate, each about 2× as long as wide, segments 4, 5, and 7 subequal, each about as wide as long, segments 6 and 8 subequal, about as wide as long and smaller than segments 4, 5, and 7, segments 9 and 10 subequal, but 9 a little longer, broader than 10, each about 2× as long as wide, widest before apex, 11th segment 3× as long as wide. Last segment of maxillary palpus subfusiform, widest medially, a little more than 2× as long as wide; last segment of labial palpus subtriangular, a little longer than wide, outer angle pointed, inner angle broadly rounded.

Dorsal surface: Pronotum widest basally, slightly wider than elytra at base, medially before base with a distinct, produced crest, surface before crest shallowly depressed, each side of crest more distinctly depressed, surface at side inflated; lateral margin sharp, complete, produced and explanate; sculpture throughout of moderate-sized, dense granules on finely granulate background. Scutellum large, about ⅓ wider than long, apex nearly truncate. Elytral striae subobsolete but traceable on disk and apex, more distinct at sides, intervals almost perfectly flat; sculpture of very fine, minute granulation.

Ventral surface: Prosternum before coxae about ¾ length of a coxa; anterior coxae separated by about ⅓ transverse coxal diameter. Middle coxae separated by about ⅓ transverse coxal diameter. Metasternal process between middle coxae broadly arcuate, surface granulate–punctate, with granulation predominating anteriorly and at sides. Abdomen granulate–punctate with punctation predominating.

Length: 6.5 mm.

The ♀ holotype (USNM no. 72671) bears the data "Grants Pass, Ore., August 18, 1966, Blk. light trap, Kenneth Goeden; Hadrobregmus sp., det. R.L. Westcott".

In addition to the differences given in the key, *obtusus* differs from this species in that the front coxae are separated by about ¼ of the transverse coxal diameter, and the last segment of the labial palpus is subfusiform, and about 2× as long as wide. In *enervatus* the front coxae are separated by about ⅓ of the transverse coxal diameter, and the labial palpus is subtriangular and a little longer than wide.

The specific name, meaning weakened, refers to the weak elytral striae.

Oligomerus grossus White, new species

fig. 23

General: Body elongate cylindrical, 2.8× as long as wide, elytral sides subparallel for about basal ⅔; body black, infused with red in many areas, tarsi and antennae brown, legs dark brown; pubescence very short, sparse, primarily appressed, head and pronotum with very short, bristling hairs, elytra with sparser bristling hairs, hairs on elytra very vaguely coalescing on intervals.

Head: Surface with fine, dense granules on minutely punctate, granulate background; eyes bulging, separated by 1.5× vertical diameter of eye. Antenna 11 segmented, a little over ½ as long as body in ♂, last 3 segments much elongated, 2.7× as long as all preceding united, 1st segment broad, arcuate, 2nd shorter, a little longer than wide, segments 3 thru 8 serrate, each widest apically, 3rd segment almost 1.5× as long as wide, segments 4 and 5 about as wide as long, segments 6, 7, and 8 wider than long, 9th segment widest just beyond middle, about 4× as long as wide, 10th segment weakly arcuate, sides subequal in width at apical ⅔, about 6× as long as wide. Last segment of both maxillary and labial palpi subfusiform, that of former a little over 2× as long as wide, that of latter a little less than 2× as long as wide.

Dorsal surface: Pronotum nearly as wide as elytra at base, disk with longitudinal crest before base weakly compressed, with fine, longitudinal impression before apex, surface depressed before base and at sides before lateral margin; latter complete, sharp, explanate; sculpture of fine, dense granules on minutely granulate background, disk nearly lusterless, sides moderately shiny. Scutellum moderate in size, a little wider than long, apex rounded. Elytra with traceable striae, latter depressed and set with fine granules, granules primarily in or near depressions of striae, surface very finely punctate and transversely rugose.

Ventral surface: Prosternum before coxae a little less than ½ length of a coxa, anterior coxae subconical, very narrowly separated. Middle coxae subconical, very narrowly separated. Metasternal intercoxal process narrowly arcuate, surface finely granulate–punctate, punctures most distinct near middle. Abdomen finely punctate throughout; 5th segment slightly depressed before apex in male.

Length: 7.2 mm.

The ♂ holotype (USNM no. 73382) bears the data "ORE., 3 mi. E. of Summer Lk. Lake Co., 12 VIII 69, Kenneth Goeden; Chrysothamnus nauseosus".

The male of this species is as large as the female of any of the other described species. If the normal situation of the female being larger than the male of the same species holds for this species, then it will be easily the largest species of the genus.

The specific name refers to the size.

Oligomerus priapus White, new species

fig. 14, 20, 21

General: Body elongate cylindrical, about 2.8× as long as wide, elytral sides subparallel for about basal ¾; body and appendages red brown to dark brown, head and pronotum predominantly dark brown in most; pubescence short, tan, moderate in density, largely appressed, minutely bristling on head and pronotum.

Head: Surface with fine, moderately dense granules on minutely granulate background; eyes separated by 2.0× vertical diameter of eye. Antenna 11 segmented, about 0.7× as long as body in male, 1st segment arcuate, nearly 2× as long as wide, 2nd segment widest near apex, a little longer than wide, 3rd through 8th segments weakly serrate, 3rd segment a little longer than wide, segments 4 through 8 transverse, 9th segment a little shorter than all preceding united, outer margin very broadly arcuate, nearly 4× as long as wide, 10th


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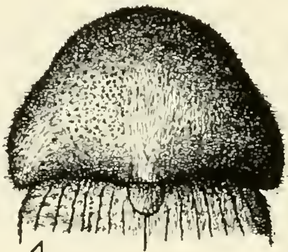
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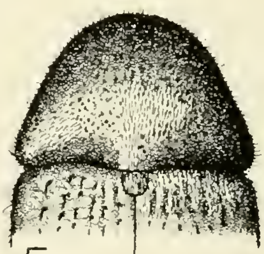
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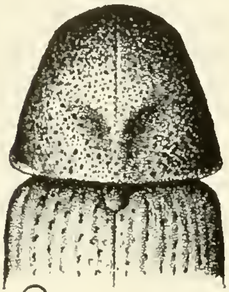
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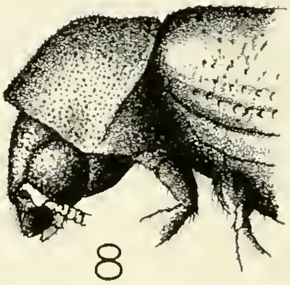
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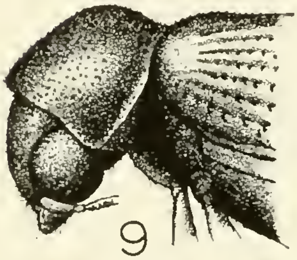
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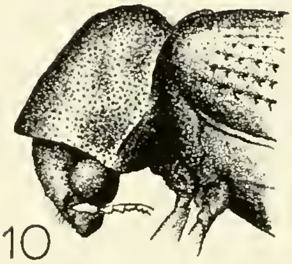
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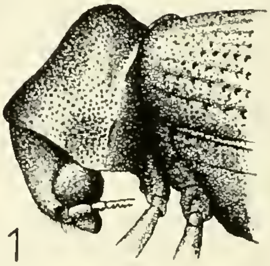
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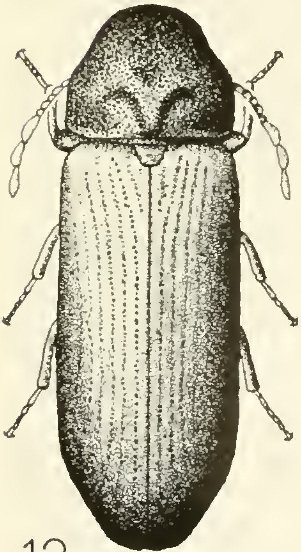
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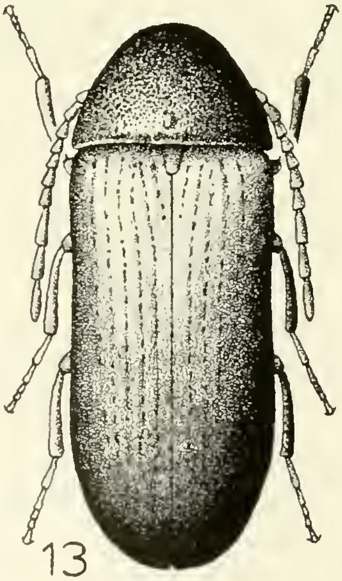
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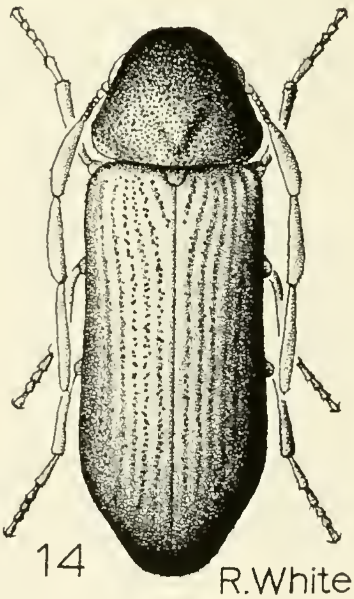
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segment similar in shape, about 5× as long as wide, 11th segment about 7× as long as wide. Last segment of maxillary palpus subfusiform, about 2× as long as wide; last segment of labial palpus subtriangular, about 2× as long as wide.

Dorsal surface: Pronotum fully as wide to a little wider than elytra at base, sides from dorsal view nearly straight, disk with moderately produced, weakly compressed crest before base, with feeble indications of impression from crest to apex; lateral margin sharp, complete, explanate, at extreme side surface nearly flat to weakly concave; sculpture of distinct, moderately dense granules, background minutely sculptured, moderately shiny. Scutellum a little wider than long, apex rounded. Elytra with more or less traceable striae formed of granulate punctures, latter often poorly aligned, intervals often weakly convex, surface minutely, transversely rugose.

Ventral surface: Prosternum before coxa nearly ½ length of a coxa; front coxae elongate, subconical, narrowly separated to touching. Middle coxae narrowly separated. Metasternal intercoxal process narrowly arcuate to nearly angulate, surface finely, densely granulate, at middle granulate–punctate. Abdominal surface finely, densely punctate, 5th segment of ♂ flat to weakly depressed before apex.

Length: 3.8–4.8 mm.

The ♂ holotype (in OSU) and 4 ♂ paratypes (2 in OSU, 2 in USNM) bear the data "Davis Mts., VII-11-55 Tex.; D.J. & J.N. Knull Collrs." The data on a single ♂ paratype (in OSU) differs from the above only in "VII-15-55".

This species is quite similar to *texanus*, new species, with the length (5.2 mm for *texanus*) and male genitalia offering the chief differences.

My first thought on examination of the male genitalia of *priapus* was that I had a specimen in which the genitalia were malformed, for on occasion in my anobiid genital dissections, I have found individuals in which the lateral lobes are much reduced from the normal condition in the species. However, I have examined the genitalia of 3 males of *priapus* and all match the illustrations (fig. 20, 21) closely, with the median lobe much produced and curving, and the lateral lobes short. The genitalia of *priapus* are markedly different from that of the other members of the genus that I have seen (fig. 22–26).

The specific name refers to the genitalia.

←

Fig. 1–3. Male antennae. 1, *Euvrilletta serricornis* White. 2, *E. arizonica*, n. sp. 3, *Eucrada robusta* VanDyke. Fig. 4–6. Pronota. 4, *Xyletomerus arbuti* (Fisher). 5, *X. histricus* Fall. 6, *Hemicoelus laticollis* (Fall) Fig. 7–11. Partial views, lateral. 7, *Oligomerus sericans* (Melsh.). 8, *O. crestonensis* Hatch. 9, *O. alternans* Lec. 10, *Hemicoelus nelsoni* (Hatch). 11, *H. gibbicollis* (Lec.). Fig. 12–14. Dorsal views. 12, *Oligomerus enervatus*, n. sp., female holotype. 13, *Euvrilletta arizonica*, n. sp., male. 14, *Oligomerus priapus*, n. sp., male.

Oligomerus texanus White, new species

fig. 24

General: Body elongate cylindrical, a little over 2.8× as long as wide, elytral sides subparallel for about basal ⅔; head, pronotum, sterna, legs, and antennae dark brown, elytra and abdomen dark red brown clouded with dark brown, tarsi brown; pubescence dark red brown, extremely fine and short, with dull gray–yellow luster, primarily appressed, head and pronotum with very short bristling hairs, elytra with shorter, sparser bristling hairs.

Head: With fine, dense granules on minutely granulate background; eyes bulging, separated by 2× vertical diameter of eye. Antenna 11 segmented, ⅝ as long as body in male, last 3 segments about 3× as long as all preceding united, 1st segment weakly arcuate, about 2× as long as wide, 2nd segment a little longer than wide, segments 3 thru 8 serrate, 3rd segment longer than wide, segments 4 thru 8 wider than long, 9th segment weakly arcuate, sides subparallel, about 10× as long as wide. Last segment of maxillary palpus widest medially, tip pointed, about 2.5× as long as wide; last segment of labial palpus similar, but tip less pointed.

Dorsal surface: Pronotum slightly wider than elytra at base, disk with moderate, weakly compressed crest before base; lateral margin sharp, produced, complete, explanate; with fine, dense granules on minutely granulate background, disk with weak luster, remainder moderately shiny. Scutellum a little wider than long, apex rounded. Elytra with traceable to obsolete striae formed of irregular, shallow punctures set with granules, surface also minutely granulate and transversely rugose.

Ventral surface: Prosternum before coxae about ⅓ length of a coxa; front coxae subconical, touching. Middle coxae touching, subconical. Metasternal intercoxal process nearly forming a right angle, surface punctate near middle, granulate anteriorly and at sides. Abdomen finely punctate throughout.

Length: 5.2 mm.

The ♂ holotype (in OSU) and only specimen bears the data "Jeff Davis Co., VII-12-50. Tex; D.J. & J.N. Knull Collrs."

This species is most similar externally to *priapus* from which it differs primarily in length (3.8–4.8 mm for *priapus*) and also in male genitalia. The genitalia of *texanus* are normal in form as opposed to the aberrant genitalia of *priapus* (fig. 20, 21). Also, the lateral lobes of *texanus* are more distinctly tapering to the apex than are those of the genitalia of any other species that I have seen.

Oligomerus crestonensis Hatch

fig. 8

Oligomerus crestonensis Hatch, 1961:316.

The following is intended to supplement the original description of this species. I have assigned the name on the basis of a paratype (in UW) with the following data "Deschutes River, near Terrebonne, Ore., 7-20-41. col. Schuh & Gray; Oligomerus?; PARATYPE, Oligomerus crestonensis, 1958-M. Hatch".

General: Body 2.7× as long as wide; red brown nearly throughout, pronotum slightly darker; pubescence short, sparse, primarily appressed, head and dorsal surface with short bristling hairs.

Head: Finely, densely granulate; eyes separated by 1.6× vertical diameter of eye. Ninth antennal segment nearly as long as all preceding united; entire antenna a little over ½ as long as body. Terminal palpal segments subfusiform, each about 2× as long as wide.

Dorsal surface: Pronotum 0.85× as wide as elytra at base, surface finely, densely granulate; lateral margin moderately explanate, medially with fine, longitudinal impression. Elytral striae of well-aligned punctures, latter with minute, not distinct granules, intervals between striae weakly convex.

Ventral surface: Prosternum before coxae about ½ length of a coxa; front coxae narrowly separated. Middle coxae narrowly separated, cavities not confluent, separated by meso- and metasternal processes. Metasternal intercoxal process acutely angulate, surface finely, densely granulate. Abdomen finely, densely granulate, 5th segment vaguely depressed before apex.

Length: 5.8 mm.

Utobium Fall

Utobium Fall, 1905:134.

Following is a new species with notes and a partial, revised key to species of *Utobium* including the new species.

Utobium granulatum White, new species

fig. 28

General: Elongate–cylindrical, body 2.5× as long as wide; ground color black, elytral apices brown in part, antennae brown, legs predominantly brown, black in part; surfaces granulate, background shiny; surfaces with moderately dense, moderately long, light colored, generally appressed pubescence, bristling in part on head and abdominal apex, that on elytra predominantly black, but with off white and light orange hairs, light colored hairs forming obscure pattern.

Head: Surface granulation moderately large and dense, background shiny; eyes small, bulging, separated by 2.3× vertical diameter of eye; antenna 11 segmented, last 3 segments enlarged and elongate, segments 5 and 7 subequal to segment 10, segments 1–4, and 6 and 8 small, latter 2 serrate. Last segment of maxillary palpus 2× as long as wide, widest medially, apex broadly arcuate; last segment of labial palpus subtriangular, a little longer than wide, inner angle broadly rounded.

Dorsal surface: Pronotum with moderately large and dense granules, evenly distributed; pubescence along side of pronotum off white with few intermixed pale orange hairs, pubescence medially on pronotum largely dark and difficult to detect, at base with only few light hairs. Elytral granulation dense, moderately large, on shiny background; with patches of light pubescence, off white pubescence most prominent in transverse patch at basal ⅓ and another at apical ⅓, light orange pubescence primarily along side and at median suture.

Ventral surface: Metasternum moderately coarsely granulate–punctate. Abdomen finely granulate–punctate.

Length: 5.1 mm.

The ♂ holotype (in USNM, no. 72670) bears the data "Ile d'Anticosti, Riv. Jupiter, Dupl., Quebec, 18-VI-73, Claude Chantal". It was taken on an old balsam fir (*Abies balsamea*).

In my key to species of *Utobium* (White, 1966), the present species runs to near *griseum* though in fact it is most similar to *elegans*. The two differ as follows: in *granulatum* the background color is almost entirely black and the light elytral pubescence is mixed off white and light orange. The background color of *elegans* varies from red brown to dark brown, and the light elytral pubescence is almost entirely off white, with little to no light orange hairs.

I have compared the female holotype of *U. griseum* White with *granulatum* and have made the following notes. In *griseum* the light elytral hairs are almost entirely off white with only a few light orange hairs on the humerus and infrequent ones along the median suture. In *granulatum* the light elytral hairs are mixed off white and light orange with most of the latter being from the humerus to along the side of the elytron and along the median suture. Also the pronotal disk of *granulatum* bears large, dense granules on a shiny background (the specific name is in reference to the granulation); the pronotal disk of *griseum* has small, dense granules on a mostly non-reflective background. Only along the median line of the pronotum of *griseum* is the background shiny.

To accommodate the new species my key to species of *Utobium* should be altered as follows:

1. Ground color of dorsal surface black throughout to nearly throughout ---- 2
— Ground color of dorsal surface mixed orange and dark reddish to dark reddish brown ---- 3
2. Light elytral hairs almost entirely off white, with few orange hairs; pronotal disk granulate and shiny only along medial line; California ---- *griseum* White
— Light elytral hairs about equally off white and orange; pronotal disk granulate and shiny throughout; Quebec ---- *granulatum* White
3. (as present couplet 2)

Euvrilletta Fall

Euvrilletta Fall, 1905:196.
Oligomerodes Fall, 1905:161, NEW SYNONYM.

I have compared *Euvrilletta xyletinoides* Fall with *Oligomerodes catalinae* Fall (type-species of the respective genera) and have found that they are congeneric. The greatest differences that I find are as follows: in the latter species the middle coxae are touching, the last segments of the palpi are fusiform, and the tarsi are long and narrow; in the former species the middle coxae are narrowly separated, the last segments of the palpi are subtriangular, and the tarsi are short and broad. These differences are not sufficient for generic separation.

In addition, the male genitalia are in close agreement; the genitalia of *O. catalinae* (fig. 17) are of the same basic form as that of members of *Euvrilletta* (see fig. 18).

Considering the very high quality of the taxonomic work done by H. C. Fall, it would seem quite unlikely that he would have made the error of describing the same genus in two different subfamilies (*Oligomerodes* in Anobiinae, *Euvrilletta* in Xyletininae), however, he did. On my own part, it can be regarded as an oversight that I had not earlier discovered this synonymy in my work on the Anobiidae. The very high reliance that I have come to place on Fall's work as a basis for my own studies led to an insufficiently critical attitude.

Although the name *Oligomerodes* appeared in print earlier in Fall's paper than did *Euvrilletta*, I select the latter as the name for this category. This genus properly belongs in Xyletininae, and my recent additions to the genus make it the larger of the two (5 species including the new species below, as opposed to 2 species). This selection will best insure stability of nomenclature. My future work will include a key to all known species of *Euvrilletta*.

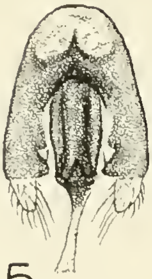
Euvrilletta arizonica White, new species

fig. 2, 13, 19

General: Elongate–cylindrical, body 2.6× as long as wide, elytral sides subparallel in basal ½, body widest (though not markedly so) just before apical ⅓; body color brown to dark brown, appendages and often some margins and sterna red brown; pubescence dull tan to brown, appressed throughout, with weak luster, moderately dense, very short.

Head: Surface nearly lusterless, sculpture of fine, moderately dense granules on minutely granulate background, vertex often weakly impressed, eyes of female separated by 3.0–3.2× frontal width of eye, eyes of ♂ separated by 1.6–2.0× frontal width of eye; antenna of ♂ about ½ as long as body, that of ♀ about ⅓ as long as body, ♂ with 3rd segment weakly serrate, segments 4 through 8 more distinctly serrate, each latter segment a little longer than wide, segments 9 and 10 weakly serrate, each about 3× as long as wide, segment 11 from 4 to 5× as long as wide, last 3 segments nearly as long as 7 preceding segments combined, ♀ antenna with proportions similar to those of ♂ antenna. Last segment of maxillary palpus about 2.5× as long as wide, inner margin broadly arcuate, outer margin nearly straight; last segment of labial palpus similar in shape, about 2× as long as wide.

Dorsal surface: Pronotum nearly evenly rounded throughout in both sexes, at side sometimes weakly inflated, lateral margin sharp, complete, narrowly explanate, surface nearly lusterless, sculpture at side of fine, moderately dense granules on minutely granulate background. Scutellum about as long as wide, apex rounded. Each elytron with 10 weak striae formed of elongated, very narrow, well-aligned punctures, striae weaker apically, intervals flat to weakly convex, striae most distinct and intervals most convex at side of elytron, with 1 short scutellar and 1 subhumeral stria, surface very finely, densely granulate, at base with larger granules.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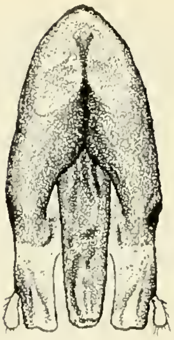
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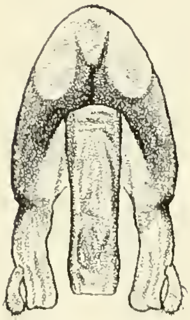
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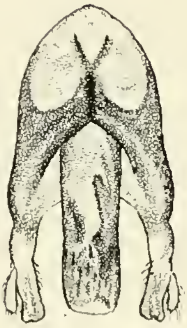
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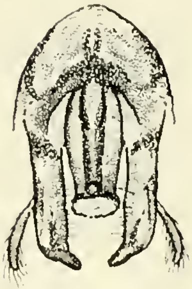
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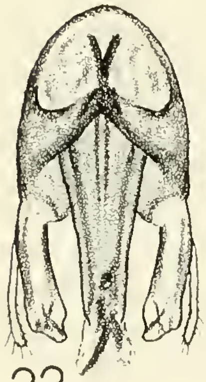
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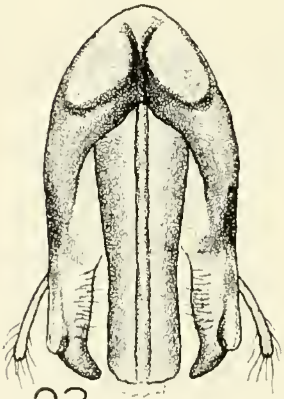
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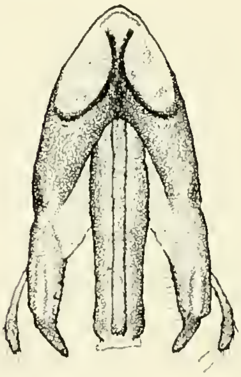
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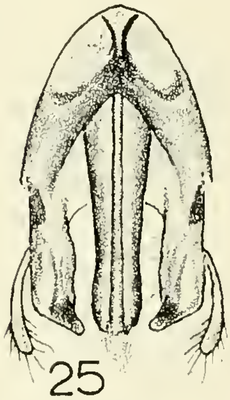
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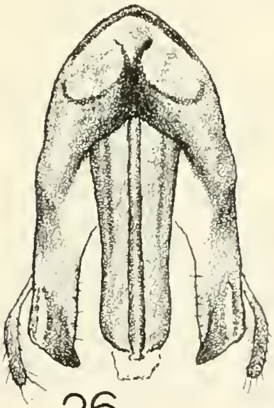
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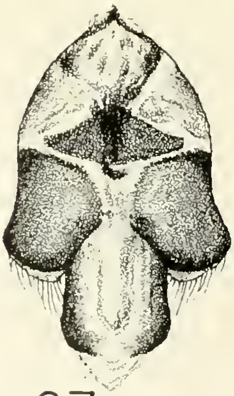
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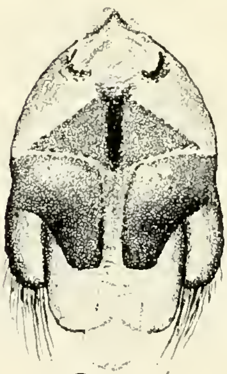
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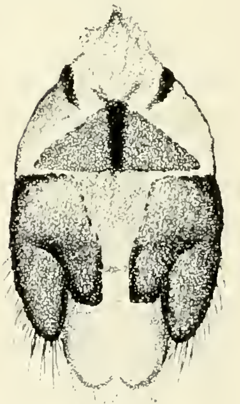
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Ventral surface: Metasternal process behind middle coxae acutely angulate, surface at middle finely, longitudinally grooved throughout, finely, densely granulate. Abdomen finely, densely granulate–punctate, 5th segment normal to vaguely depressed medially.

Length: 3.4–4.9 mm.

The ♂ holotype (in OSU) and 4 ♂ paratypes (3 in OSU, 1 in USNM) bear the data "Chiricahua M., VII-24-70 Ar.; D.J. & J.N. Knull Collrs." Three paratypes (2 ♂♂ in OSU, 1 ♀ in USNM) bear the same data except for the date VII-25-70. Two ♂ paratypes (1 in OSU, 1 in USNM) bear "Portal Ariz., Chiricahua Mts., VII-30-70; D.J. & J.N. Knull Collrs." Two final paratypes (1 ♂, 1 the allotype, both in OSU) bear "ARIZ.: Sta. Rita Mts. Madera Can.", the allotype has the remaining data "2-VIII-72; D.J. & J.N. Knull Collrs.", the other has "VII-18-1969; D.J. & J.N. Knull Collrs." The state is misspelled "ARIR." on the label of the latter specimen.

This species is most closely related to *E. serricornis* White and runs to the latter in my key (White, 1973b); *arizonica* differs from *serricornis* in a number of characters. The intermediate segments of the antenna of *serricornis* (fig. 1) are more distinctly serrate than are those of *arizonica* (fig. 2); the lateral lobes of the male genitalia of *serricornis* (fig. 18) are broader than are those of *arizonica* (fig. 19); and *serricornis* is 4.8–5.8 mm long while *arizonica* is 3.4–4.9 mm long. Also *serricornis* is known just from Nevada, and *arizonica* is known from Arizona.

Hemicoelus Leconte

Hemicoelus Leconte, 1861:204.

Following is revalidation of a species synonymized in error. Past keys to species of *Hemicoelus* are out of date (Fall, 1905; Knutson, 1963) so the discussion is followed by a revised key to species.

Hemicoelus nelsoni (Hatch)

fig. 10, 15

Hadrobregmus nelsoni Hatch, 1961:318.

Genitalic dissection of a good series now available to me has shown this species to be valid. I was thus mistaken in synonymizing it

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←

Fig. 15–29. Male genitalia. 15, *Hemicoelus nelsoni* (Hatch). 16, *H. gibbicollis* (Lec.). 17, *Euvrilletta catalinae* (Fall), cotype. 18, *Euvrilletta serricornis* White. 19, *E. arizonica*, n. sp. 20, 21, *Oligomerus priapus*, n. sp. 22, *O. obtusus* Lec. 23, *O. grossus*, n. sp., holotype. 24, *O. texanus*, n. sp., holotype. 25, *O. cylindricus*, n. sp. 26, *O. angusticollis*, n. sp., holotype. 27, *Utobium marmoratum* Fisher. 28, *U. granulatum*, n. sp., holotype. 29, *U. elegans* (Horn).

with *H. gibbicollis* Lec. (White, 1973a, p. 357). In *nelsoni* the median lobe of the genitalia bears 3 teeth (fig. 15) while that of *gibbicollis* lacks teeth (fig. 16), and there are other obvious differences in the genitalia such as in the lateral lobes. The chief external differences are in the form of the pronotum as follows: in *gibbicollis* the peak of the pronotum is more distinctly produced, and the margin is less extensive and is broadly interrupted (fig. 11); in *nelsoni* the peak of the pronotum is less produced, and the lateral margin is more extensive, and is more narrowly interrupted (fig. 10). In addition there are subtle differences in the form of the elytral apices. The strial punctures at the elytral apex of *nelsoni* show a greater tendency for confusion than do those of *gibbicollis*, and the elytral apex of *nelsoni* is more clearly truncate than is that of *gibbicollis*.

Key to North American Species of Hemicoelus

1\. Pronotum 0.95× as wide as base of elytra to fully as wide (fig. 6); California .... *laticollis* (Fall)

— Pronotum 0.7 to 0.9× as wide as base of elytra; various localities 2

2(1). Lateral pronotal margin obliterated to weakly indicated by produced, discrete granules, never sharp or distinct before base; northern U.S. and southern Canada .... *defectus* (Fall)

— Lateral pronotal margin sharp and distinct at least in part before base (sometimes very short) to sharp and distinct throughout 3

3(2). Lateral pronotal margin interrupted medially or largely obliterated before base; California to Alaska 4

— Lateral pronotal margin complete throughout; eastern to western North America 5

4(3). Lateral pronotal margin narrowly interrupted, pronotal crest less produced (fig. 10); male genitalia fig. 15; Oregon .... *nelsoni* (Hatch)

— Lateral pronotal margin broadly interrupted, pronotal crest more produced (fig. 11); male genitalia fig. 16; California to Alaska .... *gibbicollis* (Leconte)

5(3). Smaller, length 2.1–2.8 mm; northeastern U.S. .... *pusillus* (Fall)

— Larger, length 3.1–5.8 mm; northeastern U.S. west to California and north to Alaska 6

6(5). Abdomen near middle finely punctate and shiny, with little to no indication of granules; northeastern U.S. to Missouri and Manitoba, Canada; common .... *carinatus* (Say)

— Abdomen near middle finely punctate and nearly always with distinct, fine granulation, less shiny; northeastern North America west to California and north to Alaska; infrequent .... *umbrosus* (Fall)

Xyletomerus Fall

Xyletomerus Fall, 1905:197.

Following are new combinations, a new synonym, and a key to North American species of *Xyletomerus*.

Xyletomerus arbuti (Fisher), NEW COMBINATION
fig. 4

Oligomerus arbuti Fisher, 1919:296.
Oligomerus oregonensis Hatch, 1961:316, NEW SYNONYM, NEW COMBINATION.

Examination of the female holotype of *arbuti* (USNM no. 21427), along with two female paratypes, discloses that Fisher placed this species in the wrong genus. The female holotype of *Oligomerus oregonensis* Hatch (in UW; with data "ORE.: McMinnville, June 5, 1942, K. M. Fender; TYPE *Oligomerus oregonensis* 1957 M. H. Hatch") is identical with *arbuti*.

I have seen 4 males of *X. histricus* Fall (the only other species of the genus). I find a number of differences in comparing the 4 males of *histricus* with the 4 females of *arbuti*, as follows: in *histricus* the eyes are separated by almost exactly 2.5 times the vertical diameter of 1 eye, the head is more sparsely granulate and more shiny, the antenna is more elongate, about 0.35–0.40 times as long as the body, the pronotal sides are weakly inflated (fig. 5), and the length ranges from 2.9–3.1 mm; in *arbuti* the eyes are separated by 2.8–3.0 times the vertical diameter of 1 eye, the head is more densely granulate and less shiny, the antenna is less elongate at about 0.3 times as long as the body, the pronotal sides are distinctly inflated (fig. 4), and the length ranges from 3.2–3.7 mm. I regard it as very likely that the above differences are sexual, and that the 2 species I have examined represent male and female of 1 species. This is not certain, however, and I prefer to await more conclusive data before uniting the two names.

KEY TO NORTH AMERICAN SPECIES OF XYLETOMERUS

1. Length 2.9–3.1 mm; eyes separated by 2.5× vertical diameter of 1 eye; pronotal sides weakly inflated (fig. 5) .... *histricus* Fall
— Length 3.2–3.7 mm; eyes separated by 2.8–3.0× vertical diameter of 1 eye; pronotal sides distinctly inflated (fig. 4) .... *arbuti* (Fisher)

Eucrada robusta VanDyke
fig. 3

Eucrada robusta VanDyke, 1918:6.

Eucrada robusta VanDyke was described from a unique female. Hatch (1961, p. 310) provided a brief description, but again just of the female. I have seen a male from Wallowa Mts., Oregon (in ODA) and have made an illustration of the antenna (fig. 3). Unfortunately, I have no female of the species for direct comparison. The male agrees well with the original description except for antennal differences. All I can now add to the known data is that the male is 7 mm long, making the known range in length for the species 7–8 mm.

Eucrada robusta and the only other North American species of the genus, *E. humeralis* (Melsh.), are quite readily distinguished. The latter is primarily dull black but with the humeri and most of the pronotum orange, whereas *robusta* is dull black throughout. In addition, *humeralis* occurs from Quebec to South Carolina, and west to Iowa and Michigan; *robusta* is found from British Columbia to Oregon.

Thanks for loan of specimens important to this work are extended to the following: Charles Triplehorn, The Ohio State University (OSU); Sievert Rohwer, University of Washington (UW); Janice Scott, Museum of Comparative Zoology (MCZ); and Richard Westcott, Oregon Department of Agriculture (ODA). Thanks for donation of specimens to the U.S. National Museum Collection (USNM) are offered to Claude Chantal, St. Olivier, Quebec, Canada, and to Richard Westcott.

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THE NEARCTIC DISTRIBUTION, HOST PLANTS, AND NOMENCLATURE OF MONOCTONUS (HYMENOPTERA: APHIDIIDAE)[1]

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ABSTRACT—The distribution of the genus *Monoctonus* (Hymenoptera: Aphidiidae) is primarily Palearctic. Three species are Transpalearctic, 4 species are West Palearctic and 2 are East Palearctic. One species is Oriental. The Nearctic species of *Monoctonus* represent only cases of a natural spread or accidental introduction.

Our research on the taxonomy, distribution and host range of *Monoctonus* species has given some results which basically change the accepted classification of some species as well as their origin and distribution in North America. We are well aware that this study is preliminary as a lot of revisional work is necessary and comparisons should be made between aphid parasites in North America and the Nearctic fauna in Europe and other areas.

Material used for this study is deposited in the following collections: USNM, Washington, D. C.; California Academy of Science, San Francisco; C. F. Smith, Raleigh, North Carolina; and Petr Starý, Prague, Czechoslovakia.

We wish to thank the following for the loan of specimens and/or suggestions: P. Marsh, Systematic Entomology Laboratory, USDA, Washington; P. D. Hurd, Jr., USNM, Washington; P. H. Arnaud, Jr., Dept. of Entomology, California Academy of Science, San Francisco.

Monoctonus (*Monoctonus*) *caricis* (Haliday, 1833)

Specimens: U.S.A.—Minnesota: Crookston, July 19, 1960, on *Melilotus* (A. E. Grable). Maine: Aroostook Company, 1957, 1958, 1959, from *Aulacorthum solani* (Kaltenbach) (W. A. Shands). North Carolina: Mt. Mitchell, October 3, 1973, from *Pseudacaudella rubida* (Börner) on *Hylocomium splendens* (Hedw.) (C. F. Smith). North Dakota: Casselton (coll.?). Washington: Seattle, May 1963 (T. Kincaid).

The following hosts are known from Europe; *Hyalopteroides dactylidis* (Hayh.) (Starý *et al.*, 1973, France); *Metopolophium festucae* (Theobald), England (new record); *Sitobion equiseti* Holman (Starý, 1966, Czechoslovakia); *Sitobion fragariae* (Walker) (Starý *et al.*, 1973, France).

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This species is widely distributed in Europe (Mackauer & Starý, 1967). Its occurrence in North America is apparently due to natural spread via Iceland. It is possibly Holarctic–circumpolar in distribution, being primarily associated with forest tundra communities.

Monoctonus caricis is new to North America. The specimens of *Monoctonus* sp. reared from *Aulacorthum solani* (Shands *et al.*, 1965; Wave *et al.*, 1965) belong to this species.

Monoctonus (*Monoctonus*) *crepidis* (Haliday, 1834)

North American specimens of this species have not been seen by the authors.

Mackauer (1962) reported *Monoctonus crepidis* as a parasite of *Nasonovia ribisnigri* (Mosley) at Quebec, New Brunswick, Canada. In the opinion of Mackauer (1962) there is no evidence that it was introduced prior to 1952, the first known collecting data from Nearctic region. It is classified as adventive to the Nearctic fauna, accidentally introduced by ballast or as aerial plankton from Europe. *Monoctonus crepidis* is widely distributed in Europe and is known as a specific parasite of *Nasonovia* sp.

Monoctonus (*Monoctonus*) *nervosus* (Haliday, 1833)

Synonymy: *Monoctonus paulensis* (Ashmead, 1902), *Monoctonus secundus* Viereck, 1915.

Specimens: U.S.A.—Alaska: St. Paul Island, red label, Type No. 5902; white label, Allo-lectotype, Aph-paulensis, designated by Mackauer (T. Kincaid); St. George Island, Bering Sea, June 16, 1914 (G. Dallas Hanna); Mekoryuk, August 21, 1959 (R. H. Washburn). Oregon: Saddleback Mt., Lincoln C. (J. C. Dirks—Edmunds), Boyer, August 25, and September 4, 1931, shrub-herb (coll.?). Michigan: Mackinaw Co., August 24, 1952 (R. R. Dreisbach); Iron Co., August 27, 1952 (R. R. Dreisbach); Alger Co., June 19, 1955 (R. R. Dreisbach). California: Hayward, June 21, 1915, from *Acyrthosiphon pisum* (Harris) (R. E. Campbell); Mt. View (Ashmead), Sacramento, May 15 and March 18, 1931, swept from alfalfa (C. C. Wilson); Berkeley, April 22, 1921 (coll.?), May 22, 1904 (E. O. Essig), March 20, 1950 (J. I. Stage), June 7, 1907 (lectotype *M. secundus*), 1971 reared from *Sitobion fragariae* (Walker) (Tremblay).

The summary and references pertaining to this species are given by Starý (1974) and for this reason they are not mentioned in the present account.

Hosts: *Acyrthosiphon pisum* (Harris), *Amphorophora rubitoxica* Knowlton, *Aphis rumicis* L., *A.*? *tulipae* Boyer de Fonsc., *Macrosiphum euphorbiae* (Thomas), *Masonaphis grindelliae* (Williams), *Myzus ornatus* Laing, *M. persicae* (Sulzer), *Rhopalosiphum padi* (L.), *Sitobion fragariae* (Walker) (for references, see Starý, 1974). The European population of *M. nervosus*, so far as is known, is specific to *Impatientinum balsamines* (Kaltenbach), however, laboratory propagation on *Acyrthosiphon pisum* was successful. The Nearctic population exhibits a relatively very wide host range. It is interesting to note that of the ten host species recorded, only *Amphorophora rubitoxica* and *Masonaphis grindelliae* are indigenous to Nearctic America. The morpho-ecological type of the hosts seem to represent some Macrosiphine aphids, the "Sitobion-Impatientinum" type, to a lesser degree some Myzine and Aphidine groups (Starý, 1974).

According to the opinion of Starý (1974) the area of origin of *Monoctonus nervosus* is in the East Palearctic. From there, the parasite has spread over the Palearctic and to a lesser degree to the Nearctic via the Aleutian Islands, Alaska and following the Pacific coast of North America. This migration route is indicated by its occurrence in Alaska, Oregon and California, however, its migration from the Fennoscandia via Iceland is also possible, but the parasite has not been reported from Iceland yet. Its occurrence in Michigan could be an indication of the latter possibility. Its probable distribution is primarily Holarctic-circumpolar.

Taxonomic notes: A comparison of the descriptions, host range and examination of the material from Europe and Nearctic America resulted in the synonymizing of *M. paulensis* and *M. secundus* with *M. nervosus* by Starý (1974). This opinion has been recently supported by the examination of type-material, as follows:

Monoctonus paulensis: We have examined the allo-lectotype and some other specimens from the type–locality, St. Paul Island, Alaska, USNM Collection. The type has also been examined by Smith (1944).

Monoctonus secundus: Through the kindness of P. H. Arnaud we have received the holotype of this species from the collection of the California Academy of Sciences at San Francisco. The holotype is in a poor condition: the antennae are partially broken and the ovipositor sheaths are missing, owing apparently to feeding of a pest. The specimen is labeled: Berkeley, VI-7-07 Cal., W., CAS type No. 5780. The specimen agrees well with *M. nervosus* both from Europe and California, etc., except for somewhat more rugose sculpture and consequently less prominent longitudinal carinae on tergum 1, but owing to the examination of a comparatively large number of specimens, this difference is believed to be in the variation range of the species.

Monoctonus (*Harkeria*) *rufus* (Cameron, 1900)

Specimens: U.S.A.—Pennsylvania, Spring Br., May 23, 1945 (coll.?). Maine: Aroostook Co., June 6, 1953 (W. A. Shands).

The two examined specimens (females) fit perfectly with those we have seen from England and Finland, the antennae are 19-segmented.

Host: Unknown. The known distribution range of the parasite, England and Finland and recently eastern United States (Maine, Pennsylvania), indicate a natural spread via Iceland from Europe; thus most probably *M. rufus* is a Holarctic species associated primarily with forest tundra communities.

Monoctonus spp.

Specimens: Canada–Newfoundland: Aspen Br. K, July 17, 1961 (C. P. Alexander). U.S.A.—Oregon: Boyer, August 7, 1937, June 24, 1938 (coll.?). Pennsylvania: Spring Br., May 23, (coll.?).

Undetermined species were reported from the following hosts: *Aulacorthum solani* (Kaltenbach) (Shands *et al.*, 1965; Wave *et al.*, 1965). A part of this material is deposited in the USNM and belongs to *M. caricis*. *Macrosiphum euphorbiae* (Thomas), Sullivan and van den Bosch (1971); Calvert and van den Bosch (1972) refer to this record as "*M. paulensis*". *Schizaphis graminum* (Rondani), Wadley, 1931.

The origin and distribution of the genus *Monoctonus* with respect to its occurrence in North America was discussed by Starý (1974). *Monoctonus* is classified as a genus of Palearctic origin, its distribution is also primarily Palearctic, with an extension to the Oriental (Taiwan) and Nearctic regions. However, our present results require some changes in the grouping of the world species of *Monoctonus* in comparison with the aforementioned paper, as follows:

1. Transpalearctic, extending to the Nearctic: *M.* (*Monoctonus*) *nervosus* (Haliday), *M.* (*Monoctonus*) *caricis* (Haliday), *M.* (*Harkeria*) *rufus* (Cameron).
2. West Palearctic: *Monoctonus* (*Paramonoctonus*) *angustivalvus* Starý, *M.* (*Monoctonus*) *cerasi* Marshall, *M.* (*M.*) *crepidis* (*Haliday*) (accidentally introduced to North America), *M.* (*Falciconus*) *pseudoplatani* Marshall.
3. East Palearctic: *M.* (*Falciconus*) *longiradius* Takada, *M.* (*Monoctonus*) *similis* Starý and Schlinger.
4. Oriental: *Monoctonus* (*Monoctonus*) *woodwardiae* Starý and Schlinger.

The Nearctic species of *Monoctonus* represent only cases of a natural spread or accidental introduction.

Host and Parasite List

Acyrthosiphon pisum (Harris)
  M. nervosus
Amphorophora rubitoxica Knowlton
  M. nervosus
Myzus ornatus Laing
  M. nervosus
M. persicae (Sulzer)
  M. nervosus

Aphis rumicis L.
  M. nervosus
A. ?*tulipae* Fonsc.
  M. nervosus
Aulacorthum solani (Kaltenbach)
  M. caricis
  M. sp.—see *M. caricis*
Macrosiphum euphorbiae (Thomas)
  M. nervosus
  M. sp.—see *M. nervosus*
Masonaphis grindelliae (Williams)
  M. nervosus
Nasonovia ribisnigri (Mosley)
  M. crepidis
Pseudacaudella ribida (Börner)
  M. caricis
Rhopalosiphum padi (L.)
  M. nervosus
Schizaphis graminum (Rondani)
  M. sp.
Sitobion fragariae (Walker)
  M. nervosus

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TABANIDAE (DIPTERA) AT SELECTED SITES IN MARYLAND[1,2]

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ABSTRACT—Routine collections of Tabanidae were made from 3 areas in Prince George's County and 1 area in Anne Arundel County, Maryland, during 1973. Combined catches produced 20,068 specimens representing 20 species of *Chrysops*, 20 species of *Tabanus*, and 6 species of *Hybomitra*.

Thompson (1967) reported the known distribution of Maryland tabanids by county. Subsequent collections in the State, especially at the Patuxent Wildlife Research Center and the Pocomoke River Swamps, increased the number of state and county records (Thompson, 1970, 1971; Thompson and Sagle, 1969; Thompson *et al.* 1972).

During the summer of 1973, a survey of tabanid populations was made at 3 locations in Prince George's County and at 1 location in Anne Arundel County.

Sites and Methods

Survey areas: The northernmost station was at the Hayden Farm, part of the Beltsville Agricultural Research Center, East (BARC-E). The other sites were near the Patuxent River ca. 25 mi south of BARC-E and within 5 miles of each other. They were Mount Calvert Manor and the Merkle Wildlife Management Area on the west side of the river, and a station near Wayson's Corner on the east side of the river in Anne Arundel County.

The Hayden Farm was mostly grassland, and during the time of the survey, 2 Holstein steers were pastured near the traps. The trapping area at Mount Calvert Manor was located in a small clearing in a woodland of pine and hardwood, next to the Western Branch of the Patuxent River. The Merkle Wildlife Management Area is used primarily as a refuge for Canadian geese, and most of its 1000 acres were planted in corn. Traps were placed along the edge of the corn fields next to the dense vegetation that bordered the river.

Collection methods: Sweep-net collections around the collector's head were made along woodland paths at the 3 areas near the Patuxent River, but not at the Haydēn Farm.

Flies were captured by several box and canopy traps operated at each location. These traps were modifications of traps described by Catts (1970) and Hansens

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et al. (1971) as discussed by Uebel (1974). The survey traps were emptied twice weekly, and the numbers of flies were combined to form weekly totals.

Results and Discussion

Table 1 shows the total number of each species captured at the 4 trapping areas, along with the seasonal range. A combined total of 20,068 female tabanids, consisting of 1963 specimens of *Chrysops*, 8397 specimens of *Tabanus*, and 9708 specimens of *Hybomitra* were collected. Twenty species of *Chrysops*, 20 species of *Tabanus*, and 6 species of *Hybomitra* were represented. Of the total number of tabanids captured, 84.1% were taken at the Hayden Farm. Twenty-one males were captured in the traps and none was taken in overhead net collections.

Chrysops montanus Osten Sacken, the most numerous species of *Chrysops* trapped at the Hayden Farm, was represented by 150 specimens. The most numerous species of deer fly collected at the Patuxent River areas was *C. obsoletus* Wiedemann followed by *C. vittatus* Wiedemann and *C. dacne* Philip. No specimens of *C. montanus* were collected at the 3 Patuxent River areas and neither *C. obsoletus* nor *C. dacne* was collected at BARC-E.

Hybomitra lasiophthalma Macquart (9625 specimens) and *T. quinquevittatus* Wiedemann (5626 specimens) comprised over 90% of the tabanid catch at BARC-E. These 2 species were not nearly so abundant at the 3 Patuxent River stations where only 21 specimens of *H. lasiophthalma* and 8 specimens of *T. quinquevittatus* were captured. Thompson (1970, 1972) also found these species to be much less numerous at the Patuxent Wildlife Research Center. Perhaps the presence of cattle was influential in increasing the numbers of these horse flies at the Hayden Farm.

Only at the Hayden Farm were horse flies present in sufficient numbers to be a serious annoyance to livestock. The two steers at this location were often observed standing in a muddy water hole in an effort to evade the flies. Although the numbers of deer flies captured were not large, certain species, e.g., *C. vittatus*, *C. dacne*, and *C. univittatus* would have caused annoyance to anyone walking the woodland pathways at the Patuxent River locations, when peak numbers of these species occurred.

Appreciation is expressed to Dr. R. W. Miller and Dr. N. O. Morgan of the U.S.D.A. Chemical and Biophysical Control Laboratory, Beltsville Agricultural Research Center East, for their helpful advice and for aid in providing materials and facilities. Thanks are extended to Ronald Rosensteel and George Foster for help in making trap collections and identifying some specimens. Acknowledgment is also made of partial support under NSF-RANN grant GI 29906 through the Chesapeake Bay Consortium, Inc.

Table 1. Tabanidae (females) taken at three trapping areas in Prince George's County and one trapping area in Anne Arundel County, Maryland in 1973.

	Prince George's Co.			Anne Arundel Co.		
	Hayden Farm[a]	Mt. Calvert Manor	Merkle W.M.A.	Wayson's Corner	Total	Seasonal Range[c]
Chrysops						
callidus Osten Sacken		71 (23)[b]	69 (21)	6 (2)	146	June 2–Aug 4
calvus Pech. & Teskey	5	7	7		19	May 26–June 16
carbonarius Walker	15	4 (2)	1	1 (1)	21	June 9–June 30
celatus Pechuman	30	2			32	June 9–July 21
cincticornis Walker	23	7	1	1	32	June 2–June 30
cursim Whitney	1				1	June 30
dacne Philip		72 (65)	108 (104)	14 (44)	224	June 16–July 28
delicatulus Osten Sacken	3				3	June 16–July 17
dimmocki Hine	1				1	June 23
dorsovittatus Hine	1				1	June 16
flavidus Wiedemann	3	1	6 (4)		10	June 16–Aug 11
geminatus geminatus Wied.	18		5 (4)	1	24	June 16–July 21
macquarti Philip		11 (8)	2 (2)	5 (15)	28	June 9–July 21
montanus Osten Sacken	150				150	June 16–Aug 25
niger Macquart	4	36	27 (6)	6 (1)	73	May 19–June 23
obsoletus obsoletus Wied.		558 (74)	254 (31)	29 (6)	841	June 16–Aug 25
pudicus Osten Sacken	5				5	June 23–July 28
sequax Williston	2				2	Aug 4–Aug 11
univittatus Macquart	30	2 (2)	1	17 (17)	50	June 30–Sept 1
vittatus Wiedemann	4	150 (147)	97 (90)	49 (49)	300	June 16–Sept 15
Tabanus						
calens Linnaeus	1				1	Aug 11
cymatophorus Osten Sacken		3	1	3	7	June 30–July 14
fulvulus Wiedemann	17				17	June 23–Aug 4

Table 1. (*Continued*)

	Prince George's Co.			Anne Arundel Co.		
	Hayden Farm	Mt. Calvert Manor	Merkle W.M.A.	Wayson's Corner	Total	Seasonal Range
lineola Fabricius	306	726	57	164	1253	June 2–Sept 29
marginalis Fabricius	64	60	57	6	197	June 2–June 30
melanocerus Wied.	91	4	4		99	June 30–Sept 1
nigrescens Palisot	1	2	15		18	June 30–Aug 11
nigripes Wiedemann	247	3	3		253	June 16–Sept 1
petiolatus Hine	4	15	1	4	24	June 30–Aug 4
pumilus Macquart	130	74	29	22	255	June 9–July 21
quinquevittatus Wied.	5626		7	1	5634	July 16–Sept 1
reinwardtii Wiedemann				1	1	July 7
sackeni Fairchild	6	5	1		12	Aug 4–Sept 1
sparus milleri Whitney	1				1	July 7
sparus sparus Whitney	6				6	June 16–July 28
stygius Say	1	2	21	3	27	June 23–July 21
subsimilis subsimilis Bell.	226	29	6	25	286	June 2–Sept 29
sulcifrons Macquart	134	6	12	32	184	July 7–Sept 22
superjumentarius Whitney	7		2	1	10	June 9–July 7
trimaculatus Palisot	34	44	25	9	112	June 9–July 21
Hybomitra						
cinta (Fabricius)	1				1	July 7
hinei (Johnson)	26		1		27	June 16–July 14
lasiophthalma (Macquart)	9625	13	3	5	9646	May 12–July 7
sodalis (Williston)	4				4	June 30–July 7
trispila (Wiedemann)	8		1		9	June 23–July 14
typhus (Whitney)	21				21	June 2–June 16
Total	16,882	1,907	824	455	20,068	

[a] No aerial net collections were made at the trapping location on the Beltsville Agricultural Research Center.
[b] Values in parentheses represent the number of the total caught by net collections.
[c] The dates for the seasonal range are based on weekly totals.

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GALAPAGOS LACE BUGS: ZOOGEOGRAPHIC NOTES AND A NEW SPECIES OF PHATNOMA (HEMIPTERA: TINGIDAE)

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ABSTRACT—Including the present new species, *Phatnoma* **biordinatum**, the Galápagos Archipelago has 5 species of lace bugs, all endemic, in 2 widespread genera: *Corythaica* known only from the New World, and the pan-tropical *Phatnoma*. Apparently a minimum of 3 invasions from South America account for these 5 species.

The current emphasis on research in the Galápagos Archipelago demands awareness and knowledge of all forms existing thereon. Specimens of 2 species of lace bugs kindly supplied by Dr. Robert Silberglied furnish part of the information offered here as a supplement to the Drake and Froeschner (1967) synopsis of the lace bugs of the Galápagos and prompt some remarks on the zoogeography of the family on those islands. With the kind consent of Dr. Silberglied, the holotype of the new species described herein is deposited in the national insect collection in the United States National Museum of Natural History.

The family Tingidae is now known to be represented on the Galápagos Islands by 5 species, all endemic, in the widely ranging genera *Corythaica* and *Phatnoma*. The absence of endemic lace bug genera conforms to Usinger and Ashlock's (1966) statement that a lygaeid genus "is the only endemic heteropterous generic unit in the islands." The presence of so few species of lace bugs (verification needed because collecting of Tingidae requires special methods) on these oceanic volcanic islands in contrast to the rich fauna of Central and South America may well be due to the 600 or more miles of ocean isolating them from the mainland, but the inhospitable arid conditions on the islands could have contributed to the poverty of this fauna by preventing establishment of other tropical American forms which might have managed to survive the intervening ocean. As explained below, the present lace bug fauna on the Galápagos apparently resulted from a minimum of 3 invasions from tropical America, a region that has long been recognized as the source of a large part of the animal fauna of the Galápagos.

Genus *Corythaica* Stål

The genus *Corythaica* is wholly American, ranging from the southern United States south through Central America and the West Indies to Argentina in South America. Thus the founding stock from which the Galápagos *Corythaica* arose had to invade from somewhere along the western shores of the Americas, perhaps transported on ocean-carried drift floated on known favorable currents from either the Gulf of Panamá or from the coast of Peru.

The genus contains 3 Galápagos species of which 2, *C. cytharina* (Butler) and *C. wolfiana* Drake and Froeschner, are very similar to each other and to *C. costata* (Gibson) from Peru, Ecuador and Colombia. These 3 share the significant features of the ancestral uniseriate hypocostal lamina and the following 3 derived characters: the elevated inner limiting vein of the discoidal area, the somewhat tumidly swollen outer limiting vein of the discoidal area, and the paranotum being concave anterolaterally as a result of a broad, angular projection opposite the humerus; they quite probably had a common ancestor and the 2 very similar endemic Galápagos species easily could have descended from a single invasion by that stock. In contrast, the third Galápagos species, *C. darwiniana* Drake and Froeschner, while agreeing with the above trio on the first 3 features, has the paranotal outline broadly convex and so represents another part of the genus whose other species, *C. cucullata* (Berg), is known only from Argentina. At this time it is impossible to decide if specimens from a more northern population *C. cucullata* invaded the Galápagos Islands only to transform into *C. darwiniana* by genetic drift, or if another species existed along the northern part of the western coast of South America and was ancestral to both *C. cucullata* and *C. darwiniana*; or if *C. darwiniana* has a yet undetected South American population from which it invaded the Galápagos Islands. Regardless of this inability to decide upon the exact ancestry of *C. darwiniana*, its occurrence on these Islands had to result from one or more invasions different from that mentioned above for *C. cytharina* and *C. wolfiana*.

Corythaica cytharina (Butler). A single specimen was collected April 29, 1970, from the plant *Crytocarpus pyriformis* (family Nyctaginaceae) on Isla Santa Cruz. This record adds a fifth family to the list of plants frequented by this insect.

Genus *Phatnoma* Fieber

The other successful invading lace bug genus, *Phatnoma*, is pantropical and occurs south of the Tropic of Cancer on all major land masses and many of the islands. A South American origin is suggested by the fact that these 2 species of *Phatnoma* on the Galápagos Islands share their critically allying construction of the derived thickened supraclypeal spines and the ancestral and derived features of the delimiting veins of the elytral areas with the South American species *P. maculata* Monte known from Argentina and Brazil. While *P. maculata* is not known to occur along the Pacific Coast, the

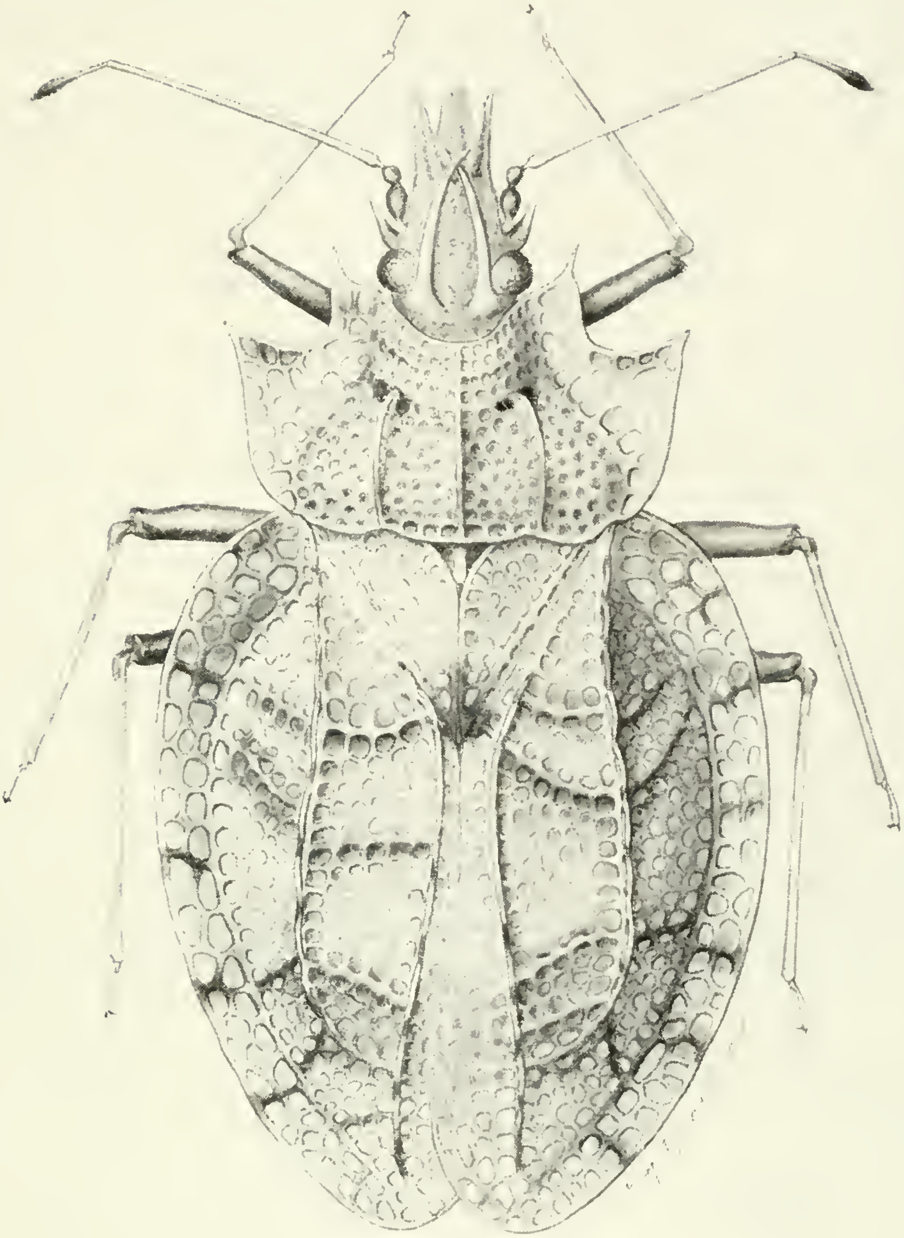

Fig. 1. *Phatnoma biordinatum*, new species, dorsal view.

shared derived structures may be interpreted to indicate a possible descent from a costal population that also gave rise to the common ancestor of the 2 Galápagos species.

Phatnoma biordinatum Froeschner, new species
fig. 1

The presence of but 2 rows of cells on the apical ¾ of the costal area (triseriate on basal ¼) will separate this species from all others in the genus.

Holotype ♀: Length 2.61 mm, width 1.4 mm. Brachypterous. Dorsal venation tannish yellow, elevated or thickened veins clouded with fuscous; cells hyaline or milky white. Head, most of ventral surface, tibiae and tarsi brownish yellow. Femora and first 2 antennal segments deep reddish brown.

Head with 7 cephalic spines: dorsally with slender horizontal occipitals surpassing eyes by ½ their length, supraclypeals distinctly thicker than occipitals, decurved, diverging from contiguous bases; anteriorly with 1 long tapering decurved spine on clypeus and on each jugum. Antennal segments: I, 0.06; II, 0.04; III, 0.62; IV, 0.16; 1st pyriform, 2nd globular, 3rd very slender except for thickened base, 4th gradually thickening to apical ¼. Labium reaching onto 2nd abdominal sternite.

Pronotum slightly convex, coarsely punctate. Tricarinate; lateral carinae parallel, slightly taller than median carina, terminating anteriorly on calli. Anterior margin broadly concave. Collum wide, not elevated. Paranotum moderately wide, flaring anteriorly, quadriseriate across widest part; anteriorly with 2 strong forward-directed, acute, spine-tipped angles separated by angular emargination. Posterior margin transverse, broadly exposing small, compressed scutellum.

Elytral outline oval. Elytral areas, including clavus, well developed and delimited; limiting veins of discoidal area laminate, with single row of elongate cells, without elevations. Discoidal area 6 cells wide, divided by 3 distinctly elevated transverse veins. Subcostal area oblique, with 7 cells across widest part; divided by 4 distinctly elevated cross veins. Costal area triseriate in basal ¼, with 2 mostly regular rows of cells on apical ¾. Sutural areas each 4 cells wide, superimposed at rest.

Sternal laminae uniseriate. Median line of abdomen impressed basally.

Holotype ♀: Galápagos Archipelago, Isla Santa Cruz, February 26, 1973, under bark along trail between Academy Bay and Bella Vista, Robert Silberglied, 1 specimen (USNMNH type number 72596).

The close relationship between this new species and *P. eremaeum* Drake and Froeschner [erroneously stated to be described from macropterous individuals], as attested to by the thickened supraclypeal spines, the absence of elevations on the uniseriately laminate delimiting veins of the elytral areas, and the same island habitat, probably resulted from a common descent from a single ancestral invasion; however, antennal segment III being much thinner in *biordinatum*, the outer row of subcostal cells being distinctly enlarged and in a regular row in *biordinatum*, and costal area being only biseriate on the apical ¾ in *biordinatum* are of specific value elsewhere in the family.

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NESTING BEHAVIOR OF MICROBEMBEX HIRSUTA PARKER, WITH NOTES ON RELATED SPECIES (HYMENOPTERA: SPHECIDAE)[1]

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ABSTRACT—The nesting behavior of *Microbembex hirsuta* Parker is described from 2 localities in Colorado and 1 in New Mexico. No important differences from other North American species were discovered. Notes are also presented on *M. monodonta* (Say) from localities where this species occurs with *hirsuta* and with *californica* R. Bohart. No evidence was found that these species differ in nesting sites, type of provisions employed for the nest, or gross aspects of behavior. Notes are also present on *M. argyropleura* R. Bohart from a site near Dateland, Arizona.

Members of the genus *Microbembex* are common inhabitants of tracts of open sand throughout temperate and tropical parts of the Americas. Specimens from the United States have often been assigned uncritically to *M. monodonta* (Say), but it is now apparent that at least 7 species occur north of Mexico, although only *monodonta* occurs east of the 100th meridian (Bohart and Horning, 1971). Since my review of the nesting behavior of *monodonta* (Evans, 1966, pp. 361–388), several papers have appeared on western members of this genus: *californica* R. Bohart (Goodman, 1970), *nigrifrons* Provancher (Alcock and Ryan, 1973), and *argyropleura* R. Bohart (Alcock, 1975). Notes on 3 species occurring in South America were also published by Matthews and Evans (1974). None of these species appear to differ from *monodonta* in any important way: so far as studied, all make unicellular nests in sand which they close upon leaving; all lay the egg erect in the empty cell before provisions are brought in; all "prey" upon dead or disabled arthropods of many different kinds; all make shallow "sleeping burrows" apart from the brood nest; and so forth.

The present paper concerns itself primarily with *M. hirsuta* Parker, a characteristic inhabitant of the western Great Plains, chiefly in New Mexico and western Texas (here recorded from Colorado for the first time). The data presented below further confirm the lack of any obvious behavioral differences among members of this genus. All of the species occur in apparently identical habitats: broad expanses of bare, fine-grained sand. Yet in the Southwest there is

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[1] Research supported by National Science Foundation, Grant GB-43790. The *Microbembex* were identified by R. M. Bohart, University of California, Davis, other insects by the writer.

much overlap in the ranges of the various species. In eastern Colorado, *hirsuta* and *monodonta* occur together commonly, nesting in the same situations and behaving apparently identically. In the Great Sand Dunes of Alamosa Co., Colorado, at about 2500 m elevation, just west of the first major range of the Rockies, *monodonta* occurs together with *californica* (here also recorded from Colorado for the first time). In this case I found no nests of *californica*, but the report of Goodman (1970) reveals no differences in nest depth, type of "prey", or other features, from *monodonta*. This would appear to be a situation in which there is ample substrate and a sufficient abundance of dead arthropods to support 2 closely related congeners.

On the other hand, at La Joya, New Mexico, and in the Mescalero Sands, east of Roswell, New Mexico, intensive collecting revealed only *hirsuta*, although at the Monahans dunes of western Texas, about 200 km south of the Mescalero Sands, an extensively maculated form of *monodonta* was very abundant at the same season. There may well be subtle features of habitat selection and minor differences in behavior not yet apparent.

Microbembex hirsuta Parker

This species was studied in sand dunes at La Joya, Socorro Co., New Mexico, 28 May 1974; in dunes near Hasty, Bent Co., Colorado, 18 July 1974; and in dunes and blowouts near Roggen, Weld Co., Colorado, 6 Sept. 1974. It was collected at several other sites in these 2 states and in western Texas and on many different dates, May to September. Males were abundant in most localities and were often seen landing here and there on the sand or on low vegetation during the morning hours. Both males and females dig shallow "sleeping burrows" in the late afternoon, usually grouped somewhat apart from the main nesting area, as is common in this genus.

There was no concentration of brood nests in any of the study areas; rather, nests were scattered widely over the available sand, chiefly in blowouts and windward slopes, the entrances one to several meters apart. Digging behavior is exactly as described for *monodonta* (Evans, 1966, pp. 368–370); as in that species, no appreciable mound accumulates, and at the initial closure several "radiating lines" are made at the entrance. As in *monodonta*, the burrow penetrates the soil at a 35–55 degree angle with the surface and may be perfectly straight or have one or more changes in slope or lateral bends before leveling off just before the cell. The cell is elliptical, slightly oblique, and measures about 1 × 2 cm. Data on burrow length and cell depth are shown in Table 1. The egg is laid erect near the center shortly after completion of the nest.

Table 1. Nest dimensions of *Microbembex* species.

Species	Locality	Note nos.	No. nests	Burrow length (cm)	Cell depth (cm)
hirsuta					
	La Joya, N.M.	2358	1	37	20
	Hasty, Colo.	2396	1	35	23
	Roggen, Colo.	2430	1	29	15
monodonta					
	Monahans, Tex.	2363	2	21–30	15–21
	Roggen, Colo.	2367	1	26	17
	Great Sand Dunes, Colo.	2403–2407	4	15–26	10–15
argyropleura					
	Dateland, Ariz.	2356	1	58	29

At La Joya, New Mexico, a female was seen bringing in a dead, dried *Scolops* (Dictyopharidae), which became stuck in the entrance and was eventually abandoned. Normally, "prey" is carried directly into the nest, the wasp holding it with her middle legs while she removes the closure with her front legs. In the 2 Colorado localities, the following insects were found to be employed as food for the larvae: camel cricket (*Ceuthophilus* sp.), metathorax and abdomen only; asilid fly, thorax only; male scoliid wasp (*Trielis* sp.), thorax and abdomen only; and several queen ants (*Lasius* sp.), some complete and some missing various parts.

One female *M. hirsuta* was observed to try to pick up a dead pompilid wasp (*Cryptocheilus severini* Banks), larger than she was, but she was unable to lift it from the ground.

Final closure of the fully provisioned nest also resembles that of *monodonta* closely. In the final stages, several "radiating lines" are made, the sand being thrown back toward the entrance. Occasionally the termini of these lines are sunken into the sand, forming short quarries or "accessory burrows". One such nest, in southern Colorado, had 3 such open holes, in a radial pattern, each about 2.5 cm from the covered nest entrance. They varied in depth from 0.5 to 1.0 cm.

At all 3 study sites, the chrysidid wasp *Parnopes f. fulvicornis* Cameron was common in close proximity of *M. hirsuta* nests. This is a known parasite of *M. nigrifrons* (Provancher) (Bohart and MacSwain, 1940) and there seems little question that it also attacks *hirsuta*.

Microbembex monodonta (Say)

Since previous observations on this species were all made east of the 100th meridian, where there are no congeners, it seems desirable to record that in areas of overlap with other species there are no marked behavioral differences from these species or from eastern populations of *monodonta*. Brief observations were made at Roggen, Colorado, where *monodonta* appears to nest close beside *hirsuta*, and at Great Sand Dunes National Monument, where *californica* also occurs. At the Monahans sand dunes, Ward Co., Texas, a rather large and strongly maculated form of *monodonta* occurs in great abundance; *hirsuta* was also taken in small numbers on the periphery of these dunes. In no case were any unusual features noted in manner of digging, closure, oviposition, or provisioning. Nests at Great Sand Dunes were unusually shallow, doubtless reflecting the fact that the soil there was very moist below the top 8 cm. Otherwise nests were of about the same depth as those of *hirsuta* (Table 1).

At Roggen, Colorado, a female was seen to pick up a dead lygaeid bug from the sand, drop it, then pick it up again and carry it off. At Monahans, Texas, a female was observed carrying a queen *Camponotus* ant with several legs missing. The 4 nests excavated at Great Sand Dunes contained a variety of insects, many of them incomplete. These included: femur of a grasshopper, wing of a true bug, a complete membracid, a small beetle of the family Scarabaeidae, 2 Chrysomelidae, 2 unrecognizable beetles, an incomplete ichneumon wasp, wasps of the genera *Dryudella* and *Ancistromma* (poor condition), and several worker ants.

Provisioning at Great Sand Dunes occurred at a slow pace, doubtless because of the cool morning and late afternoon temperatures at that altitude. One nest excavated immediately after final closure contained an essentially full-grown larva and 6 recognizable insects, as well as many fragments.

Microbembex argyropleura R. Bohart

A very large aggregation of this species was located near Dateland, Arizona, on 6 May 1974. An estimated 1000–2000 wasps occupied an area about 10 × 20 m along a sloping roadside which had been bulldozed a few years earlier through low sand dunes. There were a number of large patches of "sleeping burrows" open during the day. Brood nests were often only a few cm apart. The one nest excavated was somewhat isolated from the others; it proved to be rather tortuous but was successfully traced to a cell at a depth of 29 cm. Thus it was appreciably deeper than any other nests included in this study (Table 1), but unexpectedly shallow considering the fact that the sand here was exceedingly dry and powdery. Near Phoenix, Arizona, Alcock (1975) found the nests of *argyropleura* to be considerably deeper than this, cells varying from 45 to 67 cm in depth and some burrows being nearly a meter in length.

The nest excavated near Dateland contained a larva about 6 mm long with 3 dead insects: 2 shriveled beetle larvae, probably Chrysomelidae, and 1 immature cockroach lacking legs and antennae. A number of females carrying "prey" were followed by satellite flies, *Senotainia rufiventris* (Coquillett). Bombyliid flies, *Exoprosopa* sp., were also common, and were seen apparently ovipositing in open "sleeping burrows".

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A NEW GENUS FOR SEVERAL CHEYLETID MITES FORMERLY IN ACAROPSIS (ACARINA: CHEYLETIDAE)

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ABSTRACT—Action is taken to remove from *Acaropsis* Moquin-Tandon several species not congeneric with its type-species, *Tyroglyphus mericourti* Laboulbène. This species undoubtedly belongs to *Cheyletus* Latreille. Others hitherto assigned to *Acaropsis*, including *A. docta* (Berlese), are placed in a new genus, **Acaropsellina**, based on *Acaropsis sollers* Rohdendorf. *Acaropsellina* **anarsia** new species is here described.

It now appears that several species of mites presently assigned to *Acaropsis* Moquin-Tandon, 1862, are not congeneric with its type-species, *Acaropsis mericourti* (Laboulbène). The writer's attention recently focused on this matter when specimens were received from Dr. L. D. Charlet, University of California, Riverside. He had tentatively identified these mites as *Acaropsis mericourti* (Lab.) because the specimens sift to this name in Volgin's key (1969).

A search of old literature on *Acaropsis* reveals that recent students have improperly assigned other species to this genus. Laboulbène's (1851) description of *Tyroglyphus mericourti* is scarcely informative but the one illustration (his fig. 4) does not depict an *Acaropsis* species in the sense of current definitions of this genus (Oudemans, 1906; Baker, 1949; Volgin, 1969; Summers and Price, 1970). Laboulbène's illustration of *T. mericourti* shows a massive gnathosoma on which the femora of the pedipalps are robust and have diagonal lines of flexion with the sidewalls of the basis capituli. The coxal areas of the basis are mostly occupied by the extensive coxotrochanteral articulations. This is the structural pattern displayed by *Cheyletus* and its close allies.

The other species now assigned to *Acaropsis* have a different configuration to the mouthparts. In these forms the gnathosoma comprises a smaller fraction of total body length as compared with *Cheyletus* types (fig. 3). The palp femora are modest in girth and articulated with the basis in almost transverse lines of flexion. The basis thus resembles a short, flattened tube with movable mouthparts attached near its distal end.

While the true identity of *A. mericourti* may never be established beyond question, it is my opinion that Laboulbène incompletely described a nymph or a female of a species of *Cheyletus* which bears slender or acicular setae. Railliet (1886) expressed the belief that the mite collected by Leroy Méricourt is possibly identical with *Cheyleté erudit*, now called *Cheyletus eruditus* (Schrank).

Laboulbène and Moquin-Tandon described the palp terminalia of "l'acaropse" as comprising 1 stout apical claw, 1 elaborately pectinate seta and 1 arcuate seta. The presence or absence of a smaller, internal comb (or its homologue) and an additional sicklelike seta is critical for distinguishing several of the more recently created genera of cheyletids. The revision here proposed is based on the premise that the original describers dealt with a species of *Cheyletus* and that both Laboulbène and Moquin-Tandon failed to illustrate or describe the other, smaller sensilla on the palp tarsus.

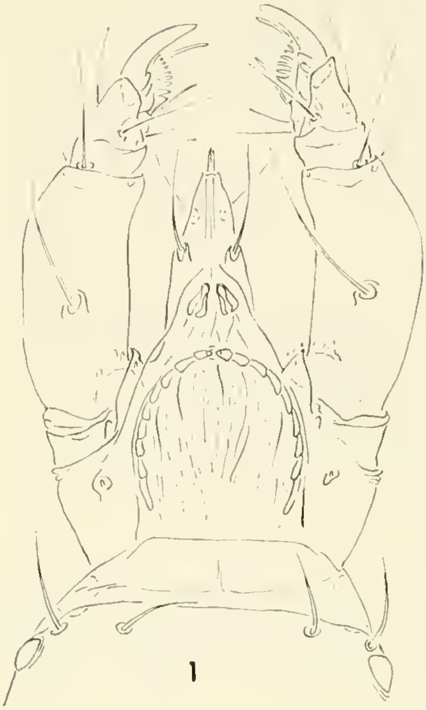
The species at hand which was first thought to be *Acaropsis mericourti* is a new species congeneric with those now called *Acaropsis docta* (Berlese) and *Acaropsis sollers* Rohdendorf. These 2 species are herewith transferred from *Acaropsis* Moquin-Tandon, based on *Tyroglyphus mericourti* Laboulbène, to a new genus having *sollers* as the type. The latter is selected in preference to the older *docta* because it has been redescribed in 2 modern works (Volgin, 1969; Summers and Price, 1970).

Oudemans (1906) included in *Acaropsis* a species which Karpelles (1884) described as *Cheyletus rufus*. Clues obtainable from Karpelles' illustrations indicate that *rufus* is not congeneric with *docta* and *sollers*. *Cheyletus rufus* is illustrated as having strongly barbed dorsal setae, a single basal tooth on the claw of the palp tibia, disproportionately long front legs and a very long, conspicuous guard seta covering the solenidion of tarsus I. It is advisable therefore to exclude *rufus* from consideration here. It appears to resemble species assigned to *Cheletomorpha* (Shaw) and was so regarded by Volgin (1969).

Acaropsellina Summers, new genus

Palp tarsus with 1 comblike sensillum, 2 sicklelike sensilla, 1 smooth acicular seta and 1 small solenidion; smooth acicular seta believed to be homologous with inner comb of other cheyletid genera. Claw on palp tibia with 2 or 3 pointed denticles on mesal face. Rostrum prominently displayed, conical, tapered to an almost pointed apex, approximately as long as palp femur. Peritremes form horseshoe pattern, without abrupt changes in curvature, 6–7 links or cells per side. Idiosoma rhombic or somewhat lozenge-shaped, widest behind legs II. Dorsal plating lightly sclerotized, faintly tanned in some specimens; 2 large median plates incompletely cover dorsum; humeral setae set on 1 pair of laterally situated platelets; sternal plating absent. Eyes small but well-defined. Dorsal body setae acicular to narrow lanceolate. Humeral setae flagelliform, much longer than dorsal body setae, smooth or nearly so. Tarsi I–IV with paired claws and multirayed empodia; claws hooklike, without basal swellings or apophyses.

Type-species: *Acaropsis sollers* Rohdendorf, 1940, by present designation.



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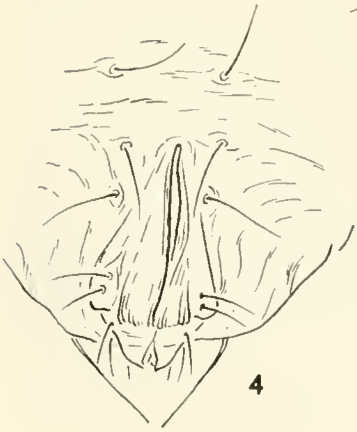

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Acaropsellina anarsia Summers, new species

fig. 1–5

Female: Palptarsal comb bears approximately 10 stubby tines; basal tine triangular, more robust than more distal tines (fig. 2). Seta corresponding to inner comb of other genera acicular, apparently smooth. Tegmenal surface of stylophore with striae broken into short, varicose segments covering almost entire upper surface, these in longitudinal rows some of which converge towards middorsal line. Two weakly sclerotized dorsal plates, both plates with faint broken striae; striae mostly in longitudinal direction; some striae arranged so as to form imperfectly developed meshwork or coarse reticulum; network better defined on margins of propodosomal plate, scarcely discernible on hysterosomal plate. Dorsal body setae acicular, barbed, sharply pointed, all fairly short. Dorsomedians slightly shorter than dorsolaterals, 2–3 pairs on propodosomal plate, 3–4 pairs on hysterosomal plate. Humeral setae flagelliform, with few basal barbs, slightly more than 2× longer than nearest dorsolaterals ($he = 70\mu$ on holotype). Numbers of setae on podomeres of legs I–IV: femora 2-2-2-1, genua 3-2-2-2, tibiae 6-4-4-4, tarsi 9-8-7-7. Measurements of several parts of 4 specimens (range, in microns): gnathosoma—dorsal baseline of stylophore to tip of rostrum = 113–121; idiosoma—dorsal baseline of stylophore to rear end of opisthosoma = 357–372; leg I—proximal tip of trochanter to tip of claws = 205–228; dorsal seta on palp femur = 51–55; vertical seta = 27–27; humeral seta = 70–86; 1st dorsolateral seta on hysterosoma = 31–35; 1st dorsomedian seta on hysterosoma = 23–27; solenidion *w* I = 39–43.

Male: Rostrum and palp femur slightly longer than for female but not obviously heteromorphic in form. Tibia II, tarsi III and IV with 1 small mesoventral solenidion each. Basis capituli with a bulbous protuberance below coxotrochanteral articulation of each side; each protuberance with thin, transverse flange serrated to form an arched row of 5 or more anteriorly directed denticles (fig. 1).

Type-series: 7 ♀♀, 1 ♂, C. A. Fleschner, Colr. Five paratype ♀♀ (one slide) deposited in United States National Museum, Washington, D.C., holotype ♂ and other paratypes (one slide in Entomology Museum, University of California, Davis).

The action taken in this paper creates new name combinations for the 2 previously described species, viz., *Acaropsellina sollers* (Rohdendorf), NEW COMBINATION, and *Acaropsellina docta* (Berlese), NEW COMBINATION. It is believed that the species of this new genus are separable according to the characters given in the key below.

←

Fig. 1–5, *Acaropsellina anarsia.* 1, Gnathosoma of male, dorsal. 2, Gnathosoma of female, dorsal. 3, Dorsal aspect of female. 4, Anogenital region, female. 5, Illustration of several setae, l. to r.: anterior dorsomedian of propodosoma; humeral; 1st dorsolateral of hysterosoma. Index lines = 0.01 mm, applicable only to adjacent figures.

KEY TO FEMALES OF ACAROPSELLINA SUMMERS

1. Dorsal body setae acicular, barbed, sharply pointed .... *anarsia*, new species
— Dorsal body setae plumose, with slightly widened blades, tips blunt, frayed or fringed 2
2. Two pairs of dorsomedian setae on propodosomal plate .... *sollers* (Rohdendorf)
— Three pairs of dorsomedian setae on propodosomal plate .... *docta* (Berlese)

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ALEUROPTERYX JUNIPERI: A EUROPEAN SCALE PREDATOR ESTABLISHED IN NORTH AMERICA (NEUROPTERA: CONIOPTERYGIDAE)

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ABSTRACT—The Palearctic coniopterygid *Aleuropteryx juniperi* Ohm is reported in North America, based on specimens collected July 21, 1968, in south-central Pennsylvania, and 1972–74 in 11 additional counties of Pennsylvania on several species and cultivars of juniper. *Aleuropteryx juniperi* overwintered mainly as second-instar larvae. Adults appeared by the middle of May and oviposited on the undersides of juniper needles in early to mid-June. Adults of the second generation became abundant in late July and in mid- to late August produced eggs that formed the overwintering population. Both larvae and adults were observed to feed on juniper scale, *Carulaspis juniperi* (Bouché), and minute cypress scale, *C. minima* (Targioni-Tozzetti), infesting various *Juniperus* spp. Introduction via nursery stock is considered probable.

Aleuropteryx juniperi, recently described by Ohm (1968), has long been confused with the pine-inhabiting *A. loewii* Klapalek, but has been shown to occur mainly on *Juniperus* spp. (Ward, 1970). Meinander (1972) figured head, wings, male and female genitalia and gave Austria, Germany, Great Britain, France and Spain for its distribution. Ward (1970) reviewed the taxonomic history of *A. juniperi* and the subfamily Aleuropteryginae and described the last instar larva. She gave juniper scale, *Carulapsis juniperi* (Bouché), as the probable host for *A. juniperi* and suggested that its association with ornamental junipers may account for its introduction into Britain.

I first reported this coniopterygid new in North America based on specimens collected on *Juniperus* sp. July 21, 1968 at Harrisburg, Pennsylvania, by E. E. Simons and during 1972–74 from 6 additional counties in Pennsylvania (Coop. Econ. Insect Rep., 1974a). A second state record was reported based on specimens collected on juniper July 15, 1974, at Fairfax, Virginia, by R. W. Baumann (Coop. Econ. Insect Rep., 1974b). This paper summarizes my observations on the biology of *A. juniperi* in Pennsylvania.

Methods

Records of seasonal occurrence were obtained through weekly sampling at Harrisburg during May–September, 1974, and general collecting in other areas of Pennsylvania. Ten of 90 globose Hetz junipers were selected randomly for each weekly sample. Since coniopterygids and scales were found to be nearly restricted to the lower branches, the lowest 2′ was sampled by tapping the

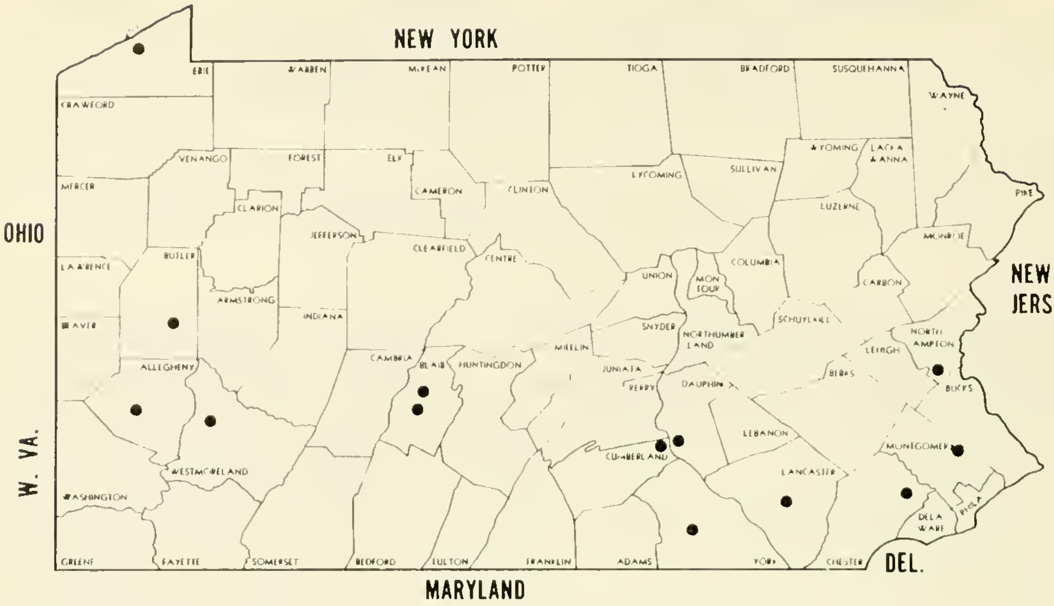

Fig. 1. Distribution of *Aleuropteryx juniperi* Ohm in Pennsylvania.

branches over a 10″ × 12″ beating tray. Adults were collected with an aspirator, counted and then released.

Biology

This coniopterygid has been collected in 12 counties (fig. 1) on scale-infested branches of andorra juniper, *Juniperus horizontalis* (Moench) Meth. cv. 'Plumosa'; Hetz juniper, *J. chinensis* (L.) Mant. cv. 'Hetzii'; Pfitzer juniper, *J. chinensis* cv. 'Pfitzeriana'; Sargent's juniper, *J. chinensis* var. *sargentii*; and eastern red cedar, *J. virginiana* L. It has been taken in association with 2 species of scale: juniper scale, *Carulaspis juniperi*, and minute cypress scale, *C. minima* (Targioni-Tozzetti). Juniper scale is found statewide, whereas minute cypress scale has been taken only in southcentral and southeastern Pennsylvania (Coop. Econ. Insect Rep., 1974c). All of my observations pertain to *C. minima* because of the convenience of a high local population of both coniopterygid and scale.

There are apparently 3 larval stages of *A. juniperi*. Second-instar larvae overwintered and became active on warm days (45–50°). Larvae were taken from the branches of Hetz juniper infested with minute cypress scale as late as December and early as mid-February. With the return of cold weather, the larvae apparently retreated into the inner branches, or sought protection in the crevices of the rough bark or needles on the outer branches. During cold weather, it became difficult to collect any specimens from the foliage.

Most of the overwintering larvae matured and pupated by the first or second week of May. Adults appeared mainly from mid- to

Table 1. Numbers of *A. juniperi* in 10 beating samples/week at Harrisburg, Pa. during 1974.

	Date	No. of Adults	No. of Larvae
May	31	66*	—
June	12	53	—
	19	16	1
	26	6	—
July	3	1	10
	10	5	23
	17	40	26
	25	65	29
	31	234	45
Aug.	7	192	—
	14	85	29
	21	23	90
	28	2	179
Sept.	5	4	184
	20	0	954*

* 5 plants/sample; counts adjusted to 10 plants/sample.

late May with the first record April 27 from Hershey, Dauphin Co. The adult population peaked by the first week of June and rapidly declined so that only a few adults were present by early July. First-instar larvae of the second generation appeared during the last week of June; adults by the middle of July. Adults became most abundant in early August and disappeared by the second week of September. The latest record for an adult was October 31 in Harrisburg. First-instar larvae were predominant during early September, and second-instar larvae representing the overwintering population were abundant in late September. They continued to feed on warm days through December.

Weekly samples taken in Harrisburg indicated 2 distinct generations of *A. juniperi* (Table 1). First generation adults reached their highest numbers on May 31; second generation adults peaked on July 31. Larvae were counted beginning in early July, and on September 20 they reached a peak of 476 in 5 samples, or nearly 100 per tray. Counts for larvae may have been low because of the difficulty in sorting them from debris.

Pairing was observed in the field and laboratory (fig. 2). The male and female assume a tail-to-tail position with the female often dragging the male behind. This process lasted for at least 20 minutes.

Fig. 2–4. *Aleuropteryx juniperi* Ohm. 2, tail-to-tail pairing position. 3, egg. 4, larva feeding on *Carulaspis minima* (Targioni-Tozzetti) nymph.

Photographing and transferring to different containers did not seem to disturb mating pairs. Even after rigorous beating, mating pairs were often taken in samples. In contrast to this tail-to-tail pairing, Collyer (1951) described a staggered-parallel position in *Conwentzia pineticola* Enderlein with the male holding onto the hind coxae of the female with its mouthparts and forelegs.

Eggs of *A. juniperi* are 0.4 mm long and oblong–oval with the ventral side slightly flattened. The chorion is brownish and finely faceted. Both field-collected eggs and eggs deposited in the laboratory are generally laid singly and glued to the undersides of the juniper needles (fig. 3). Under crowded laboratory conditions, up to 6 eggs were recovered from a single needle, and occasionally eggs were laid randomly about the stems and sides of the rearing containers.

The larvae (fig. 4) are sluggish and seem to locate their prey only by direct contact. Fleschner (1950) studied the searching capacity of the citrus red mite predator *Conwentzia hageni* Banks (prob. confused with *C. californica* (Meinander, 1972)) and concluded that this coniopterygid detected the presence of its prey only by actual physical contact. Larvae of *A. juniperi* feed at the base of the adult scale insects rather than penetrate the hard outer shell (exuviae and waxy secretions). The mouthparts are inserted to their base with the palpi forced out to a horizontal position. One third-instar larva was observed feeding for 25 minutes on a mature scale. On the softer-bodied scale crawlers and nymphs, penetration is not as critical as with the adult scales; therefore, the larvae fed at more random locations.

When mature, the larva spins a conspicuous white, double-layered silken cocoon. The inner layer is dense and completely covers the pupa; the outer layer is composed of a coarsely-woven mesh of silk that loosely covers the more compact cocoon inside. The cocoons are attached to the terminal stems and are readily visible by examining the undersides of the juniper branches. Upon emergence, the adult forces its way through the fragile cocoon, leaving the pupal skin protruding.

Adults were observed to feed on all stages of minute cypress scale. The crawlers are grasped with the mandibles and entirely consumed. On mature scales, adults chew off the "cap" or hard shell, then proceed to feed on the soft-bodied scale inside.

Adults may also feed on scale secretions. They often stop and appear to feed on the crystal-like residue that coats many of the scale-infested branches. In the laboratory, adults will feed on honey dissolved in water if no scales are present.

It was thought, perhaps, that this coniopterygid would also prey on spruce mite, *Oligonynchus ununguis* (Jacobi), as well as on scale insects. Field-collected adults were placed in control cages containing clean juniper branches, branches infested with spruce mites and branches infested with minute cypress scale. The coniopterygids on the control and mite-infested branches congregated on the sides of the rearing containers and died within 2 days. This test was run repeatedly throughout the season, and adults were never observed to feed on mites or survive more than 2 days. On scale-infested branches *A. juniperi* survived for several weeks and oviposited frequently. To further strengthen the conclusion of the host specificity of *A. juniperi*, adults, starved overnight, were released onto scale-infested branches, mite-infested branches and whitefly-infested leaves of a *Phaseolus* sp. The adults quickly began to feed on the scale insects; they again ignored the mites; and a few adults attempted to chew through the hard covering of whitefly nymphs and pupae but were never successful.

Aleuropteryx juniperi probably was introduced into this country on juniper nursery stock. It is documented that living juniper plants infested with juniper scale were brought into southeastern Pennsylvania nurseries from Europe in the early 1900's (Surface, 1915). Unlike many other introduced insects, *A. juniperi* is beneficial and may prove to be important in limiting populations of juniper and minute cypress scale on ornamental junipers.

I am grateful to Dr. Martin Meinander, University of Helsinki, for verifying my determination of *A. juniperi*. Also, thanks to Dr. Alfred G. Wheeler, Jr., Bureau of Plant Industry, Pennsylvania Department of Agriculture, for collecting many of the specimens used in this study and for kindly reading the manuscript and offering suggestions for its improvement; Janene Giomariso and Karen McIntosh, summer employees with the Pennsylvania Department of Agriculture, for their valuable help in making laboratory observations and collections of field samples; and James F. Stimmel, BPI, PDA, for his photographs included in this paper.

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A Catalogue of the Staphylinidae of America North of Mexico (Coleoptera). I. Moore and E. F. Legner. 1975. Division of Agricultural Sciences, University of California, Special Publication 3015. pp. 1–514.

These two publications are intended for joint usage as the references cited in the Catalogue are listed in detail in the Bibliography. The value of these publications cannot be questioned; as the North American Staphylinidae have not been similarly treated since the Leng catalog (checklist) and its supplements were published. To anyone other than a specialist in the family, the vast number of genera and species has presented an almost insurmountable obstacle to research. Moore and Legner have, to a large degree, removed this obstacle with their Catalogue and the accompanying keys to genera. The Bibliography includes all or nearly all of the references to the taxonomy and biology of the Staphylinidae of America, north of Mexico, through 1972. Keys to the subfamilies and genera of the Staphylinidae are presented which, although unfortunately not illustrated, are the most complete and accurate of any available. The Catalogue includes, in addition to the standard items to be expected in any comprehensive catalogue, references to existing keys to species and references that include illustrations. These illustrations are listed in detail, giving page, plate and figure numbers of each. An indication is also given as to whether the illustration is in toto or of the sexual characteristics of either male or female. When more than one article by an author in the same year is listed, it is not always possible to tell which is being referred to. These references do not have the preferred format of the year followed by a subletter. The type-species of generic synonyms are not listed, and this information would have been useful. These two publications comprise a timely, much needed contribution to the knowledge of North American Staphylinidae.

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SAWFLIES OF THE HOLARCTIC GENUS PLATYCAMPUS SCHIØDTE (HYMENOPTERA: TENTHREDINIDAE)

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ABSTRACT—The three species of the genus *Platycampus* are keyed and characterized. *Platycampus luridiventris* (Fallén) is the only Eurasian species and feeds on *Alnus*. *Platycampus albostigmus* (Rohwer) and *P. americanus* (Marlatt) are transcontinental in Canada and northern United States; the hosts are *Populus* and possibly *Corylus*. *Camponiscus smithi* Rohwer and *Platycampus vierecki* MacGillivray are new synonyms of *P. americanus*.

Platycampus is a small holarctic genus with one Eurasian and two North American species. Four species have been described from North America, but these represent only two valid species, both of which are transcontinental in Canada and northern United States. The Eurasian species is associated with alder, and the North American species are associated with poplar and possibly hazel.

Genus *PLATYCAMPUS* Schiødte

Nematus subg. *Leptopus* Hartig, 1837. Fam. Blattwespen und Holzwespen, nebst Einleitung Naturgesch. Hym., p. 184. Preocc. by *Leptopus* Latreille, 1809.
Type-species: *Nematus* (*Leptopus*) *hypogastricus* Hartig. Monotypic.
Platycampus Schiødte, 1839. Mag. Zool. (ser. 2) 1:20, footnote; pl. 6–10. N. name for *Leptopus* Hartig.
Erasminus Gistel, 1848. Naturgesch. Thierr. f. höh Schul., p. 9. N. name for *Leptopus* Hartig.
Camponiscus Newman, 1869. Entomologist. 4:215.
Type-species: *Camponiscus healaei* Newman. Monotypic.

As a member of the subfamily Nematinae, *Platycampus* belongs to the group of genera having vein 2A and 3A curved up and meeting 1A to form a basal anal cell in the forewing. The following characters will separate *Platycampus* from other genera possessing the basal anal cell: vein 2r absent in forewing; tarsal claw with long inner tooth; 2nd antennal segment as broad or broader than long; and malar space long, 1½ or more times diameter of front ocellus or nearly as long as length of first 2 antennal segments.

Rohwer (1918) listed the North American species but gave no key. He included *Platycampus juniperi* Rohwer, a species now placed in the genus *Susana*. MacGillivray (1920) gave a key to the North American species, but he also included several species now placed

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in other genera. Ross (1951) listed the four North American species which are dealt with in this paper.

In some European literature, a number of other European species have been placed in *Platycampus*, namely *duplex* (Lepeletier), *ovatus* (Zaddach), and *pectoralis* (Lepeletier). These three species, all of which have simple tarsal claws and are associated with *Larix*, belong in the genus *Anoplonyx* Marlatt where they have been placed by most authors in recent years. With the removal of these species from *Platycampus*, *luridiventris* (Fallén) becomes the sole Eurasian representative.

KEY TO WORLD SPECIES

1. Black; legs yellow and venter of abdomen usually yellowish; Eurasia .... *luridiventris* (Fallén)
— Yellow, at most infuscated to black areas on metanotum and basal abdominal segments, sometimes also on mesonotum in males; North America 2
2. First and 2nd antennal segments each wider than long; eye larger, oblong (compare fig. 1–4); penis valve of male with short, rounded apical lobe (fig. 11) .... *americanus* (Marlatt)
— First and 2nd antennal segments each as long as wide; eye smaller, round (compare fig. 1–4); penis valve of male with long, slender, pointed apical lobe (fig. 9) .... *albostigmus* (Rohwer)

Platycampus albostigmus (Rohwer)
fig. 1, 2, 6, 8, 9

Camponiscus albostigmus Rohwer, 1908. J. N.Y. Entomol. Soc. 16:105.
Platycampus albostigmus: Rohwer, 1918. Proc. Entomol. Soc. Wash. 20:172; MacGillivray, 1920. Can. Entomol. 52:60; Ross, 1951. *In* Muesebeck, *et al.*, U.S. Dept. Agr., Agr. Monog. 2:36.

Female: Length, 5.0 to 7.0 mm. Yellow with following sometimes blackish: dorsal surface of antennae; anterior and dorsal margins of cervical sclerites; area between ocelli; posttergite; metanotum; and basal 2 or 3 abdominal tergites. Wings hyaline, veins mostly brownish and costa and stigma yellow.

First and 2nd antennal segments each as long as wide; clypeus subtruncated to very shallowly, circularly emarginated; eye small, round; malar space long, more than 2× diameter of front ocellus. Sheath as in fig. 7. Lancet with 11 annuli; without surface texture of short spines; somewhat constricted near base; serrulae round, without anterior and with 2 or 3 posterior subbasal teeth (fig. 6).

Male: Length, 4.5 to 6.5 mm. Coloration and structure similar to that of female. Genitalia as in figs. 8, 9; penis valve with long, narrow, pointed apical lobe.

Type: Female at the University of Nebraska, from "Ute Creek, Costilla Co., Colo., 9000′, July 2, 1907, L. Bruner."

Distribution: I have seen specimens from the following states and

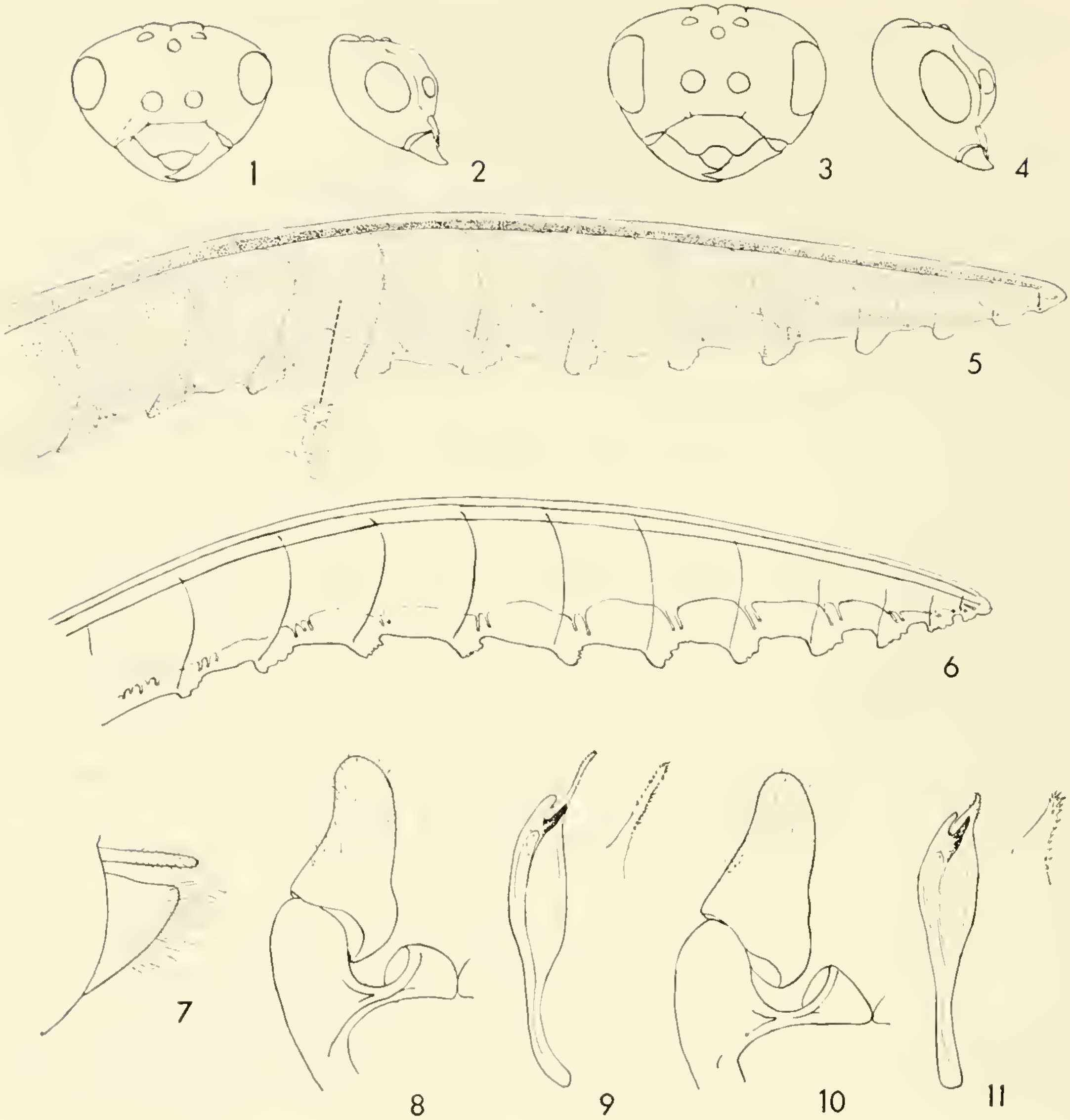

Fig. 1–2, *Platycampus albostigmus*, head. 1, front view. 2, lateral view. Fig. 3–4. *P. americanus*, head. 3, front view. 4, lateral view. Fig. 5. Lancet of *P. americanus*. Fig. 6. Lancet of *P. albostigmus* (shading similar to that in fig. 5). Fig. 7. Sheath, lateral view, of *P. americanus*. Fig. 8–9. *P. albostigmus*. 8, harpe and parapenis. 9, penis valve. Fig. 10–11. *P. americanus*. 10, harpe and parapenis. 11, penis valve.

The lancet in fig. 5 was drawn by Ann Lacey.

provinces: Nova Scotia, Maine, Ontario, New York, Michigan, Minnesota, Northwest Territories, Alberta, Saskatchewan, Colorado, Alaska, British Columbia, Washington, Nevada.

Host: One specimen from Ontario bears the host label "hazel".

Discussion: The extent of black on the structures listed varies, and there may be practically no dark areas on some specimens. The serrulae of the lancet are commonly worn; consequently, the serrulae of all specimens may not agree with the illustration.

Platycampus americanus (Marlatt)
fig. 3–5, 7, 10, 11

"2G" Dyar, 1895. Can. Entomol. 27:340 (larva, in key).

Camponiscus americanus Marlatt, 1896. Can. Entomol. 28:251; Dyar, 1897. J. N.Y. Entomol. Soc. 5:23–24 (larva).

Platycampus americanus: Rohwer, 1918. Proc. Entomol. Soc. Wash. 20:172; MacGillivray, 1920. Can. Entomol. 52:60; Ross, 1951. *In* Muesebeck, *et al.*, U.S. Dept. Agr., Agr. Monog. 2:36.

Camponiscus smithi Rohwer, 1908. J. N.Y. Entomol. Soc. 16:105. NEW SYNONYM.

Platycampus smithi: Rohwer, 1918. Proc. Entomol. Soc. Wash. 20:173; MacGillivray, 1920. Can. Entomol. 52:60; Ross, 1951. *In* Muesebeck, *et al.*, U.S. Dept. Agr., Agr. Monog. 2:36.

Platycampus vierecki MacGillivray, 1920. Can. Entomol. 52:60; Ross, 1951. *In* Muesebeck, *et al.*, U.S. Dept. Agr., Agr. Monog. 2:36. NEW SYNONYM.

Female: Length, 5.0 to 7.0 mm. Yellow with following sometimes blackish: dorsal surface of antennae; area between ocelli; anterior and dorsal margins of cervical sclerites; lateral margins of mesonotum; posttergite; metanotum; mesepimeron; extreme base of hind coxae; basal 1 to 5 abdominal tergites; sheath. Wings hyaline; veins mostly brownish; costa and stigma yellowish.

First and 2nd antennal segments each wider than long; clypeus circularly emarginated for ¼ to ⅓ its medial length; eye large, oblong; malar space long, about 1½× diameter of front ocellus. Sheath as in fig. 7. Lancet with 12 annuli; surface texture consisting of stout spines; not noticeably constricted at base; serrulae round, without anterior and with 2 or 3 posterior subbasal teeth (fig. 5).

Male: Length, 4.5 to 6.5 mm. Yellow with following usually black: 1st and 2nd antennal segments and dorsal surface of remaining segments; large spot on vertex enclosing ocelli but not quite reaching antennae, eyes, or posterior margin of head; dorsal and anterior margins of cervical sclerites; large spot on each lateral lobe of mesonotum and sometimes spot on mesoprescutum; posterior margin of mesoscutellum; posttergite; mesepimeron; metanotum; extreme base of hind coxae; basal 2 to 4 abdominal tergites. Structure similar to that of female. Genitalia as in fig. 10, 11; penis valve with short, rounded apical lobe.

Types: *Camponiscus americanus* Marlatt: U.S. National Museum type no. 3471, ♀, "2G", "reared from larva on poplar", "Jefferson, N.H., coll. H. G. Dyar". *Camponiscus smithi* Rohwer: University of Nebraska, ♀, "Ute Creek, Costilla Co., Colo., 9000′, July 1, 1907, H.S. Smith". *Platycampus vierecki* MacGillivray: Illinois Natural History Survey, ♀, "Cloudcroft, N. Mex., VI-18-02."

Distribution: I have seen specimens from the following states and provinces: New Brunswick, Quebec, Maine, New Hampshire, Ontario, New York, Pennsylvania, Alberta, Idaho, Colorado, New Mexico, Alaska, Oregon. Also recorded from Manitoba and Saskatchewan by Wong (1951).

Host: *Populus* sp., *Populus tremuloides* Michx.

Discussion: The black on the structures listed above varies, and in some specimens the black may be entirely wanting. The males have considerably more black on the head and mesonotum than do the females. The serrulae of the lancet of the female are sometimes worn with use; consequently, they may not always agree with the illustration.

I have not seen the larva of *americanus* though it was described by Dyar (1897). Though very sketchy, the description may help to distinguish the larva from other poplar feeding sawflies: "Head pale brown, shining, eye black; width 1.5 mm. Thorax enlarged, the feet spreading pale; abdominal ones on joints 6 to 11 and 13 [prolegs on abdominal segments 2 to 7 and 10]. Segments indistinctly annulate, incisures well marked, folded. Whitish, not shining, the food makes the dorsum to spiracles green, the posterior end of alimentary canal forms a blackish shade which looks like a mark at first glance. Thorax higher than head. Sits flat on the venter, usually curled spirally when at rest. Five stages observed, but not consecutively."

Platycampus luridiventris (Fallén)

Tenthredo luridiventris Fallén, 1808. Svensk. Vetensk. Akad. Handl. 29:115. ♀. For synonyms, see Berland (1947) and Muche (1974); included with synonyms are *hypogastricus* Hartig and *healaei* Newman, the type-species of *Leptopus* and *Camponiscus*, respectively. Berland (1947) recognized *Platycampus obscuripes* (Konow) from Switzerland as a separate species, separated by the black femora, but Conde (1937) considered it only a color form of *luridiventris*, and Muche (1974) put it in *Anoplonyx*.

The female is black with yellow legs, the tarsi usually infuscated, with white on the posterior corners of the pronotum and tegulae, and with yellow to orange usually on the venter of the abdomen. The male is entirely black with yellow legs. The size and structure are more similar to those of *americanus* than *albostigmus*.

Platycampus luridiventris is found throughout Europe, and was recorded from China (Szechuan) and Japan by Benson (1963). The recorded hosts are *Alnus incana* Willd., *A. glutinosa* Gaertn. and *A. rotundifolia* Mill. Obarski (1934) and Hsin (1935) gave some biological notes on the species; Maxwell (1955) described the internal larval anatomy; and Lorenz and Kraus (1957) described the larva and stated that the species sometimes feeds on *Betula*, *Corylus*, and *Rubus idaeus*. The larva is most unusual for a sawfly, the body being flattened with each segment extended laterally as lobes, and the head, in frontal view, concave on the dorsum.

Specimens were made available for this study by D. W. Webb, Illinois Natural History Survey, Urbana; G. Gibson, Biosystematics Research Institute, Agriculture, Canada, Ottawa; and R. L. Fischer, Michigan State University, East Lan-

sing. Other specimens used in this study are in the U.S. National Museum, Washington, D.C.

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ETHOLOGY OF LEPTOGASTER PARVOCLAVA IN WYOMING (DIPTERA: ASILIDAE)[1,2,3]

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ABSTRACT—Flight and foraging behavior is described for *Leptogaster parvoclava* Martin. This species captured most of its prey on a plant stem, leaf or flower; a few *Bucculatrix* sp. (Lepidoptera: Lyonetiidae) larvae were captured as the larvae were suspended by their silken threads from a plant stem. Inanimate objects were frequently mistaken for prey and attacked. Prey were manipulated with five tarsi while the asilid held onto the feeding site with one of its mid-tarsi. The preferred prey belonged to the orders Homoptera and Lepidoptera. While in-copula the male assumed a head down position with his dorsal surface facing the same way as the female's ventral surface. Matings lasted for an average of 16 minutes. Females dropped their eggs on the soil in the shade of caved in ground squirrel tunnels. Grooming behavior is similar to that described for other species of Asilidae.

Leptogaster parvoclava, as described by Martin (1957), is morphologically quite similar to many species of *Leptogaster* in that it is a slender, grayish-black fly with a long abdomen, short wings and long hind legs. Males are usually smaller than females as has been observed for other *Leptogaster* (Lundbeck, 1908; Melin, 1923; Parmenter, 1952). It is probable that the difference in size is due, in part, to the distention of the female's abdomen which occurs as the eggs mature in the ovaries.

Adult *Leptogaster* are typically associated with grassland, shrubby and/or wooded areas (Adisoemarto, 1967; Bromley, 1934, 1946, 1950, 1951; Colyer and Hammond, 1951; Hobby, 1931; James, 1938; Lehr, 1961, 1964; Martin, 1968; Melin, 1923; Newkirk, 1963, 1970; Oldroyd, 1969; Parmenter, 1952; Scarbrough and Sipes, 1973). *Leptogaster parvoclava* was studied 1.6 km east of Laramie, Wyoming, at an elevation of 1,625 m above sea level, where it occurs from about June 19 until July 30, in an area which is similar to the short- to mid-grass grasslands. Grasses found in this habitat were sandberg bluegrass (*Poa secunda* Presl.), western wheatgrass (*Agropyron*

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[2] This research was supported in part by National Science Foundation Research Grant GB-29617X.

[3] Because of the instability of the present nomenclature surrounding the establishment of the family Leptogastridae, the present authors for the purposes of this particular behavioral study prefer to continue regarding the grass flies as asilids. However, the position taken by these flies during mating and the method of egg deposition is distinct from that of any asilid thus far studied.

[4] Res. Associate and Prof. Entomol., Plant Science, respectively.

smithii Rydb.), needle and threadgrass (*Stipa comata* Trin. & Rupr.) and Indian ricegrass (*Oryzopsis hymenoides* (R. & S.) Ricker). The habitat also contained the shrub basin big sagebrush (*Artemisia tridentata* Nutt.) and the following common forbs, prickly pear cactus (*Opuntia polyacantha* Haw.), brown snakeweed (*Gutierrezia sarothrae* (Pursh) Britt. & Rusby) and plains larkspur (*Delphinium geyeri* Greene).

Foraging and Feeding Behavior

Leptogaster parvoclava always foraged from and rested on the vegetation 2.5 to 20 cm above the ground. The only time this species was observed to land on the ground, in addition to when females were ovipositing, was when the sun was obscured by clouds. Presumably this behavior allowed the asilids to absorb additional heat from the soil surface.

According to Melin (1923), *Leptogaster* rest on the vegetation with their wings closed over their dorsum, their bodies held at a 45 degree angle to the stem and ". . . with the back tarsi widely separated from the anterior . . ." tarsi. While *L. parvoclava* rested, its wings were held parallel over its dorsum, and its body was held at about a 60 to 90 degree angle to the vegetation. Additionally, the femora of the hind legs were held at a 90 degree angle to the thorax and bent at the articulation between the femora and tibiae. Thus, the fore, mid and hind tarsi were near each other as observed by Lundbeck (1908) for several species of *Leptogaster*.

These asilids usually foraged at a height 2 to 17.5 cm above the ground. In flight the body was kept parallel to the ground and the fore and mid legs were held against the body but extended forward. Similar observations have been made for other *Leptogaster* (Hobby, 1931; Melin, 1923; Parmenter, 1952; Scarbrough and Sipes, 1973; Séguy, 1950). However, unlike other species which fly with their hind legs dangling below the body or vertical to the ground, *L. parvoclava* held its legs in a "basket-like" position. While in this position the femora were at a 90 degree angle to the thorax and the hind legs were bent at the articulation between the femora and tibiae, so that the tibiae and tarsi extended forward. Presumably the positioning of the legs, while in flight, is associated with the prey capturing methods of *Leptogaster* species (Martin, 1968; Melin, 1923).

While foraging, *L. parvoclava* weaved in and out of the vegetation, hovering 2 to 4 cm in front of vegetation, apparently searching for prey. After briefly hovering the asilids would either continue foraging, land on the vegetation or back up approximately 6 cm from the vegetation and quickly fly forward and attack the "prey."

The initiation of foraging activity in the morning and the length of the forage flights throughout the day were positively correlated with temperature. *Leptogaster parvoclava* did not start to forage until the air temperature, at foraging height, exceeded 24°C. Between 24 and 28 to 29°C, forage flights lasted approximately 5 to 15 seconds and distances of 0.6 to 1.5 m were covered. During this temperature regime, the asilids rested on the vegetation for 3 to 10 minutes between forage flights. As the day progressed and air temperatures exceeded 29°C, forage flights of 30 to 120 seconds occurred and distances in excess of 3 m were covered. Additionally, time spent resting on the vegetation between forage flights was reduced to 5 to 25 seconds.

Like *L. flavipes* Loew (Scarbrough and Sipes, 1973), adult *L. parvoclava* seldom aggregated for any length of time about one plant. However, it was not uncommon to see two to three asilids foraging for a brief period of time (i.e., 20 to 30 seconds) about individual brown snakeweed plants.

Lehr (1961) observed that when *L. gracilis* Loew met in flight, they would turn their heads to one another and then ". . . come together about three or four times . . ." before flying away. When *L. parvoclava* met in flight, they would hover 2.5 to 5 cm in front of each other and then quickly fly forward hitting each other head-on. This behavior was frequently repeated two to three times before the asilids would fly off, often with one asilid in pursuit of the other.

Colyer and Hammond (1951) state that *Leptogaster* capture their prey in flight, while Melin (1923) and Parmenter (1952) observed *Leptogaster* capturing prey which were resting on the vegetation, as well as in flight. *Leptogaster flavipes* captured prey which were resting on the vegetation and never successfully captured prey in flight (Scarbrough and Sipes, 1973). According to Lehr (1964) and Oldroyd (1969), all *Leptogaster* capture prey which are resting on the vegetation. In the present study *L. parvoclava* captured several *Bucculatrix* sp. (Lepidoptera: Lyonetiidae) larvae as the larvae were suspended by their silken threads from a plant stem. However, other prey, which were observed being captured, were captured on a plant stem, leaf or flower.

Once prey were captured, *L. parvoclava* usually straddled the prey with all six legs and inserted its hypopharynx while still holding onto the vegetation. A few prey were pulled free from the vegetation with all six legs as the asilid flew backwards. Sometimes just the fore and mid legs were used while the asilid held onto the vegetation with its hind legs. Prey were then immobilized as the asilid hovered 2.5 to 5 cm above or in front of the capture site. Additionally, some prey were pulled free from the vegetation as described above but

Fig. 1. Female *Leptogaster parvoclava* manipulating immature Cicadellidae.

L. parvoclava held onto the vegetation with one of its mid legs while the remaining legs quickly manipulated the prey into position prior to insertion of the hypopharynx. *Leptogaster flavipes* also has been observed to hold onto the substrate with one fore leg and manipulate the prey with the rest of the legs before immobilizing prey (Scarbrough and Sipes, 1973). Like *L. flavipes*, *L. parvoclava* usually inserted its hypopharynx in the dorsum of the prey's thorax or abdomen.

After the prey were immobilized, *L. parvoclava* usually moved into the shade of some vegetation to feed. A frequent location chosen was the underside of a brown snakeweed branch. While feeding, prey hung free from the hypopharynx unsupported by tarsi or vegetation.

Because of the tubular shape of the majority of prey taken by *L. parvoclava* (e.g., Cicadellidae) and the ease with which digestive fluids could presumably move through the prey, it was expected that this species would rarely manipulate prey. However, this hypothesis was in error. While the asilids were feeding, prey were frequently manipulated from one to six times, with an average of four.

Prey were manipulated in the following manner (fig. 1): (1) the asilid would grip the vegetation with the tarsus of one of its mid legs; (2) swing its body out from its support site, so that the leg used for support was straight and the corresponding side of the asilid's body was parallel to the support site; (3) manipulate the

Table 1. Relation between length of *Leptogaster parvoclava* and that of its prey.

	Predator Length (mm)			Prey Length (mm)				Mean
Sex	Minimum	Maximum	Mean	Minimum	Maximum	Mean	No. of Prey Measured	Ratio of Predator to Prey
Male	7.5	9.6	8.7	1.0	3.8	2.1	30	4.1
Female	*8.2*	*10.6*	*9.2*	*0.8*	*5.0*	*2.5*	*79*	*3.7*
	7.5	10.6	8.9	0.8	5.0	2.4	109	3.9

prey with the remaining tarsi. Following the act of manipulation, the asilid would either swing back and grasp the vegetation with all legs or remain in the aforementioned position, until the completion of feeding, holding onto the prey with the same tarsi which were used for manipulation. Melin (1923), Parmenter (1952) and Séguy (1950) observed *Leptogaster* manipulating prey while holding onto the vegetation with one tarsus, the other tarsi being used to manipulate the prey.

Leptogaster parvoclava fed on prey for an average of 9 minutes 36 seconds, with a range between 4 minutes 30 seconds and 17 minutes 30 seconds. There was a positive correlation between the time spent feeding and the length of the prey. Prey with an average length of 1.2 mm (e.g., immature Cicadellidae) were fed on for approximately 10 minutes; whereas prey such as *Bucculatrix* sp. larvae, which averaged 3.5 mm, were fed on for 20 to 25 minutes.

At the completion of feeding, the majority of prey were dropped as the asilids were involved in an act of manipulation. A few prey were discarded in flight as the asilids moved to a new location or resumed foraging. Additionally, some prey were pushed off of the asilid's hypopharynx with the fore tarsi at the feeding site. The latter method appears to be the most common method of discarding prey at the completion of feeding for many species of asilids (Dennis and Lavigne, 1975; Lavigne and Holland, 1969; Rogers and Lavigne, 1972).

Most flies remained at the prey capture site until feeding was completed. If disturbed, the asilids would fly 0.3 to 1 m to a new location. In flight the prey were allowed to hang free, presumably held by bristles on the hypopharynx. However, one female was observed carrying a *Phthiria* sp. prob. *sulphurea* Loew in her hind legs as she flew about the habitat. Such behavior was frequently observed when an asilid was captured in a baby food jar. The prey would be dropped off of the hypopharynx and then picked up by the tarsi and carried while the asilid attempted to escape. Newkirk

(1963) observed similar behavior for *Psilonyx annulatus* (Say) (misidentified as *Leptogaster annulatus* Say).

The time between feedings (the interfeeding time) varied between 0 and 18 minutes 30 seconds, with an average of 8 minutes 54 seconds. Some *L. parvoclava* continued to forage even though they had prey impaled on their hypopharynx. One male dropped the prey it was feeding on and immediately captured a new victim. This was considered to be a 0 minute interfeeding time.

It is possible to calculate the theoretical number of prey an individual *L. parvoclava* could feed on in one day if one assumes the following: (1) the asilid continually forages and feeds between 9:30 AM and 3:30 PM (i.e., the major period of foraging and feeding activity; see fig. 4) and (2) the asilid captures and feeds on one prey every 18 minutes 42 seconds (based on the average feeding and interfeeding times). Thus, over a 6 hour period this species could feed on 19 to 20 prey. Lehr (1964) estimated that in one day an asilid in Russia could consume 4 to 18 prey. Dennis and Lavigne (1975) calculated the theoretical number of prey the species of asilids they studied could feed on in one day and their estimates ranged from 4 to 35.

The mean predator to prey size ratio for *L. parvoclava* is 3.9 (Table 1). This indicates that the predators were almost four times as large as their prey. Females of this species are larger than the males and catch larger prey than the males. Females thus have a smaller mean predator to prey size ratio than do males (i.e., 3.7 and 4.1, respectively).

Leptogaster parvoclava, like other species of *Leptogaster* (Melin, 1923; Parmenter, 1952; Scarbrough and Sipes, 1973) and Leptogastrinae (Martin, 1968; Newkirk, 1963), attacked inanimate objects such as plant spikelets, seeds, small bunches of leaves, parasite pupal cases, irregularities on the vegetation and other "insectlike" objects. Melin (1923) attributed such behavior ". . . to the fly's defective vision" and indicated that *Leptogaster* have ". . . no clear perception of their prey, but merely perceive the coarser shapes . . ." However, Oldroyd (1964) stated that *Leptogaster* ". . . must have a more accurate vision than . . . so far allowed to robber-flies, with the ability not only to recognize an immobile creature, but to pick it out from a confusing background." The present authors tend to agree with Melin because, (1) the inanimate objects which *L. parvoclava* attacked were of about the same size (i.e., 2 to 5 mm) and shape (i.e., oblong) as its "normal" prey; (2) it appears that this species cannot discriminate suitable from unsuitable prey until it has come into contact with the "prey" (several flies inserted their hypopharynx into inanimate objects before rejecting them); (3) because of this species' poor vision, it is thought that *L. parvoclava* is "programmed" to attack any object(s) which, from a distance, resemble prey. As a result of this habit of attacking inanimate objects, these asilids would make between 11 and 37 attacks before successfully capturing prey. Of course some of these attacks were on normal prey, but they were rejected presumably because the asilids were unable to insert their hypopharynx or for some undesirable characteristic of the prey, such as texture of the body surface or taste.

If one takes into consideration the amount of energy which is expended in searching for and capturing prey, the tendency to attack inanimate objects is quite wasteful. But, at the same time, if their vision is indeed poor, such behavior increases the probability that the predator will find and come into contact with suitable prey.

Like other species of *Leptogaster* (Bromley, 1946; Colyer and Hammond, 1951; Hobby, 1931; Lehr, 1961, 1964; Melin, 1923; Oldroyd, 1969; Scarbrough and Sipes, 1973; Séguy, 1950), *L. parvoclava* fed on soft bodied prey (see list of prey below). Approximately 58.5 percent of the prey consisted of Homoptera and 23.8 percent were Lepidoptera larvae. Diptera, Hymenoptera and Hemiptera made up approximately 7.5, 6.8 and 2.7 percent, respectively, of the prey. It is of interest to note that approximately 58.5 percent of the prey were immature insects.

The following is a list of prey taken by *L. parvoclava*. All prey were collected 1.6 km east of Laramie, Wyoming, between June 25 and July 19. In some instances prey selection is presented only to the order or family level since specific identifications are not available. R. J. Gagné (Cecidomyiidae), G. Gordh (Eulophidae, Pteromalidae), L. V. Knutson (Pipunculidae), J. P. Kramer (Cicadellidae), L. M. Russell (Aphididae, Psyllidae), C. W. Sabrosky (Chloropidae) and D. W. Weisman (Lyonetiidae, Noctuidae, Pieridae) of the Systematic Entomology Laboratory, USDA, are thanked for the identification of their respective groups.

ARANEIDA: unidentified; DIPTERA, Bombyliidae: *Phthiria* sp. prob. *sulphurea* Loew; Cecidomyiidae: Oligotrophini; Chloropidae: *Siphonella neglecta* Beck.; Pipunculidae: *Tomosvaryella* sp.; unidentified (7 records); HEMIPTERA, Lygaeidae: unidentified immatures (2 records); Miridae: unidentified adults (3 records); unidentified immatures (2 records); Nabidae: *Nabis* sp. prob. *alternatus* Parshley (immature); unidentified adults (2 records); HOMOPTERA, Aphididae: *Capitophorus* sp.; *Epameibaphis atricornis* Gill. & Palm.; *Pleotrichophorus* sp. (3 records); Cicadellidae: *Aceratagallia sanguinolenta* (Prov.) (adults, 4 records); *Aceratagallia* sp. (adult); *Dikraneura* sp. (adults, 2 records); *Empoasca neaspersa* Oman & Wheeler (adults, 14 records); *Empoasca nigra* Gillette & Baker (adults, 6 records); *Empoasca* sp. (adults, 2 records); *Hebecephalus* sp. (adult); *Mocuellus collinus* (Boh.) (adult); *Pinumius areatus* (Stal) (adults, 4 records); unidentified immatures (47 records); Psyllidae: *Craspedolepta* sp.; HYMENOPTERA, Eulophidae: *Tetrastichus* sp.; Pteromalidae: *Parecrizotes* sp.; Pteromalini (2 records); LEPIDOPTERA (all are immatures), Lyonetiidae: *Bucculatrix* sp. (33 records); Noctuidae: unidentified; Pieridae: *Colias* sp.

Despite the fact that many *Leptogaster* frequently feed on spiders (Bromley, 1946; Farr, 1963; Hobby, 1931; Lehr, 1964; Melin, 1923), only one Araneida was observed as prey of *L. parvoclava*. According to Bristowe (1968), "Asilids of the subfamily Leptogastrinae are more likely than other asilids to catch spiders because it is their custom to hunt amongst long grasses, etc., and attack victims at rest. . . ."

It is assumed that the tendency for *Leptogaster* and other Leptogastrinae to feed on soft bodied prey is due to the weakness of the mouthparts (Martin, 1968; Melin, 1923). According to Martin (1968), the weakness of the mouthparts has resulted from the reduction in size of the proboscis. Additionally, Martin states that, "with an abundance of soft prey in the grass, probably selection factors for strong mouthparts do not operate."

MATING BEHAVIOR

Numerous mating pairs of *Leptogaster parvoclava* have been observed. Prior to the initiation of copulation, males of this species did not exhibit courtship behavior. A male usually located a female resting on the vegetation, landed on her dorsum facing the same direction as the female, curved his abdomen to the right or left of the female's abdomen and then clasped the female's genitalia from below. The male would then fall over backwards and assume a head down position with his dorsal surface facing the same way as the female's ventral surface (fig. 2). Similar mating positions have been observed by Melin (1923) and Scarbrough and Sipes (1973) for other *Leptogaster*.

In addition to the above method of initiating copulation, males sometimes followed females to their resting site before landing on their dorsum. A few males also grasped females while they were still in flight. The struggling asilids would then either fall to the ground where they would assume the normal mating position prior to moving onto the vegetation or they would assume the normal mating position while still in flight.

If a male landed on a nonreceptive female or another male, the latter would frequently pull its abdomen forward and/or spread its wings at a 45 degree angle to its body. Such behavior presumably indicated the asilid's unwillingness to mate and was interpreted as being an agonistic response. Females in-copula also exhibited wing spreading when another male landed on their dorsum and attempted to clasp their genitalia.

Following the initiation of mating, the mating pair usually moved

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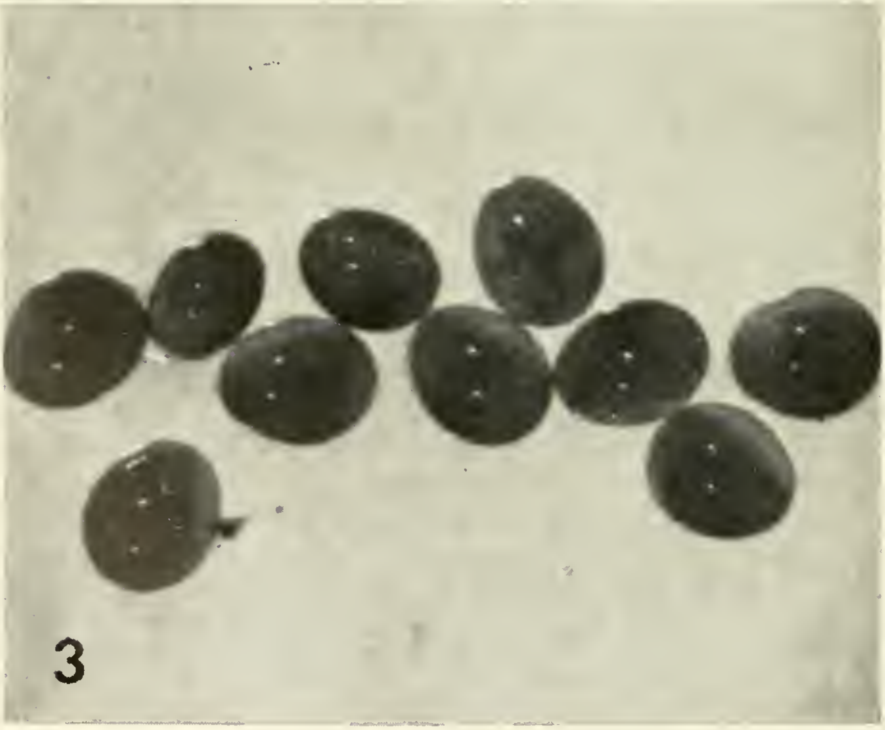

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into the shade of surrounding vegetation. The female was always the one that initiated flight, dragging the male behind her. It is assumed that the asilids moved into the shade to decrease exposure to the sun's rays. In general, the air temperature in the shade was 4.5 to 5.5°C lower than in a sun exposed location.

While in-copula males would either hang free or support themselves on the vegetation beneath the female. While males were hanging free, their legs were held in the same position as when they were foraging. Additionally, males' wings were frequently spread at about a 45 degree angle to their bodies, whereas the females' wings were folded over their dorsum.

Male asilids have frequently been observed to stimulate the female during copulation (Dennis and Lavigne, 1975; Lavigne and Holland, 1969). The only time male *L. parvoclava* exhibited such behavior was when they were hanging free below the female. While in this position, the male would quickly beat his wings and "flip" onto the female's dorsum. The male would then crawl up the female's dorsum and rub her eyes with his fore tarsi. Because some males were too small to reach the female's eyes they would often rub the dorsum of the female's thorax instead of her eyes. The male would remain in the aforementioned position 3 to 8 seconds and then resume the tail-to-tail position. This behavior was repeated up to six times during a mating.

The length of time spent in-copula varied between 9 minutes 30 seconds and 25 minutes, with an average of 16 minutes. Prior to the completion of copulation (i.e., within 3 minutes) the female would rapidly rub both her genitalia and that of the male for 3 to 5 seconds. This behavior was often repeated two to three times before the asilids separated.

Copulation was usually terminated when the male unclasped the female, dropped 1 to 2 cm below the female and then hovered 2 to 5 cm behind or to the side of the female. Frequently after hovering for 2 to 4 seconds, the male would quickly dart forward and hit the female on the dorsum or pleural area of her thorax or abdomen with his extended fore and mid tarsi. This behavior might occur one to three times before one or both asilids flew off. Sometimes the female flew off before the male could fly forward. Some males, however, remained on the vegetation below the female or flew off after they released the female. It is not known why the male hit the female following the completion of mating, but it is

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Fig. 2. Typical mating position of *Leptogaster parvoclava*. The male assumes a head down position with his dorsal surface facing the same way as the female's ventral surface. Fig. 3. Oval eggs of *Leptogaster parvoclava* (50×).

assumed that this indicated the completion of mating to the female or served as an appeasing gesture to the female.

At the beginning of copulation, female *L. parvoclava* frequently had prey. While in-copula the females continued to feed and manipulate prey as if they were not involved in mating. Also, prey were discarded as previously discussed.

Oviposition Behavior

Female *Leptogaster* have been observed to randomly drop their eggs while resting on the vegetation or while in flight (Bromley, 1946; Melin, 1923; Parmenter, 1952; Scarbrough and Sipes, 1973; Skidmore, 1966). This haphazard method of depositing eggs is presumably due to the unmodified ovipositor. According to Melin (1923), only the ventral part of the eighth abdominal segment is adapted for egg laying. However, based on our observations, we believe that the short process located on the ninth abdominal tergite of *L. parvoclava* is used in egg laying. This process is concave on the ventral surface and it is thought that the process "holds" the egg and directs the egg downward as the female is ovipositing.

Leptogaster parvoclava females drop their eggs on the soil, like other *Leptogaster*, but it is not in a random manner. Oviposition in this species begins with the female resting either on the side of a hole (typically a caved in ground squirrel tunnel) or on the vegetation next to the hole. The female extrudes one egg so that it is held in position by the ninth abdominal segment, flies into the hole, faces the shaded side of the hole, quickly bends her abdomen under her body and drops the egg onto the soil surface. The female then returns to her former resting position, extrudes another egg and repeats the above behavioral sequence. Females were observed to drop up to eight eggs, with an average of four eggs, during any one oviposition.

The average time required for oviposition was 4 minutes 24 seconds, with a range between 2 minutes 16 seconds and 10 minutes. Females usually rested for 20 to 30 seconds while extruding an egg and the flight into the hole took approximately 5 to 8 seconds.

The ground squirrel holes in which females oviposited were all approximately the same size with a diameter of 7.5 to 12.5 cm and a depth of 5 to 7.5 cm. The temperature on the shaded soil surface within the hole where eggs were dropped varied between 28 and 43°C.

The eggs of *L. parvoclava* are very similar in appearance to the eggs of other *Leptogaster* (Lavigne, 1963; Melin, 1923; Newkirk, 1963; Parmenter, 1952; Scarbrough and Sipes, 1973; Skidmore, 1966). The color of the eggs varied from light yellow to amber. The shape was

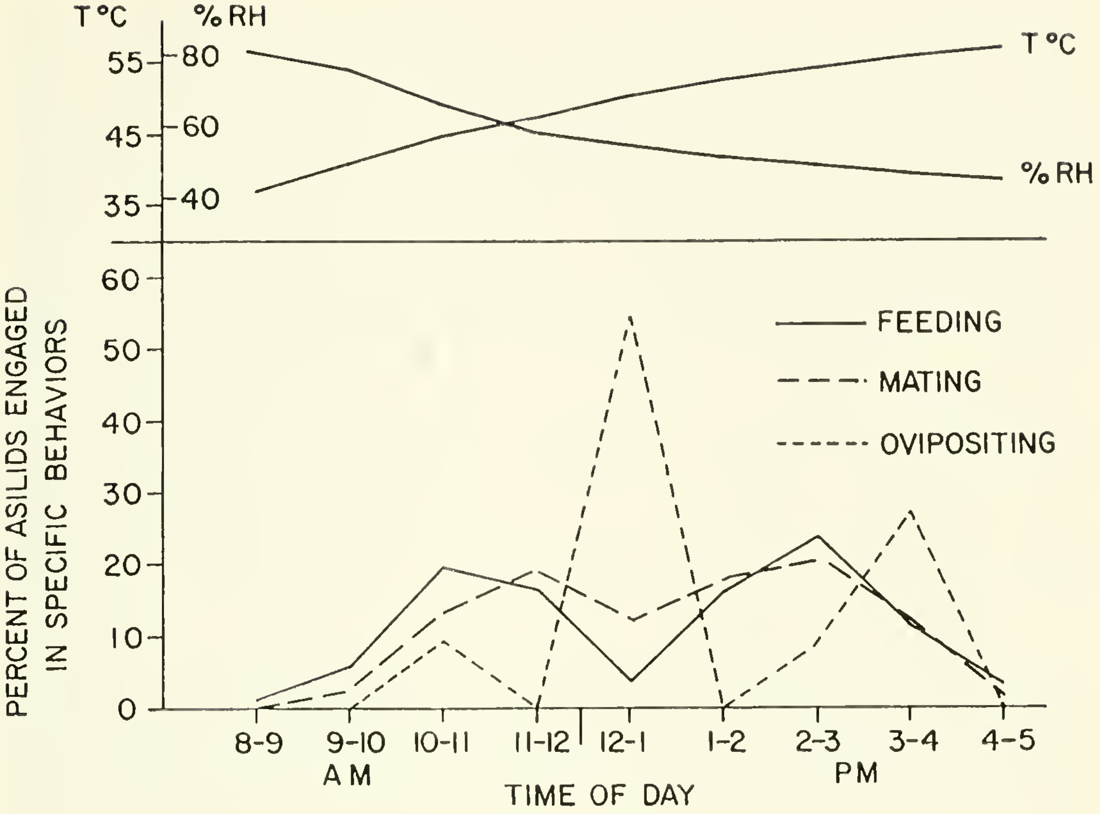

Fig. 4. The mean diurnal rhythm of activity of *Leptogaster parvoclava.*

slightly oval with an average width and length of 0.35 and 0.44 mm, respectively. The range in width was from 0.28 to 0.37 mm and the range in length was from 0.37 to 0.50 mm (fig. 3).

Leptogaster parvoclava eggs which were kept at room temperature (i.e., approximately 25°C) hatched in 9 to 10 days. Similar hatching data have been reported by Melin (1923), Newkirk (1963) and Scarbrough and Sipes (1973) for other species of *Leptogaster.*

Daily Rhythm of Activity

In fig. 4, the diurnal rhythm of activity for *L. parvoclava* is presented. Because the number of asilids which engaged in feeding, mating and oviposition were recorded during the entire duration of this study, the percentage of asilids engaged in specific activities is a mean percentage calculated from the total number of observations (i.e., 156, 258 and 11 observations, respectively, for the aforementioned activities). The graphs for the number of males and females feeding were combined since the sexes exhibited almost identical feeding periods. Temperature and relative humidity were recorded at foraging height and the curves are based on average numbers for five randomly selected days between July 5 and 14.

In any population of asilids, particular activities occur during certain daily time periods. As the frequency of occurrence of a certain behavior increases, the probability that other behavioral sequences will occur usually decreases. Thus, it is of interest to note that *L. parvoclava* foraged and mated within the same time periods as opposed to the behavior exhibited by *Efferia frewingi* Wilcox (Lavigne and Dennis, 1975). Both activities occurred primarily between 10:00 AM and 4:00 PM. At this time of day the air temperature varied between 27 and 38°C, with an average of 33°C. The relative humidity ranged from 66 to 47 percent and averaged 57 percent. During peak mating and feeding periods, there was a reduction in oviposition behavior. *Leptogaster parvoclava* had two periods of peak oviposition behavior; one between 12:00 noon and 1:00 PM and the other from 3:00 to 4:00 PM. The temperature and relative humidity during the first peak oviposition period averaged 33°C and 55 percent, respectively, and 38°C and 47 percent during the second peak oviposition period.

In addition to temperature and relative humidity, two other environmental variables, light and wind, affected the daily rhythm of activity of *L. parvoclava*. Poor light conditions, such as when the sun was obscured by clouds, appeared to affect the asilids' ability to see prey. Additionally, the males had difficulty locating females with which to mate under poor lighting. When the wind was gusting in excess of 16 to 20 km per hour, *L. parvoclava* did not forage and feed as much as when the wind was not blowing. Mating and oviposition behavior were also adversely affected by winds of these speeds and above.

Nocturnal Location

In the evening, once the air temperature at foraging height dropped below approximately 21°C, *L. parvoclava* began to settle on the vegetation and assume their typical daylight resting position. As the sun began to set and for approximately 20 to 30 minutes after sunset, the asilids groomed themselves extensively. Following this, the asilids straightened their hind legs so that they were at a 70 to 80 degree angle to their thorax. This elevated the body so it was at a 110 to 120 degree angle to the surface upon which they were resting. The asilids remained in this position and did not reassume their daylight resting position until they were exposed to the sun's rays the following morning.

Grooming

Leptogaster parvoclava exhibited grooming behavior similar to that described for other species of Asilidae, (Dennis and Lavigne, In prep.). These asilids usually groomed the face following the completion of feeding; the abdomen and genitalia were groomed following mating or oviposition. One interesting form of grooming not recorded for other asilids was exhibited by *L. parvoclava.* As the flies groomed their wings, one wing was frequently kept parallel over the body while the other wing was bent downward. Then, instead of using the tarsus of the left leg and the tarsus of the right leg to groom the left and right wings, respectively, the tarsi of both legs were used to groom the wing which was bent. This is in contrast to typical wing grooming behavior in which both wings are cleaned simultaneously.

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SOCIETY MEETINGS

827th Regular Meeting—November 6, 1975

The 827th Regular Meeting of the Entomological Society of Washington was called to order by President-elect Steyskal at 8:00 P.M. on November 6, 1975 in the Baird Auditorium of the National Museum of Natural History. Thirty-one members and 11 guests were present. The minutes of the previous meeting were read and approved.

Mr. Steyskal opened the floor to discussion of the proposed amendment to the Bylaws, as noted in previous minutes. There was no discussion and the amendment was passed unanimously.

Jack Lipes, Chairman of the Nominating Committee, announced the following slate of candidates for Society Officers in 1976:

President-elect	M. J. Ramsey
Recording Secretary	G. F. Hevel
Corresponding Secretary	D. R. Whitehead
Treasurer	F. C. Thompson
Custodian	D. R. Miller
Program Chairman	J. L. Hellman
Membership Chairman	J. M. Kingsolver
Editor	L. Knutson

Membership Chairman Kingsolver read for the first time the names of the following new applicants for membership:

Dr. John M. Burns, Department of Entomology, Smithsonian Institution, Washington, D.C.

Dr. Wayne E. Clark, Department of Entomology, Smithsonian Institution, Washington, D.C.

Dr. John L. Hellman, Department of Entomology, University of Maryland, College Park, Maryland

Notes and Exhibitions:

Ashley Gurney displayed a new book, *Borne on the Wind*, by Stephen Dalton. This book contains many excellent color photographs on insects in flight.

The principal speaker for the evening was Dr. Fritz S. Lukoschus of the Department of Zoology, Catholic University of Nijmegen, The Netherlands, who gave a very interesting talk on "Collecting Mite Parasites from Bats in Surinam." The talk was illustrated with numerous kodachrome slides. An abstract of Dr. Lukoschus' lecture follows:

> The speaker reported on his expeditions to this relatively unspoiled country, with its untouched fauna and flora. By the aid of color slides he gave an impression of the country and of his methods of capturing bats in tropical rain forests without natural caves. He reported results of studies on the collected material, done in cooperation with many colleagues, including those in bio-medical disciplines.
>
> The following topics were discussed in detail. Bats in shelters of houses did not prove to be vectors of *Toxoplasma gondi* (Piekarski, *et al.*, in prep.)

as has formerly been suggested (which is why insect eating bats are strongly controlled in this country and in the Caribbean). Finding of new, smaller biotops (Desch, Nutting, and Lukoschus, 1972, Acarologia, 14:35–53; Lukoschus, Jongman, and Nutting, 1972. Acarologia, 14:54–58) and of more than one *Demodex* species per host species has revolutionized the theory of only one host specific species (Nutting, 1974, Proc. IV Int. Cong. Acarol.). These findings may also have implications for man (Desch, 1973, M.S. Thesis). Livestock- and almost livestock-free regions with natural conditions for vampires gave possibilities for studies on their biology under natural conditions and their role as vectors in rabies. Blood sucking insects and mites may be transmitters of rabies to other bat species (Lukoschus, Cauwenberghe, and Dusbàbek, 1976, in press). Mites with an evolutionary history related to that of the hosts support the theory of affiliation of vampires to the subfamily Carollinae (Dusbàbek and Lukoschus, 1975, Acarologia, 17: 306–319; Radovsky, in prep.). Myobiids of the strongly diversified bat family Molossidae have only slight indications of species isolation (Lukoschus, Sykora, and Dusbàbek, 1976, in press). Related myobiids from old and new world hystricomorph rodents support the theory of common ancestors separated during the Oligocene by continental drift (Lukoschus, Dusbàbek, and Jameson, 1973, Acarologia, 15:310–322). The hypopes from South American marsupials are less adapted to parasitism (Fain, de Cock, and Lukoschus, 1972, Acarologia, 14:81–93), than are those from rodents (Lukoschus, Fain, and Driessen, 1972, Tijd. Entomol. 115:325–339). Bats of different families are the natural reservoir of the arbovirus, St. Louis Encephalitis, a virus of the yellow fever group (Serié, Fauran, and Pilo-Moron, 1973, Med. Malad. Infect. 3:7–19).

The meeting was adjourned at 9:40 P.M. Punch and cookies were served following the meeting.

F. Christian Thompson, *Recording Secretary.*

PUBLICATIONS FOR SALE BY THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

Miscellaneous Publications

Cynipid Galls of the Eastern United States, by Lewis H. Weld	$ 2.00
Cynipid Galls of the Southwest, by Lewis H. Weld	1.00
Identification of Alaskan Black Fly Larvae, by Kathryn M. Sommerman	.25
Unusual Scalp Dermatitis in Humans Caused by the Mite *Dermatophagoides*, by Jay R. Traver	.25

Memoirs of the Entomological Society of Washington

No. 1.	The North American Bees of the Genus *Osmia*, by Grace Sandhouse. 1939	$15.00
No. 2.	A Classification of Larvae and Adults of the Genus *Phyllophaga*, by Adam G. Boving. 1942	15.00
No. 3.	The Nearctic Leafhoppers, a Generic Classification and Check List, by Paul Wilson Oman. 1949	15.00
No. 4.	A Manual of the Chiggers, by G. W. Wharton and H. S. Fuller. 1952	15.00
No. 5.	A Classification of the Siphonaptera of South America, by Phyllis T. Johnson. 1957	15.00
No. 6.	The Female Tabanidae of Japan, Korea and Manchuria, by Wallace P. Murdoch and Hirosi Takahasi. 1969	15.00

Back issues of the Proceedings of the Entomological Society of Washington are available at $15.00 per volume to non-members and $9 per volume to members of the Society.

Prices quoted are U. S. currency. Dealers are allowed a discount of 10 per cent on all items, including annual subscriptions, that are paid in advance. All orders should be placed with the Custodian, Entomological Society of Washington, c/o Department of Entomology, Smithsonian Institution, Washington, D.C. 20560

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of the
ENTOMOLOGICAL SOCIETY of WASHINGTON

DEPARTMENT OF ENTOMOLOGY
SMITHSONIAN INSTITUTION
WASHINGTON, D.C. 20560

PUBLISHED QUARTERLY

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THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

ORGANIZED MARCH 12, 1884

All correspondence concerning Society business should be mailed to the appropriate officer at the following address: Entomological Society of Washington, c/o Department of Entomology, Smithsonian Institution, Washington, D.C. 20560.

MEETINGS.—Regular meetings of the Society are held in the Ecology Theater, Natural History Building, Smithsonian Institution, on the first Thursday of each month from October to June, inclusive, at 8 P.M. Minutes of meetings are published regularly in the *Proceedings*.

MEMBERSHIP.—Members shall be persons who have demonstrated interest in the science of entomology. Annual dues for members are $9.00 (U.S. currency) of which $8.00 is for a subscription to the Proceedings of the Entomological Society of Washington for one year.

PROCEEDINGS.—Published quarterly beginning with January by the Society at Washington, D.C. Members in good standing receive the Proceedings of the Entomological Society of Washington. Nonmember subscriptions are $15.00 per year, domestic, and $17.00 per year, foreign (U.S. currency), payable in advance. All remittances should be made payable to *The Entomological Society of Washington.*

The Society does not exchange its publications for those of other societies.

Please see inside back cover of any 1972–1975 issue for instructions regarding preparation of manuscripts. Page charges for regular papers by members (those published in order of acceptance) are $22.00 per page for pages 1–15 and $35.00 per page for each page in excess of 15. Page charges for immediate publication and for papers by non-members are $35.00 per page.

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Vol. 78 JULY 1976 No. 3

A SHORT HISTORY OF THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

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Resident Cooperating Scientist, Systematic Entomology Laboratory, IIBIII, Agr. Res. Serv., USDA[1]

In 1976, in celebration of the American Bicentennial and in recognition of the convening of the XVth International Congress of Entomology in Washington, D.C., it is appropriate to review the history of the Entomology Society of Washington. Although a "local" organization in the sense that all of its meetings are held in the Washington metropolitan area and most of its officers live nearby, its influence during the 92 years of its existence has been not only nationwide but has reached many countries abroad. Meetings have been held regularly, beginning in 1884, and the *Proceedings of the Entomological Society of Washington*, appearing first in March, 1886, has continued to carry original contributions dealing with all phases of entomology, but especially taxonomy. Among the dozens of entomological societies that have existed for varying periods (Sabrosky, 1956), only three in the Americas, which have continued uninterrupted publication of their periodicals, are older than our Society. These will be mentioned later in discussion of some influences relating to the establishment of such societies in America.

Partly due to its location here in our nation's capital, many productive and well-known entomologists have been leaders in the Society. In our profession of entomology, small at first but now in rapid growth, these men and women have achieved recognition of some permanence. Sabrosky (1964) has given some of the early history of entomological work in the U.S. government; taxonomic work was not established as a separate entity until 1925.

Early in 1884, three young to middle-aged entomologists employed by the U.S. Department of Agriculture (hereinafter referred to as USDA) felt a desire to meet with other entomologists in the Washing-

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[1] Mail address: c/o U.S. National Museum, Washington, D.C. 20560.

ton-Baltimore area to discuss entomological subjects in an informal fashion away from official surroundings.

The three, Charles Valentine Riley, Eugene Amandus Schwarz, and Leland Ossian Howard, invited local entomologists to a preliminary meeting in Dr. Riley's home on February 29, 1884, at which time the Entomological Society of Washington was organized. Brief biographical sketches of the three original organizers follow:

Riley (1843–1895), four years President of the Society, was born in Chelsea, London, England, and came to America at the age of 17. As a youth he already displayed much personal charm, intense ambition, willingness to work to the point of exhaustion, and natural talent as an illustrator. He became much interested in farm life and agricultural practices, and some personal associations, especially that with Benjamin D. Walsh of Illinois, who was also of English birth and education, fostered his enthusiasm for studying insects. Riley had an unusual blend of talents, ambition, and artistic flair. Although he was a controversial figure, he gave a great impetus to entomology. He was distinguished first as an entomologist in Missouri in 1868–1876, was Chief of the U.S. Entomological Commission in 1877, and from 1878, except for short gaps, was the ranking USDA entomologist. In an honorary curatorial position, he founded the Division of Insects (now Department of Entomology) at the Smithsonian Institution in 1880.

Schwarz (1844–1928) was twice President, and in 1916 the position of Honorary President (for life) was created for him. He was born in Germany and acquired an entomological background and classical education there. As a learned entomologist specializing in beetles, he came to Harvard University in 1872 and was associated for a short time with the famous scholars Hermann August Hagen and Louis Agassiz. From 1878 until the end of his life he was associated with the USDA and was located at the Smithsonian Institution much of that time. His European experience, classical background, and professional contacts had a rich scholarly influence on the growth of entomology in the USDA and the U.S. National Museum. He was not so much a writer of important monographs as a broad student of insect biology and constant guiding figure in the research and professional development of numerous associates. Two colleagues who came under his influence when very young and who acquired many of his skills were Herbert S. Barber (1882–1950) and Raymond C. Shannon (1894–1945). Barber did not receive collegiate training but was an extremely keen and innovative coleopterist who remained in taxonomic work in Washington throughout his life. Probing the strange life history of *Micromalthus* beetles and the distinctive flashing and other behavior of lampyrid beetles (fireflies) were among his leading research accomplishments. Shannon acquired university training and spent most of his career abroad, chiefly in South America as a medical entomologist, but remained regularly in touch with Dr. Schwarz. He became renowned for studies of *Anopheles gambiae* in Brazil, mosquito-borne jungle yellow fever, and the ecology of various other biting flies that transmit disease. During late 1927 he participated in a notable collecting expedition to the southern part of South America which supplied much material for the series "Diptera of Patagonia and South Chile" published by the British Museum (Nat. Hist.) and contributed greatly to the knowledge of the then poorly known insect fauna of that region. Both Barber and Shannon were active members of the Society, especially in their earlier years.

Howard (1857–1950) was three times President, and Honorary President from 1929 to 1950. He was born in Illinois and studied entomology under John H. Comstock at Cornell University, in fact, he was Comstock's first student on a laboratory problem, though other students attended his lectures on entomology earlier. An early associate of Riley in Washington, he was Chief Entomologist of the USDA from 1894 until 1927. A very small group of entomologists was employed by Agriculture when, at the age of 26, he helped found the Society. When he retired as Chief of the Bureau of Entomology there were hundreds of employees and dozens of laboratories in which Agriculture entomologists served. Throughout his career he tried to meet and know personally each entomologist. He was a great historian of entomology and became a highly successful leader in medical entomology and in economic entomology generally. At first he was a taxonomist of parasitic Hymenoptera, and that experience probably contributed strongly to the impetus he gave to the organization and growth of biological control of insect pests.

Entomological societies which preceded ours and which have continued to publish regularly are: 1) The American Entomological Society, 1867, successor to the Entomological Society of Philadelphia, founded in 1859, and whose *Proceedings* were prior to the *Transactions of the American Entomological Society;* 2) The Entomological Society of Canada, organized in 1863, and publishing the *Canadian Entomologist* since 1868, was interrupted from 1871 until 1951, during which period its activities were taken on by the Entomological Society of Ontario; and 3) The Cambridge Entomological Club, founded in 1874, which began the publication of *Psyche* in the same year. The Brooklyn Entomological Society, 1872, began its *Bulletin* in 1878, but publication was interrupted from 1886 until 1912, and then suspended again in 1966.

Incentives to start entomological societies probably arose from several factors. One or more men already experienced abroad, usually in England or Germany, were located where each of the above-mentioned societies started. The native urge to collect and classify the fauna was given new enthusiasm by association with those familiar with insect study in countries where it already had a place in the culture of the people. Each group of new enthusiasts felt the need to accumulate identified specimens, reference literature, and bibliographies of old and current literature. In most groups there was a physician, clergyman, or teacher at a nearby college to contribute to the group's resources. The practical aspects of learning about insects were a factor in some groups, at least in Washington and Ontario. The *Proceedings of the Entomological Society of Philadelphia* show a departure from its usual taxonomic papers in Walsh's reports on injurious insects. In 1864 he published extensive lists of insect species he regarded as common to the faunas of the Old World and North America, taking issue with the "New England School of Naturalists," who argued that the species of the two regions are nearly all distinct.

Early publications show that the Philadelphia and Ontario groups were composed chiefly of men of English origin or ancestry. The Brooklyn group was nearly all of German background, as were also many of those in Washington. Hagen was an outstanding entomologist of German origin at Cambridge, where Schwarz also participated before coming to Washington. Although a majority of the early members of the Entomological Society of Washington were of Anglo-Saxon ancestry, a considerable number besides Schwarz were of German birth, including several who were of considerable influence and did much to shape the Society. George Marx, A. J. Schafhirt, Otto Heidemann, Theodore Pergande, and Frederick Knab may be mentioned. Albert Koebele was another; he joined the Brooklyn Society before coming to Washington and joining the group here. He distinguished himself later in the introduction of imported parasites and predators in California.

Pergande (1840–1916) was a member of the Society's Executive Committee in 1886–1889, and made a much larger contribution to entomology as a whole than his position as preparator and general assistant would suggest. His limited formal research concerned aphids, but his rearing and preparing of specimens were his main achievements, earning him the appellation of "a positive genius in his work on the life history of insects." (Howard, 1930:96).

Somewhat later, two Danes, both educated in the natural sciences in their native country, were prominent members. August Busck (President, 1913) did pioneering research on the systematics of Micro-Lepidoptera, and Adam G. Böving (President, 1924) did basic work on larval Coleoptera. Howard (1931, 1934), Wade (1936), and Nelson (1960) wrote on the founders and officers of the Society at length, showing clearly that European training and methods on the part of influential members were of major importance not only in their individual careers but in the leadership given to the Society.

Ten persons attended the organizing meeting of the Society at Riley's home, and six others came to a second meeting on March 12 (Howard, 1895:162; 1934:52). From this group of 16 "real founders," membership in the Society increased to 26 by the time the first constitution was signed on April 3, 1884. Only 25 signatures are in the original record book, but a 26th man, A. J. Schafhirt, attended the first meeting and was active for some years later. By 1902 the number had grown to 114, and at the beginning of 1976 there were 498 members on the rolls. In recent years the number has remained relatively constant.

Many well-known entomologists were located for a time in the Washington area and took important parts in the Society's activities during its early years, but their careers later took them elsewhere, so that at least as far as the meetings were concerned they then had little or no participation. Lawrence Bruner came to Washington briefly on his wedding trip, during which time he helped to found the Society. His highly successful career was nearly all spent in Nebraska, but he cooperated closely with the Washington entomologists for many years. Otto Lugger, also a founder, and one who lived in or near Washington for some years, later was best known as State Entomologist of Minnesota.

John B. Smith was active in the Society during the nearly 5 years (1885–1889) that he served as Assistant Curator at the U.S. National Museum; during the remainder of his somewhat short but brilliant career he was at Rutgers University, in New Jersey. C. H. T. Townsend was often in Washington during the first half of his career, serving in various capacities for Agriculture, though periods of other employment intervened, and he was an officer of the Society as early as 1889. After World War I he was employed chiefly in South America while he was writing his Manual of Myiology. Nathan Banks was employed by the USDA for some time (1890–1892, 1896–1916), and was twice President of the Society (1905, 1906). As a taxonomist he wrote many basic synopses of several groups of insects and arachnids. Late in 1916 he moved to Massachusetts and contributed greatly to the internationally famous collection at Harvard University. W. D. Hunter came from Nebraska and spent much of his rather short career in Texas and other southern states where he led in the control of pests of cotton and other field crops, as well as contributing to medical entomology. He spent much time in Washington and served as first Editor of the *Proceedings* (1913–1914) and as President in 1914. A. C. Baker had a long career in the study of insects attacking fruit, the latter part of it in Mexico for the USDA. He was Editor from 1918 through 1923 and President in 1931.

The Society's regular meetings have changed much since the early years when lively discussion and conviviality were probably the "real life" of the group. Even in recent years, for members who do not publish or have only marginal taxonomic interests, meetings are the main function of the Society. During the first 25 years, meetings were held mostly in the homes of members. Pre-announced subjects were introduced by short talks, followed by lively comment and a social hour with refreshments (usually beer). Manuscripts for publication were sometimes "presented by title only" and until mid-1918 program items were called "Communications." A large and interesting collection of program cards is preserved in three large spring-binder notebooks. There are no cards for the first 245 meetings (1884–1910), and there are other gaps, notably meetings 318–451 (1919–1933). The first meeting designated by a number was the 137th, on October 20, 1898. The first meeting of 1976, in January, was the 829th.

Attendance averaged 11 per meeting for the first 99 meetings, and the men were of early middle age. For a while, even after increased attendance made it impractical to meet in homes, one member would "entertain" at each meeting, that is, arrange for the refreshments and perhaps choose the subject for discussion. The term "entertain" was discontinued at the beginning of 1918. Howard (1895) summarized the first 99 meetings, giving locations, subjects discussed, and he told which members participated most. He later recalled (Howard, 1909: 14) how strongly the convivial character of the meetings was akin to German university life, perhaps due to the generous representation of members of German origin or to the fact that in those years many American students took advanced training in German universities. On this subject it is interesting to read an informal poem read by Howard at the 100th meeting on June 7, 1894 and quoted by him later (Howard, 1931:210).

There was some difference of opinion in early years concerning the propriety of Agriculture employees talking about their official duties at Society meetings. Riley was opposed to it (Howard, 1909; Walton and Bishopp, 1937). Through the years, however, many meeting programs have dealt with the scientific aspects of insect study or control projects, though questions of policy and administrative decisions have been avoided. Another question which arose concerned contributions from members who studied Crustacea or other "non-insects," an indication of the breadth and vitality of early meetings attracting professional men of other disciplines. In 1894, when a member wished to publish a paper on crabs, arguing that they were as closely related to insects as are arachnids, it was decided that the field of endeavor afforded by insects was so large that it would be unwise to expand manuscript acceptance to include Crustacea (Howard, 1909). For many years manuscripts intended for publication were "read" at a meeting and then turned over to the Publications Committee. The practice was discontinued, perhaps because of a situation that arose in 1915, when a member was scheduled to "read" a taxonomic paper, but when called upon for it he declined to do so, explaining that following the reading of another paper of his at an earlier meeting a fellow member had published on the same subject with "remarkable celerity." This controversy about the time schedule for the publishing of a manuscript was apparently finally settled amicably, according to correspondence in the Society's files.

A few particularly notable meetings have been held. One was for a lecture on insect coloration given at a special meeting on February 28, 1894 by Prof. E. B. Poulton, of Oxford, England, with 27 in attendance, the largest number to that date. Dr. August Krogh, of Denmark, lectured on respiration of insects at a meeting on November 8, 1922. On January 7, 1915, when W. D. Hunter gave his address as Retiring President on "Some Observations on Medical Entomology" at a regular meeting, the 48 members and 21 visitors comprised the largest attendance again for a regular meeting. At the March 1, 1934 meeting, held at the Cosmos Club, when Howard and Rohwer each spoke, 151 people attended. At the meeting honoring the memory of Herbert Barber, held on October 5, 1950, 141 persons registered, although the room was too small for all to remain.

When the number of Society members was small and the working entomologists in Washington (mostly employed by Agriculture) were a closely-knit group, the death of a colleague often was recognized by a special meeting or a special program at a regular meeting. Such were two joint meetings of the Society and "the force of the Bureau" held in June and July, 1911 in honor of the recently deceased members D. W. Coquillett and F. C. Pratt, respectively. Coquillett was a largely self-educated entomologist, a distinguished dipterist and applied entomologist, and Pratt was a highly skilled preparator and aid in rearing procedures and a wide variety of general duties, so highly regarded both for his work and as a person that he became a vital member of the Society and the Bureau. Such meetings were often held shortly after the demise of the member, and several associates would make spontaneous remarks in tribute to him.

Reports of the early meetings gave much detail. Entomologists elsewhere found them of interest, probably because there were fewer journals then, but also because many discussions centered about field experiences and general biological notes. For one thing, members prepared for and expected to discuss particular subjects, so that considered, worthwhile comments were made. Techniques were described too; for instance, at the April 5, 1894 meeting Schwarz showed specimens of "small insects mounted on cardboard triangles in such a manner as to leave the sternum free for examination and study," a method that has become the commonly used one of "pointing" specimens with triangles and adhesive. Another interesting item in the old reports is one by Howard (1909:16): "While I was writing these words this morning the door of my office opened, and in came old Professor Cyrus Thomas, 84 years of age, but mentally as active as ever. He came in to suggest the idea that certain non-migratory locusts, after a succession of dry seasons, grow longer wings and become migratory." Thomas was suggesting then what proved to be a tremendous independent discovery more than 10 years later by Boris P. (later Sir Boris) Uvarov, the "phase theory" about changed behavior and morphology of gregarious vs. solitary phases of some destructive grasshoppers.

"Abridged minutes" of the meetings were published in *Insect Life*, a periodical published by the USDA and edited by Riley and Howard, during its short but productive life from 1888 until it was discontinued in favor of 2 series of *Bulletins* in July 1895. This also considerably enlarged public awareness of the Society's activities. Later minutes have been in less detail because of higher printing costs and fewer original observations reported at meetings. In 1918–1931, reports of Society meetings were published in the *Journal of the Washington Academy of Sciences*, as documented in detail by Wade (1931), then later and still published in the *Proceedings*.

After it became impractical to hold meetings in members' homes, a variety of locations were used. For many years the Saengerbund Hall, 314 C Street N.W., provided a friendly gathering place. So congenial was the atmosphere and so cooperative was the "Bund" that at the 301st meeting, February 8, 1917, a "nearly life-size portrait" of Schwarz, a guiding spirit of the Society, was presented to the Saengerbund and accepted by its president as a mark of close ties. Meetings at the Saengerbund were discontinued soon after Prohibition (Rohwer, 1934). After meeting at several places, including the Cosmos Club, meetings at the Natural History Museum of the Smithsonian Institution became regular; the meeting of November 4, 1920 was probably the first.

With increased attendance, often well over 50 persons, including many women, there has been somewhat less audience participation. Recent meetings have usually had a single speaker, sometimes two, and occasionally there has been a panel presentation. Subjects have varied widely, including original research, travel reports, reviews of national and international meetings, summaries of current projects, and historical reviews. An effort has been made to stimulate spontaneous notes on any aspect of entomology, and at some meetings there is a lively volunteer session. There has unfortunately never been much participation by amateur entomologists, as already noted by Howard (1924). For many years refreshments were omitted, mainly because of building management's requests, but for several years now they have been resumed. With a larger number of women active in entomology, they have contributed more; in 1966 and 1969, Louise M. Russell and Helen Sollers-Riedel, respectively, were President.

A total of 77 volumes of the *Proceedings* has appeared. Material from more than one year was included in a single volume in some early years. The *Proceedings* was published quarterly at first; it was monthly except for July, August, and September during 1919–1948; it became bimonthly in 1949; and since 1960 it has again been quarterly.

Indexing of the *Proceedings* has been various, from lacking to detailed. Exchange subscriptions for other journals was discontinued about 1911. Most editors have not published editorials; Carl Heinrich and A. C. Baker often did, and there has occasionally been an editorial by someone else, such as L. O. Howard or W. L. McAtee. Prior to 1913, the *Proceedings* were edited by a Publications Committee; since that time, there has been a succession of 12 Editors. William R. Walton served longest, 1927 through 1942. At present the Editor is Chairman of the Publications Committee, consisting of 3 appointed members, one of whom is replaced each year.

At the meeting of December 5, 1912, H. G. Dyar (1866–1929) was referred to as "editor," but apparently only in the sense of being on the committee responsible for editorial duties. He was an unusual, very talented and productive entomologist, working chiefly on the taxonomy of Diptera and Lepidoptera. He was a man of considerable private means, and after completing his term on the Publications Committee he organized his own journal, *Insecutor Inscitiae Menstruus*, published during 1913 to 1927. Until the end of 1912 he had been active in the Society and was twice President (1901, 1902).

At that same meeting of December 5, 1912, J. C. Crawford was elected Editor, as noted by Rohwer (1934), but he resigned on February 6, 1913 and W. D. Hunter was elected in his place and served through 1914. Crawford served during 1915 through 1917. Later Editors are: A. C. Baker, 1918–1923; Carl Heinrich, 1924-1926; William R. Walton, 1927–1942; Alan Stone, 1943–May, 1947; Karl V. Krombein, June 1947–1951; Barnard D. Burks, 1952–1954; Richard H. Foote, 1955–1962; Jon L. Herring, 1963–1967; Paul M. Marsh, 1968–1972; Lloyd V. Knutson, 1973–. Baker and Hunter have already been mentioned. Crawford (1880–1950) was a specialist in Hymenoptera and late in his career also studied thrips. Heinrich (1880–1955) specialized on Lepidoptera and was an accomplished writer on many subjects, including poetry and newspaper editorials. Walton (1873–1952) was a skilled illustrator, an experienced dipterist, and a good general entomologist; he was twice President (1920, 1921) and Editor for a longer time than anyone else. Stone (1904–) was President in 1951 and served Agriculture as a Diptera specialist for 40 years. He is best known for his studies on bloodsucking flies, *Anastrepha* and other fruitflies, other Diptera, and catalogues. Krombein (1912–) served as President in 1970, is well-known as a wasp specialist, and took a leading part in the preparation of Hymenoptera catalogues. Burks (1909–) was President in 1974, is an outstanding specialist on Chalcidoidea (Hymenoptera), and did major work on mayflies. Foote (1918–), President in 1968, is currently Chief of the Systematic Entomology Laboratory, USDA, and for many years has been an active taxonomist on Diptera, especially mosquitoes and Tephritidae. Herring (1922–) is active with Hemiptera, especially aquatic families, in the Systematic Entomology Laboratory. Marsh (1936–) serves as taxonomist on parasitic Hymenoptera, primarily Braconidae, for the Systematic Entomology Laboratory. Knutson (1934–) is a specialist on Diptera, especially the snail-killing flies of the family Sciomyzidae, and is currently Chairman of the Insect Identification and Beneficial Insect Introduction Institute, USDA.

In 1939 the publication of Memoirs, each representing a separate comprehensive study of major importance, was begun, and 6 Memoirs have been issued at irregular times, as the availability of appropriate manuscripts and the necessary funds permit. The Memoir series is supported by a special publication fund maintained by donations, the sale of Memoirs and certain back stock of the *Proceedings*, and formerly by a portion of members' annual dues. The fund was established, effective January 1, 1915, on a motion by H. S. Barber at the April 1, 1915 meeting. At the June 7, 1894 meeting, L. O. Howard already had suggested such a fund. In 1913, a member then living in Baltimore, J. M. Lawford, died and bequeathed to the Society in his will a collection of specimens and a library. The specimens were donated to the U.S. National Museum and the books sold, the proceeds being added to the publication fund (Rohwer, 1934). Since that time, the chief donations to the Fund have been by Alan Stone, $4,070; Frederick Knab, $1,400; E. A. Schwarz, $1,000; Charles T. Greene, $500; Lewis P. Ditman, $100. These donations have been the means of publishing some important works of lasting value.

Categories of membership have varied through the years. Active and associate members were distinguished early, those in the local area being classed as Active Members, those living elsewhere as Associate Members. The latter were for a while called Corresponding Members. During the 1890's Rudolph Leuckart, of Germany (1823–

1898), who had been one of Schwarz' professors, was elected Honorary Member, but he died soon afterward. At that time, this class membership was restricted to foreign entomologists who had made outstanding contributions to entomology, but later a local coleopterist, Henry Ulke (1821–1910), was elected. In 1915 Jean H. Fabre, of France, and David Sharp, of England were elected. Fabre died in 1915, Sharp in 1922, and resolutions of esteem and remembrance were adopted for both (*Proceedings*, 18:1; 24:207). For a long while there were no further Honorary Members, but in the late 1950's this class was reactivated for "recognition of long and meritorious effort to advance entomological science." Honorary Members shall not be more than 3, or 4 if one is also Honorary President. The following entomologists, all long-time members in the Washington area, are the current Honorary Members, together with their date of election to that status: C. F. W. Muesebeck, 1955 (Honorary President); E. N. Cory, 1965; F. W. Poos, 1965; R. A. St. George, 1975.

Life Membership, which gives full membership privileges without further payment of dues in return for a substantial single fee, is now held by 7 persons. Emeritus Members, now 12 in number, are those of 15 or more years standing, who elect to forego receiving the *Proceedings*, who are retired from regular employment, and are approved for this status by the Executive Committee.

The office of Honorary President for Life, was created for E. A. Schwarz in 1916 in recognition of his exceptional contributions to the Society. Following the death of Schwarz in 1928, L. O. Howard, then the sole surviving founder (except for Lawrence Bruner, who was retired in California) was chosen. He was succeeded in 1951 by C. L. Marlatt (1863–1954), who was twice President (1896, 1897) and best known as Chief of the Bureau of Entomology, USDA, from 1927 through 1934 and for his studies on the periodical cicada and the history of the spread of the San José scale. Following Marlatt was Robert E. Snodgrass (1875–1962), President in 1939, who was the foremost American insect morphologist of his time and the author of 4 outstanding books and 80 scientific papers, most of which remain classics in their field. His skill as an illustrator contributed much to the usefulness of his work. The Honorary Presidency was next awarded to Thomas E. Snyder (1885–1970), President in 1949, a leading figure in the systematic and applied phases of termite study and a lifelong student of other pests of wood products. The current Honorary President is Carl F. W. Muesebeck (1894–), President in 1940, who has continued taxonomic research on parasitic Hymenoptera since his retirement over 20 years ago. As head of the Taxonomic Investigations Unit, USDA, for about 20 years, now reorganized as the Systematic Entomology Laboratory, he established for the Laboratory an enviable tradition of service and research and at the same time led the compilation of the *Synoptic Catalog of the Hymenoptera of America North of Mexico*, published in 1951.

During the Society's 92 years, 75 people have served as President. Until the 1920's, reelection for a second year was normal, though there were exceptions due to job transfers, health, etc. A nearly complete departure from 2-year terms began in 1922, when Arthur B. Gahan, the well-known specialist on parasitic Hymenoptera, then in his first year as President and a sincere admirer of his chief, felt it appropriate that Dr. Howard should again head the Society to which he had given so much. Hence, Dr. Howard served a third term. Since that time, only J. E. Graf, 1929 and 1930, has served for two years.

Because the early Presidents were relatively young and some of them lived remarkably long, while the single-term tradition has resulted in a larger number of them, it is interesting to note that a few living members of advanced age have known personally all except ten or fewer of the Presidents. Even the writer of these lines, who came to Washington in 1936, has known all but 13 of the 75 Presidents! There has been a marked trend toward increased age in the presidency. During the first two decades, 1884–1903, the average age was under 44; during the past four decades, it has been 54, and the average age of the last ten Presidents is 58. The youngest President was L. O. Howard, 28 when his first term began, the oldest Otto Heidemann, 69 at the end of his second term. The youngest President chosen recently is Arthur K. Burditt, Jr. (1928–), who was 44 when elected in December, 1972 after serving a year as President-Elect and previously as an energetic Treasurer. Unfortunately, because of a transfer to Florida, he found it necessary to resign immediately after taking office.

A chronological list of the Presidents was published in 1970 (*Proceedings*, 72:512). Bibliographies of those who served up to 1935 were given by Wade (1936), who himself served in 1934 and was an enthusiastic and patient bibliographer and compiler.

Other officers have provided able and dedicated service to the Society, and the value of their service is no less than that of the Presidency, but they remain largely unsung. The office of Treasurer is laborious and time-consuming, but very important. We have been fortunate in having some very capable Treasurers. Sievert A. Rohwer (1888–1951) held the combined office of Corresponding Secretary-Treasurer during 1911–34, and the breadth of his work for the Society is suggested by the fact that 4 officers now share the responsibilities that he bore single-handedly. In 1928 he also served as President. As a USDA entomologist for more than 40 years, he was a specialist on wasps and later had extensive managerial duties as an Assistant Chief of the Bureau of Entomology and Plant Quarantine. Donald J. Caffrey (1886–1960) was Corresponding Secretary during 1937 through 1940, and did an unusually fine job in arranging and revitalizing the sale of the stored volumes of the *Proceedings* and the general conduct of the office. He was an Agriculture entomologist for 43 years, dealing with many crop pests, especially the European corn borer, and planning and leading an extensive research program. We hope that someone will continue the biographic work so ably started by Wade, referred to in the preceding paragraph.

On the cover of the *Proceedings* issued in March, 1894 there first appeared the outline of an insect as the Society Seal, which remained in use there except for the years 1921–1936. A new engraver's cut was made in 1937 and again in 1964. Jon L. Herring made the drawing for the last cut and explained its significance (Herring, 1964). The insect is a winged male of *Rheumatobates rileyi* Bergroth (Hemiptera, Gerridae), a water strider about 7 mm long, including outstretched legs. The middle legs are longest, and the male has peculiarly specialized antennae. The species is widely distributed on quiet freshwater in the eastern United States. Two brief notes were published by Riley and Howard (1891, 1893). The design was originally adopted at the Society meeting of November 2, 1893 (*Proceedings* 3:83): "President Riley in the chair, and 12 members present. Mr. Heidemann presented designs for a seal for the Society. One of the designs was adopted, and Mr. Heidemann was urged to engrave it upon wood. Upon motion a vote of thanks was extended to Mr. Heidemann for his voluntary services in this matter." Otto Heidemann (1842–1916), President in 1909–1910, learned wood engraving as a student in Leipzig, Germany, and continued as an illustrator and engraver of insects after coming to this country. He was past 50 when hired as an entomologist by Agriculture in Washington, but he became a highly respected and productive specialist on Hemiptera.

This account has brought together many of the more interesting facts in the history of the Entomological Society of Washington, but there is not space to recount, even briefly, many more interesting aspects of the people who have been connected with the Society. Howard (1930) and Mallis (1971) have told more about many of them.

The Society is fortunate to have been located where there are enough entomologists to form a strong nucleus, but the majority of its members and subscribers live outside the Washington area, and readers of the *Proceedings* are widespread in the United States and foreign countries. Current circulation, to both members and subscribers, is about 750 copies. Although without a formally organized office facility and salaried staff, the Society has continued to serve entomology usefully within the scope of its traditional functions. One of its most active members, Curtis W. Sabrosky (President, 1972), has the distinction of being President of the XVth International Congress of Entomology, which meets in Washington during August 19–27, 1976.

What of the future? We cannot predict what economic and populational changes will bring. The Society has had numerous fine younger officers in recent years, but we clearly need more younger members to participate in the production of stimulating and innovative programs. We must become familiar with new and more economical methods of information dissemination and have good, sound managers to continue to publish and be responsive to the needs of our readers. Our current President, George C. Steyskal, a long-time student of the Diptera, is an imaginative and dedicated leader, and with his help we hope that 1976 will begin a new strong period of service to entomology by the Society.

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THE GENUS OTIORHYNCHUS[1] IN AMERICA NORTH OF MEXICO (COLEOPTERA: CURCULIONIDAE)

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ABSTRACT—A key, illustrations, distributions, and host records are given for 16 species of *Otiorhynchus* (Coleoptera: Curculionidae) known or believed to be established in North America.

Of the thirty-nine or more genera of alien weevils that are known or believed established in America north of Mexico the genus *Otiorhynchus* has the largest number of species (Lindroth, 1957). Essig (1933) reported seven species in North America, including five in California.

The economic importance of *Otiorhynchus* in North America is well documented. The majority of the species, all Palearctic, are serious pests of cultivated plants, in both their native country and in North America. The adults are flightless, and the larvae feed underground; several species are known to be parthenogenetic. In Europe males of all species have been described, but only those of *ligneus* (Olivier), *meridionalis* Gyllenhal and *porcatus* (Herbst) have been found in North America.

We are presenting a key to the species, illustrations, distribution maps and tables giving the most important host plants for sixteen species known or believed to be established in North America. One species, *auricapillus* Germar, is not included. This European species was reported to have been introduced with imported nursery stock at Cromwell, Connecticut (Leng, 1916; Blatchley and Leng, 1916:112). No subsequent records have been found, nor have we seen the original specimens.

Otiorhynchus Germar

Oval, varying from black, to reddish black, to grey or brown. Rostrum stout, apex notched and extremely dilated to form a pterygium; mandibles large, with prominent scar; scrobes vaguely defined posteriorly. Antennal scape long, when retracted next to head usually passing middle of eye and attaining thorax; funicle 7-segmented. Eyes round. Prothorax oval, truncated anteriorly and posteriorly.

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[1] In North America this genus has been known as *Brachyrhinus.* A ruling of the International Commission on Zoological Nomenclature has validated the name *Otiorhynchus.* (Bull. Zool. Nomenclature, V. 29(1), May 1972:19.

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Scutellum very small or indistinct. Elytra oval to oblong. Protibia usually arched; femur clavate, with or without teeth. Wingless; elytra united.

The distinctive feature of this genus is the pterygium, as shown in fig. 3, 8. Most species are shiny, glabrous, black or dark red. They are nocturnal and their movements are generally slow. They move and feed during the warm nights of spring, summer and fall. The winter is passed largely in the larval stage, but adults may also hibernate in warmer regions. The larvae live in the soil and feed upon the roots and underground stems of plants. Pupation occurs in the soil.

Key to Species

1. Apex of tibia I expanded dorsally (fig. 33) 2

— Apex of tibia I rounded dorsally (fig. 34) 3

2. Femora toothed. Body dull, with numerous small, appressed, greyish or yellowish scales and setae covering elytra. Elytra finely granulate over entire surface, striae very fine. Prothorax covered with large, flat tubercles. Rostrum long, slender, without median furrow, with sharp median carina from base to raised V-shaped, emargination at apex (fig. 1, 17). Black. Length: 10–12 mm .... *ligustici* (Linnaeus)

— Femora not toothed. Body shiny, without scales, with semierect, short hairs in single row on each elytral interval and shorter hairs from each strial puncture. Prothorax densely punctured, punctures large, each with a fine hair. Rostrum short, broad, with deep subtriangular furrow which is wider at apex than at base, with lateral margins raised, converging posteriorly and attaining the eyes (fig. 2, 18). Blackish brown. Length: 7–8 mm .... *cribricollis* Gyllenhal

3. Femora not toothed 4

— Femora 1 and 3 toothed 12

4. Elytra with scales 5

— Elytra without scales, hairs only 8

5. Alternate elytral intervals raised 6

— All elytral intervals flat 7

6. Alternate elytral intervals strongly raised, tuberculate, with short curved seta from each tubercle; even intervals flat; strial punctures large, deep; elytra, prothorax, and rostrum with short, narrow, greenish scales condensed in scattered spots and generally distributed. Prothorax tuberculate, coarsely granulate; medially impressed from base to apex, impression with thin line of greenish scales. Rostrum with broad median furrow and lateral carina from base almost to antennal insertions; apex with elevated, broad, shiny carina (fig. 3, 19). Brownish black. Length: 4–5 mm .... *porcatus* (Herbst)

— Alternate elytral intervals weakly raised, each with row of long, club-shaped, semierect setae; even intervals flat; strial punctures large, each covered with round scale. Elytra mottled with submetallic, tan and brown, round, appressed scales. Prothorax with only tan scales; densely punctured. Rostrum dorsally convex, without median furrow or carina, densely covered with tan scales and setae to antennal insertions; bare from insertions to apex (fig. 4, 20). Brown. Length: 4–6 mm.................. ....*scaber* (Linnaeus)

7\. Elytral intervals completely covered with yellow-brown and grey-brown submetallic, striate, attenuate scales; strial punctures large, diminishing in size to apex. Prothorax on disc densely puncto-tuberculate, tubercles smooth; with smooth shiny, sinuous, median carina; laterally tubercles densely punctured, dull, coalescing, each puncture with long brown seta; large, attenuate greenish scales generally distributed over disc. Rostrum rugosely punctured, with median carina from frontal fovea to raised emarginated apex, apex depressed each side of carina; vestiture of brown setae and greenish scales (fig. 5, 21). Brownish black. Length: 6–7 mm ....*raucus* (Fabricius)

— Elytra shiny, vestiture sparse, fine hairlike golden scales serially arranged on each interval, with scattered patches of broader scales. Prothorax on disc, with low, smooth, shiny tubercles, tubercles becoming smaller and coarser laterally, without median carina; vestiture fine, sparse. Rostrum densely, coarsely punctured from base to apex, with broad, dull, finely punctured median carina from frontal fovea to antennal insertions. Black, antennae and legs red to reddish black (fig. 6, 22). Length: 7–8 mm ....*dubius* (Ström)

8\. Rostrum with median longitudinal carina 9

— Rostrum without median longitudinal carina 10

9\. Rostrum elongate, nearly glabrous, deeply furrowed on each side of median carina; Y-shaped median carina enclosing triangular, glabrous area at apex (fig. 7, 23). Elytra elongate oval, puncto-rugose on disc and finely granulate on sides and apex; very short, stiff, semierect grey hairs generally distributed. Prothorax granulate or puncto-granulate, or only punctured. Brownish black. Length: 7–10 mm ....*meridionalis* Gyllenhal

— Rostrum a little longer than wide, dull, with very sparse, fine, white hairs, densely punctured on each side of median longitudinal carina (fig. 8, 24). Elytra convex, oblong, abruptly narrowing posteriorly; pubescence sparse, scattered small spots of fine white setae laterally; striae fine, scarcely distinct; intervals with fine transverse lines; species appearing smooth. Black. Length: 10–13 mm ....*clavipes* Bonsdorff

10\. Elytra almost glabrous. Rostrum short, dorsally flat, densely punctate, punctures increasing in coarseness and density toward apex (fig. 9, 25). Elytra and prothorax finely punctate, each puncture with minute silvery setae. Black. Length: 6–7 mm ....*arcticus* (O. Fabricius)

— Elytra with fine erect hairs in serial rows on all intervals 11

11\. Reddish, curled hairs in double rows on each elytral interval. Prothorax with dense, round tubercles, each tubercle with reddish, curled hair. Rostrum coarsely punctured, with deep longitudinal furrow at base; slightly raised, transverse ridge between antennal insertions; coalescent punctures forming lateral furrow above scrobe from antennal insertions to eye; coarsely punctured from antennal insertions to apex and depressed on each side of 2–3 short median carinae (fig. 10, 26). Reddish to piceous black. Length: 6–8 mm .... *rugosostriatus* (Goeze)

— Whitish, stiff erect hairs in single row on each elytral interval. Prothorax with dense low tubercles medially, becoming coarser and rough laterally, each tubercle with yellowish hair. Rostrum without median furrow; with wide shiny, smooth diagonal carina between antennal insertions; glabrous and almost impunctate from antennal inesertions to apex. Reddish brown. (fig. 11, 27). Length: 4–6 mm .... *ligneus* (Olivier)

12\. Femora 1 and 3, sometimes femur 2, with simple tooth 13

— Femora toothed, tooth on femur 1 bifid or notched, femora 2 and 3 with simple, rarely bifid, tooth 14

13\. Elytra densely covered with tannish, submetallic, small round scales, irregular patches of lighter scales scattered over entire surface; each interval with row of small shiny tubercles, each tubercle with semierect golden seta; each strial puncture covered with round scale. Prothorax coarsely, densely tuberculate, tubercles becoming smaller laterally, scales as on elytra, very dense laterally. Rostrum densely scaly, with fine setae from base to smooth transverse raised area between antennal insertions; rugosely punctured from insertions to apex; laterally carinate with single line of long yellow hairs (fig. 12, 28). Black. Length: 6–7 mm .... *singularis* (Linnaeus)

— Elytra with scattered patches of small golden, metallic, elongate scales and generally distributed, curved, yellow hairs; puncto-tuberculate; intervals convex, about as wide as striae, each with irregular row of low, shiny tubercles; striae deep, strial punctures separated by low shiny tubercle. Prothorax coarsely, densely tuberculate, each tubercle with curved yellow hair; sometimes with thin median line of yellowish-green scales in apical ⅓. Rostrum with wide, deep, longitudinal furrow; laterally carinate from base to antennal insertions; with deep furrow each side of raised emarginated apex (fig. 13, 29). Black, legs sometimes reddish. Length: 8–10 mm .... *sulcatus* (Fabricius)

— Elytra with fine curled setae serially arranged on intervals; intervals wide with fine granules; striae narrow, each puncture with fine short seta. Prothorax with low tubercles, each tubercle with deep puncture; with narrow, shallow, median furrow or with punctures coalescing to form short rugae. Rostrum without denuded apex, punctures strigose, coalescing to form a number of short longitudinal ridges from head to apex (fig. 14, 30). Black. Length: 4–6 mm .... *rugifrons* (Gyllenhal)

14\. Femur 1 with bifid tooth (fig. 35). Elytra with sparse, fine yellowish setae. Elytral intervals wide, transversely rugose; elytral striae shallow on disc, deeper laterally. Prothorax with large lateral tubercles and several elongate, smooth median ridges separating deep grooves. Rostrum flat, dull, coarsely, rugosely punctured, punctures coalescing to form short ridges, ridges extending backward and around deep frontal fovea to head, terminating a short distance behind eyes (fig. 15, 31). Black. Length: 5–6 mm .... *ovatus* (Linnaeus)

— Femur 1 with tooth notched at apex (fig. 36). Elytra with dense, yellowish setae. Elytral intervals narrow; elytral striae well developed, punctures large, deep. Prothorax with small acute, lateral tubercles and 1 smooth, uninterrupted ridge. Rostrum shiny, with shallow furrow and numerous elongate ridges from head to apex (fig. 16, 32). Brownish black. Length: 4–5 mm .... *desertus* Rosenhauer

Hosts: Feeding habits of otiorhynchine weevils are diverse. Larvae feed exclusively underground; and some species, such as *ligustici*, which feeds only on alfalfa, are very host specific. Larvae of other species have a broader range; *sulcatus*, for example, has been recorded from more than 100 plant species. Adults of all species generally feed on a wider range of plants than the larvae and may feed on foliage, buds, and young shoots.

Table 1. Important European (E) and North American (NA) host plants of the three most common species of *Otiorhynchus* in North America.

HOST	*ovatus*	*rugosostriatus*	*sulcatus*
Acer sp. (maple)			NA
Adiantum sp. (maidenhair)			NA
Borago sp. (borage)	NA		
Celastrus sp. (bittersweet)			NA
Clematis sp. (clematis)			NA
Cordyline sp. (dracaena)			NA
Crataegus spp. (hawthorn)			NA
Cyclamen spp. (cyclamen)		NA, E	NA
Daucus sp. (carrot)	NA		
Fragaria spp. (strawberry)	NA	NA	NA
Humulus sp. (hops)	NA		
Ilex spp. (holly)		NA	
Juniperus spp. (juniper)	NA		NA
Ligustrum spp. (privet)		NA	NA
Medicago sativa (alfalfa)	NA		
Mentha sp. (mint)	NA		NA
Mirabilis sp. (four o'clock)			NA
Phaseolus sp. (bean)	NA		
Picea sp. (spruce)	NA		
Pinus sp. (pine)	NA		
Polianthes tuberosa (tuberose)			NA
Primula obconica (top primrose)		E	
Prunus sp. (peach)	NA		
Rhododendron sp. (rhododendron)	NA		NA
Rosa spp. (rose)	NA	E	NA
Rubus spp. (raspberry)	NA	NA, E	NA
Solanum sp. (nightshade)			NA
Solanum tuberosum (potato)			NA
Spiraea sp. (spirea)			NA
Taxus spp. (yew)	NA		NA
Thuja spp. (arborvitae)	NA		NA
Trifolium pratense (red clover)	NA		
Tsuga sp. (hemlock)	NA		
Vaccinium sp. (blueberry)	NA		NA
Vitis sp. (grape)	NA		E

Table 2. Some important European (E, e) and North American (NA) host plants of the less abundant species of *Otiorhynchus* in North America. Uppercase letters indicate the host was recorded more than once for each species; lowercase letters are used when only one record was found for that species. * species found on moss in subalpine forests.

HOST	*ligustici*	*cribricollis*	*porcatus*	*scaber*	*raucus*	*dubius*	*meridionalis*	*clavipes*	*arcticus*	*ligneus*	*singularis*	*rugifrons*	*desertus**
Abies sp. (fir)				E									
Amygdalus persica (peach)										E	E		
Artemisia maritima (maritime wormwood)		E								NA			
Chrysanthemum sp.		NA								E			
Crataegus sp. (hawthorn)		NA											
Cynara scolymus (globe artichoke)		NA											
Daucus sp. (carrot)		NA											
Fragaria spp. (strawberry)	NA	NA						E				E	
Humulus sp. (hops)											E		
Ilex (holly)		NA											
Jasminum sp. (jasmine)		NA											
Lactuca sp. (lettuce)							E			NA			
Larix sp. (larch)				E									
Ligustrum spp. (privet)		NA					NA, E	e					
Lonicera sp. (honeysuckle)		NA						E					
Melilotus (sweetclover)	NA												
Medicago sativa (alfalfa)	NA												
Olea sp. (olive)		NA			E		E						

Table 2.—Continued.

HOST	*ligustici*	*cribricollis*	*porcatus*	*scaber*	*raucus*	*dubius*	*meridionalis*	*clavipes*	*arcticus*	*ligneus*	*singularis*	*rugifrons*	*desertus**
Paeonia (peony)	NA						NA, E						
Pinus spp. (pine)				E	E						NA		
Plantago sp. (plantain)										NA			
Platanus orientalis (oriental planetree)		NA											
Primula sp. (primrose)			E								NA		
Pyracantha sp. (firethorn)		NA											
Pyrus communis (pear)					E						E		
Quercus spp. (oak)		NA		E									
Reseda luteola (weld mignonette)										NA, E			
Rheum spp. (rhubarb)					E		E		E				
Rosa spp. (rose)		NA					NA, E	E					
Rubus spp. (raspberry)	NA	NA						E			NA		
Rumex spp. (dock)	NA					E		e					
Saxifraga spp. (saxifrage)			E			E						E	
Scorzonera humilis (slimleaf wallrocket)										E, NA			
Syringa spp. (lilac)			NA				NA, E	e					
Trifolium spp. (clover)	NA				E	E							
Viburnum sp. (viburnum)			NA					E					
Vitis spp. (grape)					E		E	e			E		

Tables 1 and 2 are composed of host plants recorded for a particular species of *Otiorhynchus*. A distinction is made in Table 2 between a single record for a host and multiple records. The list is by no means inclusive.

Otiorhynchus ligustici (Linnaeus)

fig. 1, 17, 39

This widely distributed Palaearctic species is recorded from England and Scotland, through northern and central Europe to Siberia, and south to Italy. It feeds on many plants but seems partial to and is a serious pest of alfalfa. *Otiorhynchus ligustici* was first recorded in North America from specimens taken on recently set raspberry plants near Oswego, New York (Herrick, 1933). The species was found in a few townships in Oswego and Jefferson counties, New York, in 1936 (Palm, 1936:960) and collected in Oswego by F. W. Poos in 1950. The species now extends throughout western Jefferson Co., along the lake in Oswego Co., the northern tip of Cayuga Co., an isolated area of Wayne Co., near Butler, and on several islands in the St. Lawrence River, including one Canadian island, probably Wolfe Island (G. G. Gyrisco, 1976, personal communication). A single specimen from the Wickham collection in the U. S. National Musuem, is labeled Oswego, N. Y., May 4, 1896; this may be evidence that the species had been in New York for 37 years or more before it increased sufficiently to be noticed. A detailed account of the species is given in Balachowsky (1963:896) and Lincoln and Palm (1941).

Distribution (Fig. 39): Canada: Wolfe Island. United States: New York.

Otiorhynchus cribricollis Gyllenhal

fig. 2, 18, 37

This species occurs in southern Europe and the Mediterranean region and is widely distributed in all of North Africa. The host plant for the larva is wormwood, *Artemisia gallica* Willd., but the adult may feed on the foliage of almond, peach, olive, and citrus. The species is also established in Australia where in some districts it causes more damage to apples than all other insect pests combined (Tillyard, 1926: 242). Andrewartha (1933:373) gave an account of the life history, habits, food plants, and parthenogenesis of *cribricollis* in Australia. Zimmerman (1962:189) reported the larvae feeding on the roots of great burdock, *Arctium lappa* L., near Kamuela on the island of Hawaii. Davis (1966) recorded it established on the Island of Maui; adults of *Cribricollis* caused economic damage to commercial plantings of chysanthemum in Kula, Hawaii.

In North America, *cribricollis* apparently was first found in June 1928 at Montebello, Los Angeles County, California (Van Dyke, 1929). The species now also occurs in Contra Costa, Yuba, Sacramento, San

Joaquin, and Santa Clara counties, California. Lange and McCalley (1962) reported economic damage to artichokes in California. The species was found in Midland, Texas, in 1966; on roots of honeysuckle, in Tucson, Arizona, 1950; on privet hedge, in Albuquerque, New Mexico, 1974, on rose; and in Carlsbad, New Mexico, 1975, on apple foliage.

Distribution (fig. 37): United States: Arizona, California, Nevada, New Mexico, Texas.

Otiorhynchus porcatus (Herbst)

fig. 3, 19, 40

According to Lona (1936:70), the Palaearctic distribution of *porcatus* is "Middle Europe." Kevan (1943:207; 1944:173) reported that the species is found in Scotland and gave notes on the habitat; it is associated with london pride, *Saxifraga umbrosa* L., and other border plants of the garden. Specimens were usually found on the soil under the leaves of london pride, feeding as larvae on the roots of the plant or similar plants and as adults on the leaves. In Norway, where it has been known as a pest since 1935, Fjelddalen (1963:144) describes injury to *Primula* sp. grown in greenhouses; the larvae were found feeding on rootlets and bark of larger roots. The symptoms of attack and damage resemble that of *sulcatus*. Live specimens from England, Germany, and Austria have been intercepted several times at eastern United States ports.

Distribution (fig. 40): Canada: Newfoundland, Quebec.

Otiorhynchus scaber (Linnaeus)

fig. 4, 20, 39

This species occurs in central and northern Europe. Kleine (1910: 50) reported adults feeding on 1–4 year old plantings of norway spruce, *Picea abies* (= *excelsa*) L., and the leaves of silver fir, *Abies alba* Mill. In central Europe *scaber* is an important forest pest, feeding on foliage and bark of fir, pine, oak, and larch.

In North America *scaber* is known only from Nova Scotia (Lindroth, 1957:62).

Distribution (fig. 39): Canada: Nova Scotia.

Otiorhynchus raucus (Fabricius)

fig. 5, 21, 39

This species is widely distributed throughout Europe, less so in the Mediterranean region. Balachowsky (1963:884) and Hoffmann (1923: 233; 1950:92) reported the species as a serious pest of cultivated rhubarb and garden vegetables; the larvae eat the young shoots. Adults feed on foliage, young shoots of apple, pear, cherry and the petioles of olive.

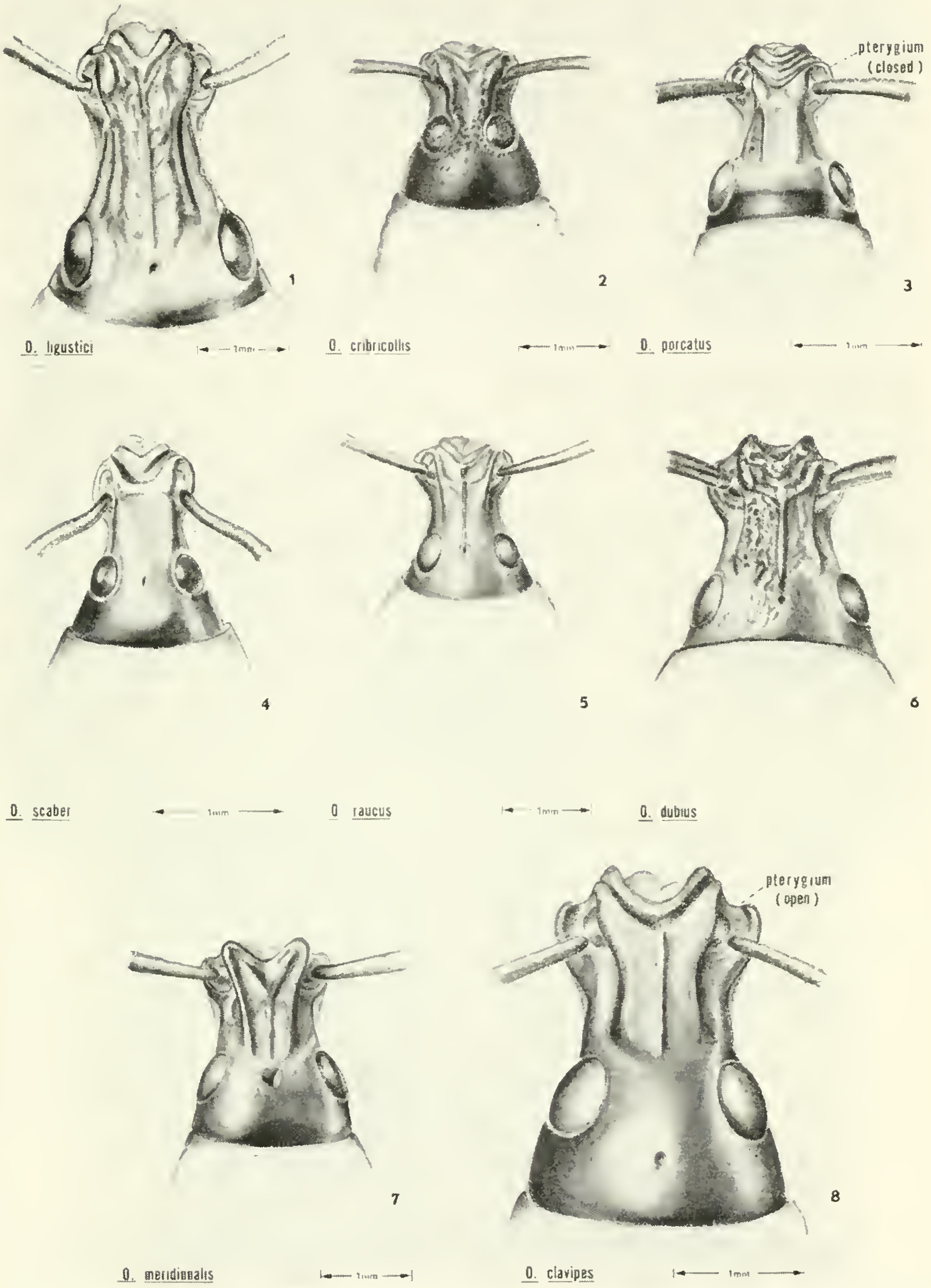


Fig. 1–8. *Otiorhynchus* spp., dorsal view of rostrum. 1, *ligustici*. 2, *cribricollis*. 3, *porcatus*. 4, *scaber*. 5, *raucus*. 6, *dubius*. 7, *meridionalis*. 8, *clavipes*.

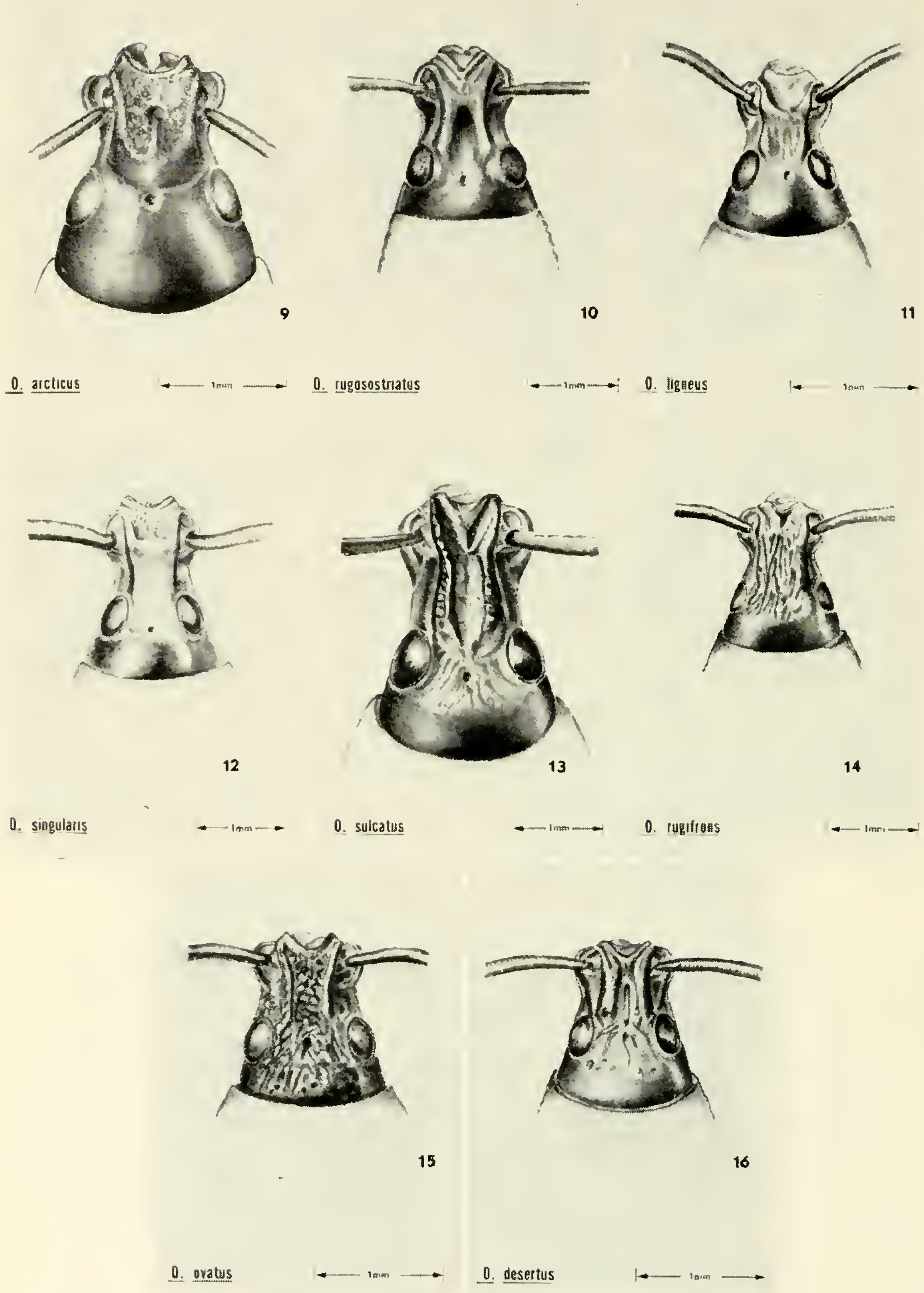


Fig. 9–16. *Otiorhynchus* spp., dorsal view of rostrum. 9, *arcticus*. 10, *rugosostriatus*. 11, *ligneus*. 12, *singularis*. 13, *sulcatus*. 14, *rugifrons*. 15, *ovatus*. 16, *desertus*.

Hicks (1947) reported the species new to North America and established in Ontario, Canada. The specimens were found in Fonthill Nurseries, Fonthill, Ontario in 1936.

Distribution (fig. 39): Canada: Ontario.

Otiorhynchus dubius (Ström)
(*nodosus* of O. Fabricius, *nodosus* Müller of authors)
fig. 6, 22, 42

This species occurs in the alpine regions of middle Europe, in northern Europe, British Isles, Iceland, and Greenland. In Greenland it is found only in the far south and along the west coast (Henriksen, 1939:46).

The adult feeds on the green parts of many different dicotyledonous plants, and the larva is a root feeder (Larsson and Gija, 1959:190). In Iceland, *dubius* has been observed eating the leaves of sorrel, *Rumex acetosa* L., *R. domesticus* (Platt); dryad, *Dryas octopetala* L.; saxifrage, *Saxifraga hirculus* L.; and the blossoms of white clover, *Trifolium repens* L., (Lindroth, 1931:231); Holdhaus and Lindroth, 1939:215). According to Hamilton (1889:108) this species was found in the nests of *Formica rufa* L., at Kirjola, [Finland].

Distribution (fig. 42): Greenland.

Otiorhynchus meridionalis Gyllenhal
fig. 7, 23, 37

According to Balachowsky (1963:884) this species is widely distributed in the Mediterranean region and lives principally on Oleaceae: *Olea*, *Ligustrum*, *Syringa*, *Forsythia*, and *Jasminum*. Essig (1933:400, 405) listed *meridionalis* on citrus and olives in Spain and Algeria. Keifer (1931) reported the first discovery of *meridionalis* in North America at San Jose, California, on California privet, *Ligustrum ovalifolium* Hassk.

Distribution (fig. 37): United States: California, Idaho, Montana, Nevada, New Mexico, Utah, Washington.

Otiorhynchus clavipes Bonsdorff
fig. 8, 24, 40

This species is common in western Europe but does not extend to the Mediterranean region.

Otiorhynchus clavipes is polyphagous and in the larval stage is especially destructive to numerous nursery plants. It is a serious pest of strawberries in sections of England (Ibbotson and Edwards, 1954). The larvae eat the roots of lilac, *Syringa*; raspberry, *Rubus*; strawberry, *Fragaria*; smooth sumac, *Rhus glabra* L.; European cranberry bush, *Viburnum opulus* L.; bigsting nettle, *Urtica dioica* L.; *Weigelia*; curly dock, *Rumex crispus* L.; Japanese aucuba, *Aucuba*; and honeysuckle, *Lonicera*. The adults eat the leaves of many fruit trees and vines (Hoffmann, 1950:70; Balachowsky, 1963:881).

The only known North American record is from one specimen in the USNM labeled "Newport County, Rhode Island, July 16, 1942." Although the fifth visible abdominal sternum is missing, the specimen is easily determined as a female of *clavipes*.

Distribution (fig. 40): United States: Rhode Island.

Otiorhynchus arcticus (O. Fabricius)

fig. 9, 25, 42

Otiorhynchus arcticus was described from Greenland and also occurs in north and central Europe. The species was recorded by Fjelddalen (1963:143) as a pest of strawberry in Norway and in 1959 was responsible for heavy losses to strawberry plants in northern Norway. The life cycle is very similar to that of *ovatus*; feeding symptoms and damage are the same. Poppius (1910:420) reported larvae of *arcticus* from roots of common statice or thrift, *Armeria vulgaris* Willd., and Kleine (1910:51) recorded the species on the leaves of rhubarb, *Rheum undulatum* L. The species has been intercepted at New York with sod roots from Scotland.

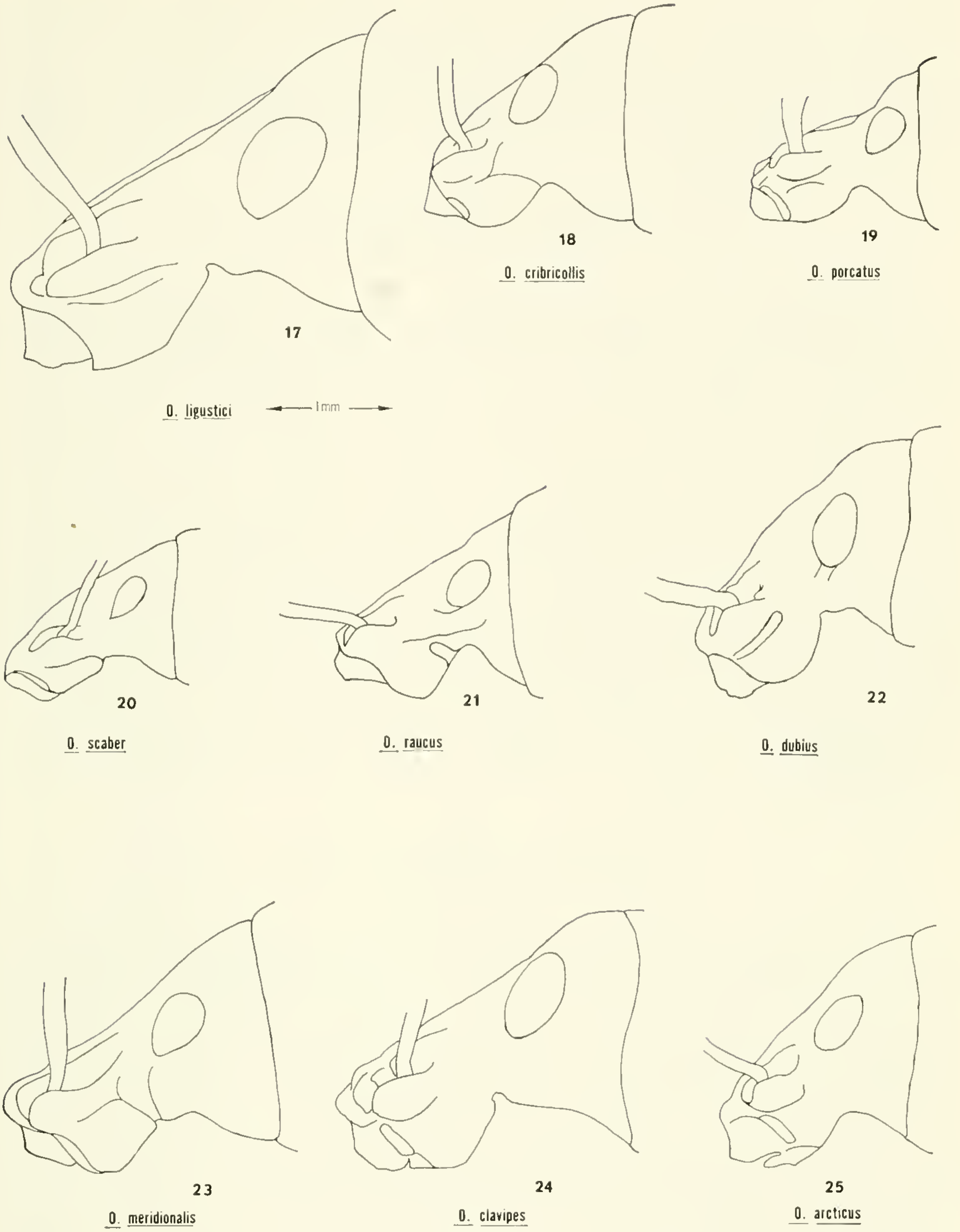
Distribution (fig. 42): Greenland.

Otiorhynchus rugosostriatus (Goeze)

fig. 10, 26, 41

This species is widely distributed in the western part of the Palaearctic region. The adult is polyphagous; Balachowsky and Mesnil (1935:473) said it is injurious to cyclamen plants in France and calls it "l'otiorhynque des cyclamens." *Otiorhynchus rugosostriatus* is established in Australia where Tillyard (1926:242) reported it as injurious to fruit trees. It might also be established in South America, for there are three specimens evidently from Santiago, Chile, in the United States National Museum and, according to L. L. Buchanan's note in the tray with the specimens, there is a specimen from Juan Fernandez Is., Chile, in the American Museum of Natural History collection.

As far as is known, *rugosostriatus* was first reported from North America by Horn (1876:61) under the name "*rugifrons* Gyll." from the "Middle States." This geographical term today might be interpreted as the middle West; but in Horn's time it doubtlessly still retained its original meaning of Middle Atlantic States, i.e., Delaware, New Jersey, New York, Pennsylvania, and sometimes Maryland, an area in which several foreign weevils have first been detected in America.



17 O. ligustici
18 O. cribricollis
19 O. porcatus
20 O. scaber
21 O. raucus
22 O. dubius
23 O. meridionalis
24 O. clavipes
25 O. arcticus

Fig. 17–25. *Otiorhynchus* spp., lateral view of rostrum. 17, *ligustici*. 18, *cribricollis*. 19, *porcatus*. 20, *scaber*. 21, *raucus*. 22, *dubius*. 23, *meridionalis*. 24, *clavipes*. 25, *arcticus*.

In North America, it is injurious to strawberry in California, Colorado, Oregon, Washington, and British Columbia (Wilcox *et al.*, 1934: 63). These authors suggested the name "rough strawberry root-weevil."

Distribution (fig. 41): Canada: British Columbia, Nova Scotia, Ontario. United States: Arizona, California, Colorado, Connecticut, District of Columbia, Georgia, Idaho, Indiana, Maryland, Michigan, Missouri, Montana, Nevada, New Jersey, New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Utah, Virginia, Washington, West Virginia, Wisconsin, Wyoming.

Otiorhynchus ligneus (Olivier)

fig. 11, 27, 40

This species is widely distributed in middle and northern Europe. There it feeds on a number of plants including: slimleaf wallrocket, *Diplotaxis tenuifolia* D. C.; weld mignonette, *Reseda luteola* L.; and bohemian serpentroot, *Scorzonera humilis* L. (Hoffmann, 1950:100).

In North America it is evidently very abundant in the Canadian Maritime Provinces; according to Brown (1940:76) it was collected at St. Stephens, New Brunswick, in 1917, Economy, Nova Scotia, in 1927, and Yarmouth, Nova Scotia, in 1935 and 1936. The specimens from St. Stephens are not now in the Canadian National Collection. Blatchley (1928:240) reported *ligneus* from Machias, Maine, where it occurred in numbers, crawling in the rooms of a farmhouse. The only North American host record is on a specimen in the USNM; it was intercepted from Nova Scotia "alive with trailing arbutus."

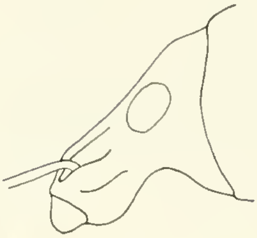
Distribution (fig. 40): Canada: New Brunswick, Nova Scotia. United States: Maine.

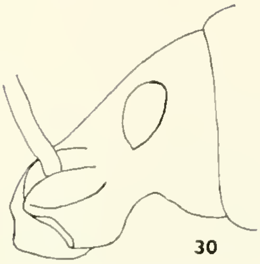
Otiorhynchus singularis (Linnaeus)

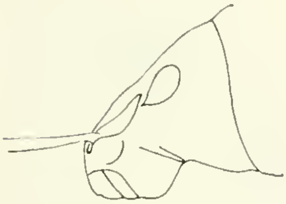
fig. 12, 28, 37

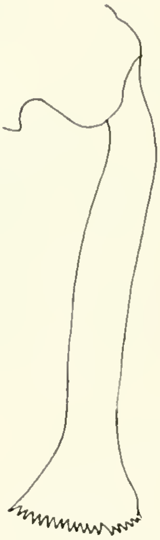
Otiorhynchus singularis occurs in the cooler western and central regions of Europe. There it feeds on rose, magnolia, azalea, *Ampelopsis*, *Thuja*, conifers, beech, hazel, alder, pear, apple, and cultivated vegetables (Balachowsky and Mesnil, 1935:57; Balachowsky, 1963:886; Hoffmann, 1950:106). In a detailed study Kolbe (1974) found that this species damaged the following conifers: Norway spruce, *Picea abies* (L.) Karst.; Port-Oxford-cedar, *Chamaecyparis lawsoniana* (A. Murr.) Parl.; Western red cedar, *Thuja plicata*, Donn.; dawn redwood, *Metasequoia glyptostroboides* Cheng and Hu; white fir, *Abies concolor* (Gord. and Glend.) Lindl.; and giant sequoia, *Sequoia giganteum* (Lindl.) Decne.

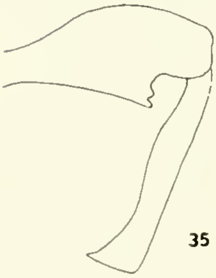
The first North American report of *singularis* (as the synonym, *picipes* Fab.) was made in 1872 from Essex, Massachusetts (Brown, 1940:76). Brown also recorded the species from several places in New Brunswick, Nova Scotia, Ontario, Quebec, and Victoria, British Columbia. From labels on specimens in the United States National Museum, *singularis* was found on white pine blister cankers, *Cronartium ribicola* Fischer and on laurestinus, *Viburnum tinus* L.











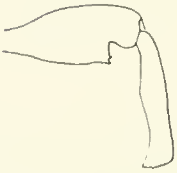
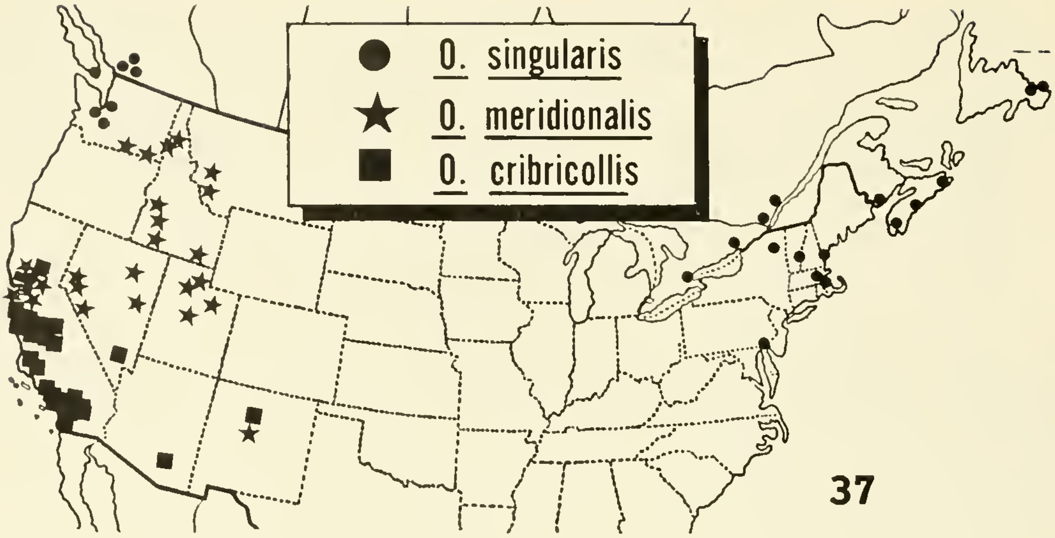


Fig. 26–32. *Otiorhynchus* spp., lateral view of rostrum. 26, *rugosostriatus*. 27, *ligneus*. 28, *singularis*. 29, *sulcatus*. 30, *rugifrons*. 31, *ovatus*. 32, *desertus*. Fig. 33–34. *Otiorhynchus* spp., protibia. 33, *ligustici* and *cribricollis*. 34, all other species. Fig. 35–36. *Otiorhynchus* spp., profemur. 35, *ovatus*. 36, *desertus*.



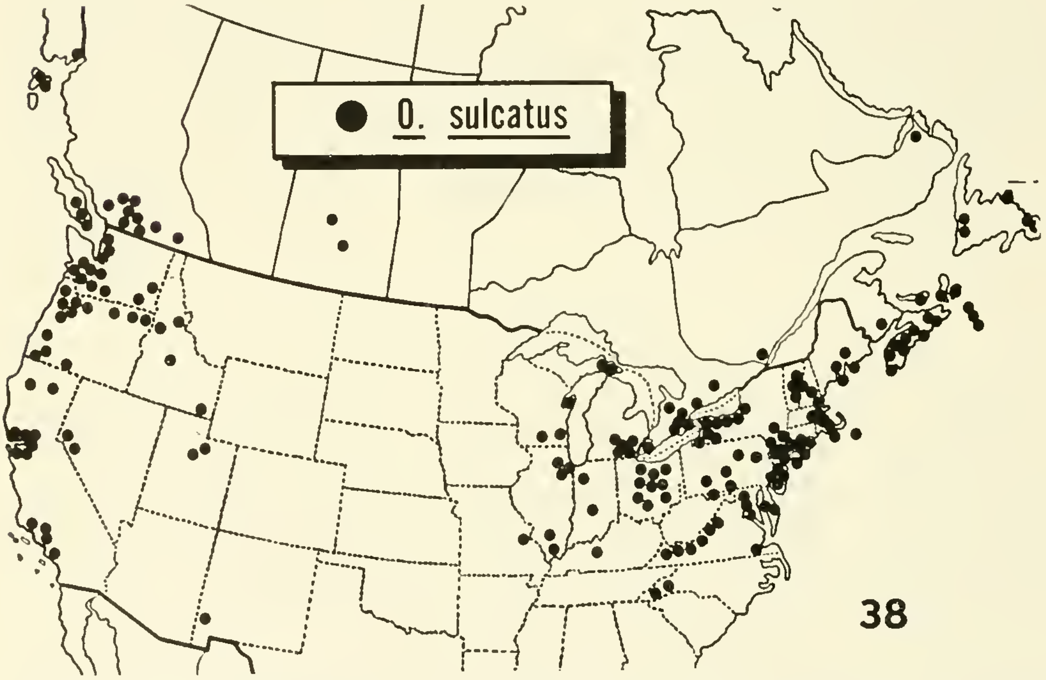


Fig. 37–38. *Otiorhynchus* spp., distribution. 37, *singularis*, *meridionalis*, *cribricollis*. 38, *sulcatus*.

Distribution (fig. 37): Canada: British Columbia, Newfoundland, Nova Scotia, Ontario, Quebec. United States: Maine, New Hampshire, New York, Pennsylvania, Washington.

Otiorhynchus sulcatus (Fabricius)
fig. 13, 29, 38

In the Palaearctic this species is widely distributed over northern and middle Europe as far south as France and Italy. It is also recorded from Australia, New Zealand and Tasmania (Tillyard, 1926:242). In Europe, this species is most widely known for its economic damage to grapevines.

Harris (1835:569[3]) recorded "*Curculio* (*Otiorhynchus* Germ.) *apiculatus*," from Massachusetts, and evidence presented by Hagen (1890) indicates that Harris' specimen was collected in 1831. Schoenherr (1843:371) listed *apiculatus* as a Say manuscript name and placed it as a synonym of *sulcatus* (F.). Thus *sulcatus* has apparently been present in this country about as long as *ovatus*, and it is possible that they arrived about the same time. The overall American ranges of the two are quite similar, but *ovatus* has seemingly spread farther and more rapidly; the area occupied by it being greater, more continuous, and extending farther south. The distribution of *sulcatus* is less extensive and much more "spotty."

The more or less indiscriminate preference of the black vine weevil is shown by the list of 77 host plants given by Smith (1932:4). The USDA, Plant Pest Survey files contain approximately 70 additional hosts. The literature on the economic importance of this species in the United States frequently includes greenhouse, nursery, and other horticultural plants. The larvae feed on roots and adults on foliage. Wilcox *et al.* (1934:73–76) mentioned several instances of damage to strawberry plants, though they considered it as probably the least important of the root weevils attacking strawberries in Oregon. The species has increased rapidly in numbers, and Cram (1958) reported that in the Pacific Northwest, *sulcatus* is probably more important than *ovatus*, the strawberry root weevil.

Distribution (fig. 38): Canada: British Columbia, New Brunswick, Newfoundland, Nova Scotia, Quebec. United States: Alaska, Arizona, California, Connecticut, District of Columbia, Illinois, Maine, Maryland, Massachusetts, Michigan, Montana, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oregon, Rhode Island, Texas, Utah, Vermont, Virginia, Washington, Wisconsin.

Otiorhynchus rugifrons (Gyllenhal)

fig. 14, 30, 40

This species, widely distributed in northern and middle Europe, is a pest of alpine saxifrage, *Saxifraga* spp., in Great Britain (Essig, 1933).

Otiorhynchus rugifrons was first recorded in North America in 1884 at Sydney, Nova Scotia (Harrington, 1891:22), and, according to Brown (1940:76) Harrington took it at the same place in 1890 and 1894.

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[3] In Harris' (1833) original edition of the list of species apparently had not yet been identified, because what presumably is *apiculatus* appeared on page 577 as "*Curculio* (*Otiorhynchus*), one species much like *rugosus*."

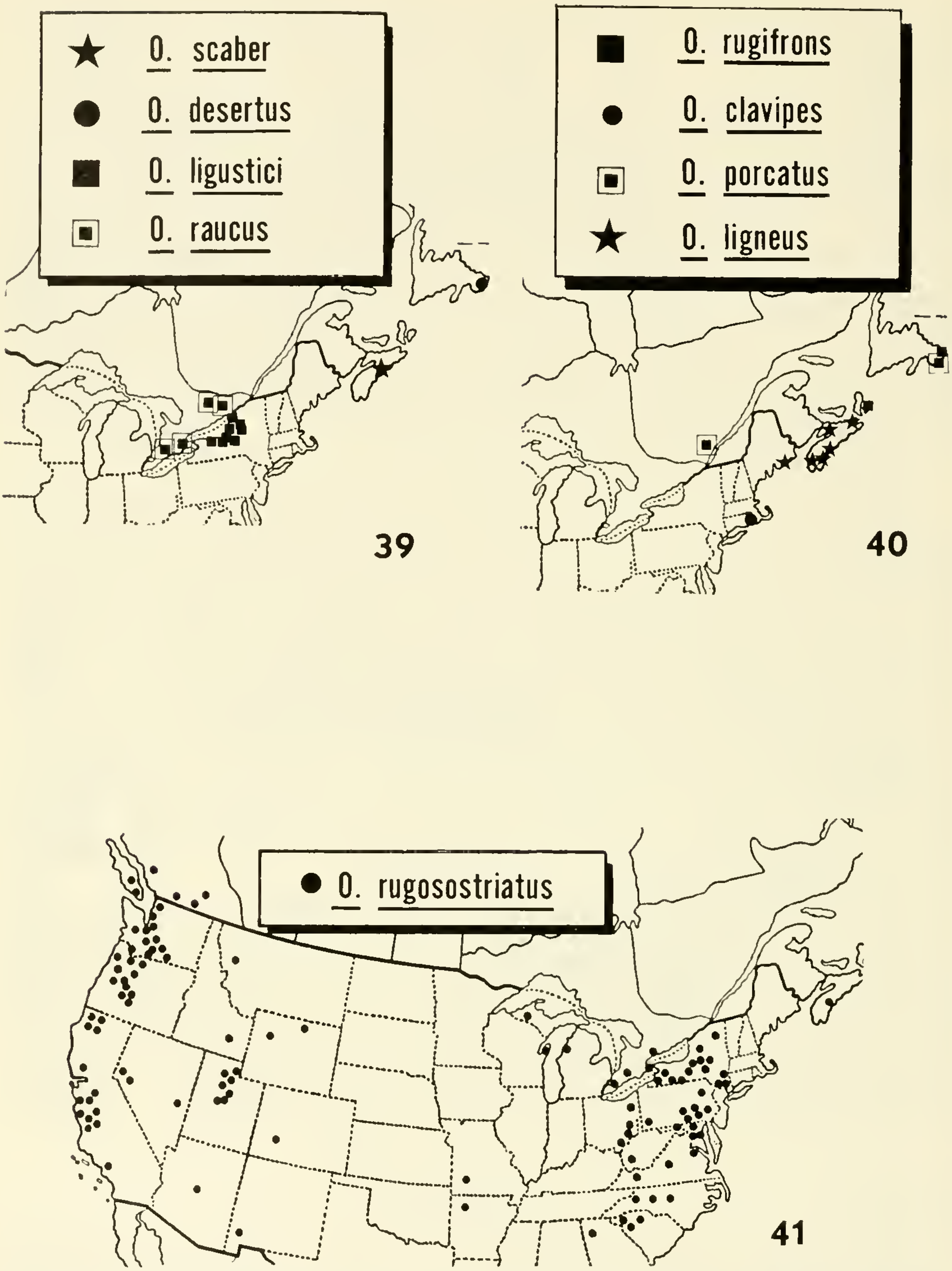

Fig. 39–41. *Otiorhynchus* spp., distribution. 39, *scaber, desertus, ligustici, raucus*. 40, *rugifrons, clavipes, porcatus, ligneus*. 41, *rugosostriatus*.

Buchanan (1927) noted the confusion of *rugifrons* with *rugosostriatus* in the North American literature and wrote "it is safe to say that practically all the American records for *rugifrons* excepting the Nova Scotian one by Harrington properly refer to *rugosostriatus*."

Distribution (fig. 40): Canada: Newfoundland, Nova Scotia.

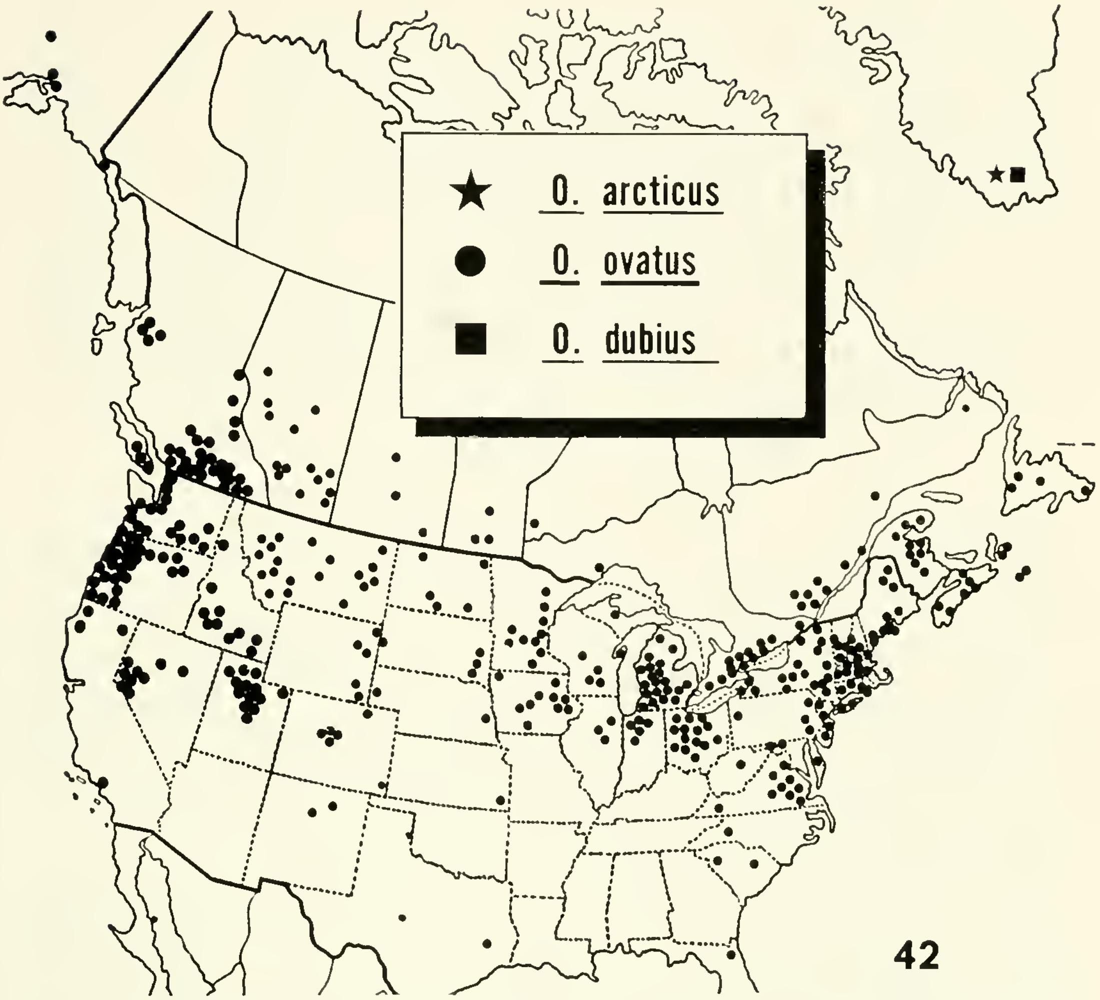

Fig. 42. *Otiorhynchus* spp., distribution of *arcticus*, *ovatus*, and *dubius*.

Otiorhynchus ovatus (Linnaeus)

fig. 15, 31, 35, 42

In the Palaearctic this species is well known and widely distributed and damages strawberry, raspberry, and beets. In North America, the species is known as the strawberry root weevil, because it frequently causes economic damage to strawberries, but it is a general feeder and occasionally becomes a pest of conifer seedlings in the Pacific Northwest (Wilcox *et al.*, 1934).

Because of its early introduction and its economic importance, *ovatus* has an extensive North American literature. Wickham (1894) reported *ovatus* from Massachusetts in 1852; by 1882 it was a strawberry pest in southern Michigan. It was collected at Iowa City, Iowa, at least as early as 1886, in Wyoming in 1893, and in New Mexico in 1894. In the USNM collection, there are specimens collected on strawberry at Montavilla, Oregon, in 1900.

A peculiarity common to *ovatus*, *rugosostriatus*, *ligneus* and *singu-*

laris is the habit of entering houses and other buildings in large numbers during the summer. We have seen no references to this habit in European literature.

Distribution: In North America *ovatus* is the most widely distributed of all the species of *Otiorhynchus*. It extends across the continent in a broad band that includes all the provinces of Canada and the northern half of the United States. The southern limit, as shown by specimens examined, is the Welder Wildlife Refuge, Sinton, Texas. Specimens have been examined or records seen from all the United States *except* Georgia, Alabama, Arizona, Arkansas, Kentucky, Louisiana, Mississippi, Missouri, Oklahoma, and Tennessee.

Otiorhynchus desertus Rosenhauer
fig. 16, 32, 36, 39

This species is found in the Palaearctic region in northwestern and central Europe, especially in the Alpine and Pyrenees region. The adults have been found in the mosses of subalpine forests.

In North America *desertus* is known only from Newfoundland (Lindroth, 1957:62). A single specimen was found in 1949 by E. Palmen and Lindroth at Cape Broyle, in southeastern Newfoundland. This specimen is in the Canadian National Collection.

Distribution (fig. 39): Canada: Newfoundland.

We wish to express our gratitude to Dr. William J. Brown, Agriculture Canada, Biosystematics Research Institute, Research Branch, Ottawa, Canada (now retired) for his assistance in some of the initial work on the distribution of the Canadian species, and to Donald E. Bright of the same Institute for arranging the loan of the material in the Canadian National Collection. Theodore J. Spilman, USDA, Systematic Entomology Laboratory, Washington, D. C., Thomas J. Henry, Karl Valley and A. G. Wheeler, Jr., Pennsylvania Dept. of Agriculture, Harrisburg, reviewed and improved the manuscript. We extend special thanks to the staff of the Cooperative Plant Pest Report, USDA, Hyattsville, Maryland, who so generously printed-out from microfiche all collection and host records for each species. The figures, maps, and tables were prepared by Finley B. Negley.

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THE MATURE LARVAE AND PUPARIA OF EPHYDRA (HALEPHYDRA) CINEREA JONES AND EPHYDRA (HYDROPYRUS) HIANS SAY (DIPTERA: EPHYDRIDAE)

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ABSTRACT—*Ephydra* (*Halephydra*) *cinerea* Jones and *E.* (*Hydropyrus*) *hians* Say have attracted considerable interest due to their occurrence and, at times, superabundance in mineral lakes of western North America. The mature larvae and puparia of both species are described and illustrated.

Ephydra (*Halephydra*) *cinera* Jones inhabits permanent brine lakes in warmer parts of western North America and hypersaline lagoons along the Pacific and Caribbean coasts. *Ephydra* (*Hydropyrus*) *hians* Say is restricted in its distribution to saline and alkaline lakes of western North America (Wirth, 1971).

The ability of these flies to inhabit strong mineral lakes has generated considerable curiosity and consequently, their biological traits are among the best known for the Ephydridae. Numerous biological accounts of these two species have been deftly summarized by Wirth (1971), who also clarified the adult taxonomy for the North American species of *Ephydra*. Less detailed information is available concerning the morphology of the immature stages. Aldrich (1912) presented brief descriptions and photographs for the mature larvae and puparia of both *Ephydra cinerea* (as *gracilis*) and *E. hians*. The purpose of the present paper is to provide more detailed descriptions and illustrations than are currently available for the mature larvae and puparia of these two species.

Methods

Specimens were obtained from the shallow-water margins of 3 mineral lakes in the central and western United States during the summer of 1969. The material of *E. cinerea* was harvested from the south shore of Great Salt Lake, Salt Lake Co., Utah. Representatives of *E. hians* were found at a small alkaline lake 2.3 miles east of Palermo, Mountrail Co., North Dakota and along the eastern shore of Mono Lake, Mono Co., California.

The larvae were killed in hot water, then placed in 70% ethanol. Puparia were lanced several times with an insect pin, then placed in the above preservative.

In the descriptions that follow, "main body length" refers to the distance from the anterior end of the specimen to the posterior margin of its terminal proleg. "Breathing tube length" is the distance from the posterior margin of the

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terminal proleg to the apex of the fully extended posterior breathing tube (fig. 9). The tube is partially retracted in many preserved specimens, but is easily extended to its full length by gently pulling the apex of the tube posteriorly with a pair of forceps while keeping the main body of the larva in a stationary position. "Indentation index", used to characterize the pharyngeal skeleton, is the length of the sinus separating the dorsal and ventral cornua divided by the total length of the pharyngeal sclerite times 100.

Abbreviations used in figures: A, antenna; AF, accessory filament; AHB, anterior hypostomal bridge; AMS, accessory mouthhook sclerite; ASl, anal slit; ASp, anterior spiracle; BTL, breathing tube length; CSP, circular sensory plate; DB, dorsal bridge; DC, dorsal cornua; DCC, dorsal cephalic cap; FH, float hair; ILR, inner longitudinal rod; LPP, lateral pharyngeal process; LS, ligulate sclerite; MH, mouthhook; OLR, outer longitudinal rod; OP, oral papilla; PB, parastomal bar; PcS, pseudocephalic segment; PHB, posterior hypostomal bridge; PP, perianal pad; PoSB, postoral spine band; S, sensillum; SpO, spiracular opening; SpS, spiracular scar; VC, ventral cornua; W, window.

Ephydra (*Halephydra*) *cinerea* Jones

fig. 1–7

Third-instar larva. (fig. 2). Main body length 5.60–11.25 mm, approximate breathing tube length 3.30–7.50 mm; maximum width in dorsal view 1.07–1.65 mm. Shape cylindrical, tapering somewhat anteriorly; first 2 segments retractile, pseudocephalic segment mostly hidden; segments 5–12 each with fleshy proleg, equipped with long curved clawlike spines ("claws"), caudal segment elongated to form posterior breathing tube, telescoping and branching distally. Segment 1 (pseudocephalic) bilobed anteriorly; each lobe with small, 3-segmented sensory papilla ("antenna") directed anteroventrally, circular sensory plate on each lobe ventral to antenna. Internal structures mostly white; integument translucent and somewhat leathery, grayish-white to brown; spines indistinct except on ventral portions of segments 2 and 3 and on prolegs; segments 2–11 banded on anterior ⅓ by 10 tri-lobed sensilla. Segment 2 (prothoracic) with weak postoral spine band anteroventrally, composed of irregularly arranged rows of minute spinules; anterior spiracles small and palmate, usually with 3 marginal papillae. Segment 3 spinose anteroventrally, remainder with spines indistinct. Segments 4–11 leathery, variously wrinkled and tuberculated, lacking dorsal patterns. Prolegs 1–7 elongate; lobes of each proleg united near basal ⅓; each lobe bearing 2 rows of small claws arranged along outer apical circumference; apical row with 5 claws, subapical row with 4–6 slightly smaller claws. Segment 12 bearing posterior breathing tube distally and large, subcylindrical proleg ventrally. Lobes of proleg well developed; claws of apical row 5 per lobe, those of preapical row somewhat smaller, 4–6 per lobe. Perianal pad (fig. 4) with V-shaped row

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Fig. 1–7. *Ephydra* (*Halephydra*) *cinerea*. 1, anterior end of mature third-instar larva, lateral view. 2, mature larva, lateral view. 3, puparium, lateral view. 4, terminal proleg of mature larva, ventral view. 5, posterior spiracular cap of same, distal view. 6, epistomal sclerite of same, dorsal view. 7, cephalopharyngeal skeleton of same, lateral view.

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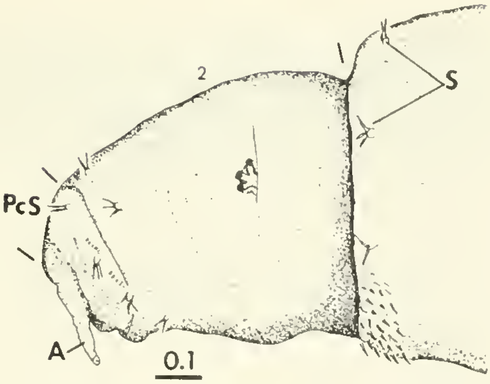
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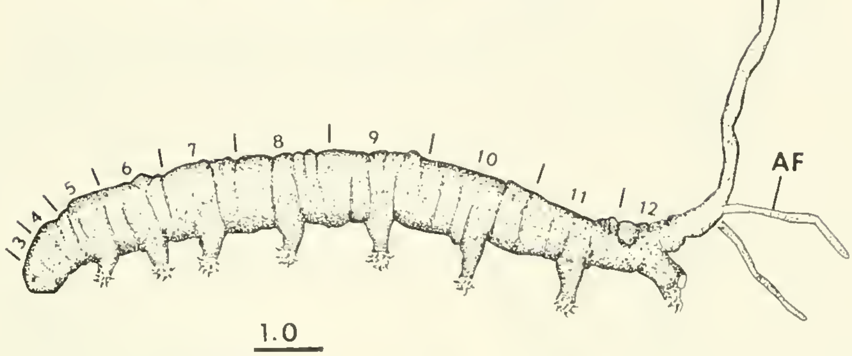
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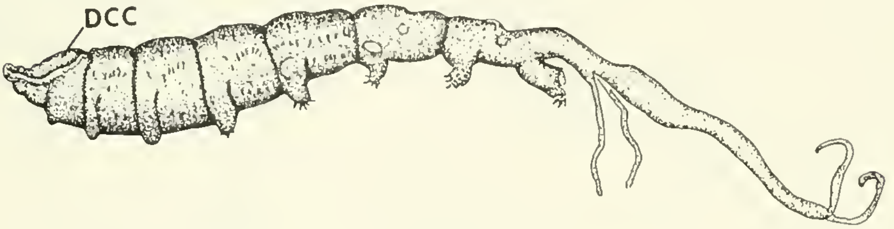
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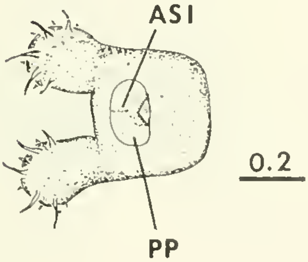
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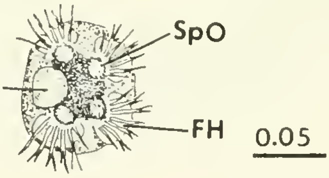
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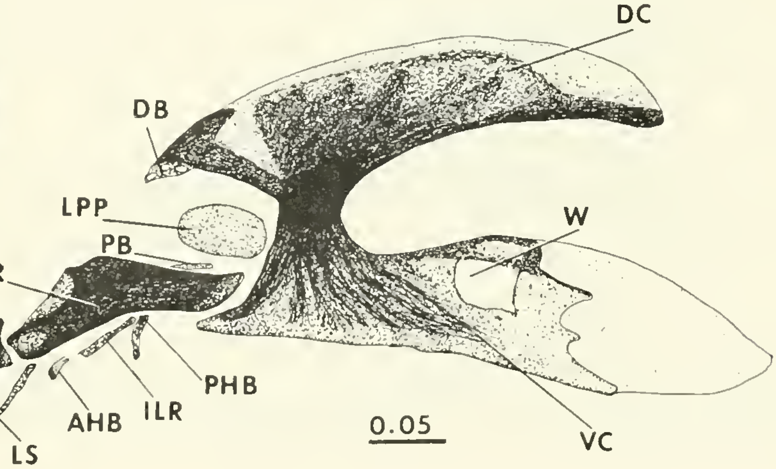
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of small, dark spines posteromedially. Breathing tube extremely elongate and somewhat flaccid, bearing paired accessory filaments approximately 2–3 mm in length near its base. Branches bearing spiracles thin and elongate, often curved. Posterior spiracular caps small, occupying only terminal portion of each branch; 4 indistinct spiracular openings present; float hairs present but much reduced (fig. 5). Cephalopharyngeal skeleton (fig. 7) length 0.54–0.61 mm. Mouthhooks paired, not interconnected; length 0.09–0.11 mm; hook part more or less rounded and spoon-shaped, golden yellow, bearing well-developed teeth marginally; small marginal window posterior to basal tooth. Accessory mouthhook sclerite located ventrolaterally to mouthhook on each side, appressed to basal portion; triangular and yellowish. Ligulate sclerite paired, each piece long and thin, with 2 or more small, angular bends; posterior part lying beneath anterior edge of hypostomal sclerite, directed anteriorly toward midline. Hypostomal sclerite paired, length 0.16–0.18 mm, composed of 2 pairs of longitudinal sclerites and 2 transverse bridges; each outer longitudinal rod stoutest at junction with parastomal bar, anteroventral portion expanded laterally to articulate with mouthhook; anterior hypostomal bridge intersecting anterior ¼ of outer longitudinal rods, thin, slightly curved and bowed ventrally; posterior hypostomal bridge intersecting posterior ⅓ of outer longitudinal rods, much like anterior bridge but more strongly bowed; inner longitudinal rods articulating with interior and posterior bridges, angled near midlength, slightly diverging posteriorly. Epistomal sclerite strongly convex, mostly lightly pigmented, shaped as illustrated (fig. 6). Pharyngeal sclerite length 0.31–0.38 mm; indentation index 66–77; anteroventral edge ventral to and free from hypostomal sclerite; paired lateral pharyngeal processes rounded, flat, disc-like and free from pharyngeal sclerite; dorsal bridge highly reticulate; dorsal cornua without distinct windows, and much darker than ventral cornua; ventral cornua with subovate to subtriangular window posterodorsally. (Based on 22 specimens.)

Puparium. (fig. 3). Main body length 6.92–11.35 mm ($\bar{x} = 8.75$), approximate breathing tube length 4.83–7.25 mm; maximum width in dorsal view 1.16–1.93 mm ($\bar{x} = 1.49$). Yellowish brown to brown; subcylindrical in lateral view; dorsum flattened; venter tapering gradually posteriorly and abruptly anteriorly from segment 6. Main body rigid, breathing tube somewhat flexible, integument devoid of spines, scales and setae except spinose apices of prolegs. Anterior spiracles sessile. Dorsal cephalic cap delineated by line of weakness extending laterally along segments 2–5, strongly indented near posterior margin of segment 4, transversing segment 5 dorsally near its posterior margin. Segments 6–11 completely ringed by dark brown intersegmental indentations; secondary dark brown indentations along posterior border of prolegs 2–7, extending dorsally to approximately ½ puparium height. Lobes of prolegs 1–7 opposed to each other; lobes of prolegs 1–3 strongly opposed and slightly bulging, claws usually not visible laterally; lobes of prolegs 4–7 more strongly bulging, claws more often visible laterally. Segments 11 and 12 with 1 small tubercle above each proleg and 2 dorsal tubercles on each side. Terminal proleg fully distended; lobes projecting ventral to posteroventrad, diverging. Breathing tube fully extended and flexible, variously coiled and wrinkled; light to dark brown; bearing 1 pair of filaments near its base; branches usually moderately spiraled outward. (Based on 24 specimens.)

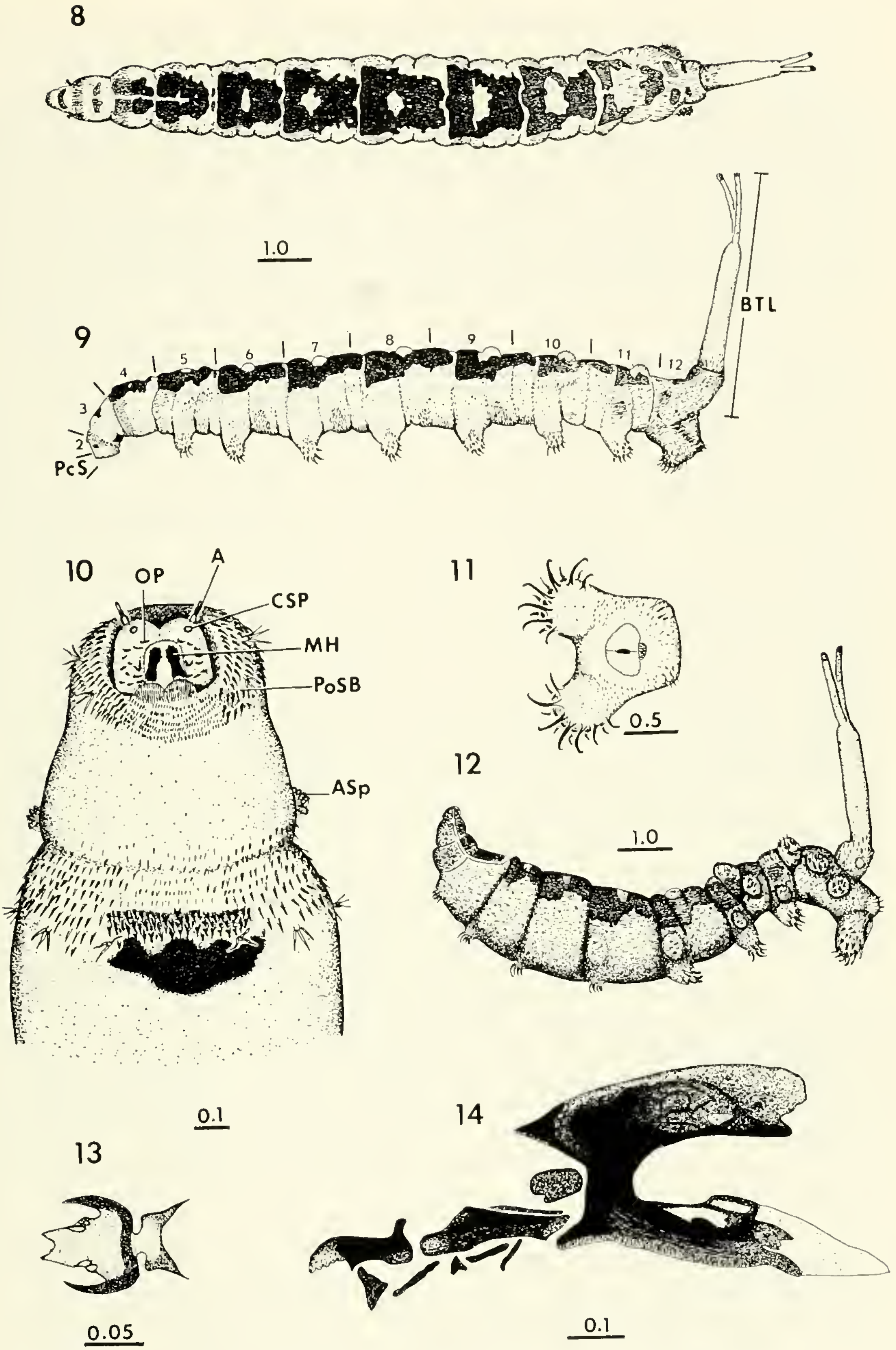

Fig. 8–14. *Ephydra (Hydropyrus) hians.* 8, mature third-instar larva, dorsal view. 9, same, lateral view. 10, anterior end of same, ventral view. 11, terminal proleg of same, ventral view. 12, puparium, lateral view. 13, epistomal sclerite of third-instar larva, dorsal view. 14, cephalopharyngeal sclerite of same, lateral view.

Ephydra (*Hydropyrus*) *hians* Say
fig. 8–14

Third-instar larva. (fig. 8, 9). Main body length 9.62–11.95 mm, breathing tube length 4.32–4.81 mm; maximum width in dorsal view 3.15–3.48 mm. Internal structures mostly white; integument transparent with numerous spinules and spines, some flattened and scale-like. Shape cylindrical, tapering anteriorly; first 2 segments retractile, evaginated or invaginated in preserved specimens; caudal segment elongated to form posterior breathing tube, telescoping and branching distally. Segment 1 (pseudocephalic) bilobed anteriorly; each lobe with small, 3-segmented sensory papilla ("antenna") directed anterodorsally; circular sensory plate on each lobe ventral to antenna (fig. 10). Atrium banded laterally by 2–3 indefinite rows of comb-like oral papillae, light to dark brown apically, extending into buccal cavity. Segment 2 (prothoracic) with postoral spine band weak anteroventrally, widening laterally into well-developed spine patches and absent dorsally; remainder of segment with uneven rows of peg-like structures, appearing as light brown area dorsally; banded on anterior ⅓ by 10 tri-lobed sensilla; anterior spiracles palmate, usually with 5 marginal papillae, occasionally 4 or 6. Segments 3–12 with dark patterns dorsally, formed by flattened, scale-like spines (fig. 8) arranged in mosaic pattern; each pattern banded by 10 tri-lobed sensilla, often with dark apices. Segment 3 (mesothoracic) heavily spinose, completely ringed on anterior ¼ by dark spines, some interconnected basally in groups of 2–4; posteroventral portion occupied by slightly asymmetrical, variously shaped, solid black shield (fig. 10). Segment 4 heavily spinose; strong spine band encircling anterior ⅓ of segment, blending with dark dorsal pattern. Segments 5–11 (1–7 abdominal) spinose, more or less with 3 annuli, variously wrinked and tuberculate; each segment bearing ventral proleg; dorsal patterns extremely dark; each pattern with variously shaped, light tubercle medially and various small, light oval patches in lateral portions; patterns on segments 10 and 11 lighter, each median tubercle with small spines. Prolegs 1–7 well developed, slightly bilobed, all subequal except slightly smaller on segment 5; lobes subspherical and united near basal ½; each lobe with 2 distinct rows of 5 long, stout curved spines ("claws"), claws of posterior row ½ those of anterior row; ventromedial portion of prolegs glabrous. Segment 12 with dorsal pattern reduced; bearing posterior breathing tube distally and large, subcylindrical proleg ventrally; proleg with spines on posterolateral corners slightly larger than on rest of proleg; lobes well developed and approximately perpendicular to each other, each with 3 rows of 6–8 claws (fig. 11). Perianal pad ventral on proleg; subcircular, somewhat bilobed posteriorly and glabrous; small patch of small, dark spinules at posteromedial border; anus longitudinal in middle of pad. Breathing tube spinose at base, tapering distally; distal ⅔, including branches, glabrous; posterior spiracular caps light to dark brown, bluntly rounded apically; 4 oval spiracular openings apically, each bordered basally by a webbed, hydrofuge structure. Cephalopharyngeal skeleton (fig. 14) length 0.87–0.93 mm, mostly darkly pigmented. Mouthhooks paired, not interconnected, length 0.17–0.19 mm; hook part of each mouthhook golden yellow and slightly decurved, rounded and spoon-shaped with approximately 9 marginal teeth; basal part with weak lateral flange apically and buntly rounded dorsally projection. Ligulate sclerite paired, each piece long and thin, with 2 or more small angular bends;

posterior part lying beneath anterior edge of hypostomal sclerite, directed anteriorly toward midline. Hypostomal sclerite paired, length 0.27–0.29 mm, composed of 2 pairs of longitudinal sclerites and 2 transverse bridges; anteroventral portion expanded laterally to articulate with mouthhook. Epistomal sclerite (fig. 13) strongly convex, mostly lightly pigmented, bracing outer longitudinal rods of hypostomal sclerite dorsomedially; shaped as illustrated. Pharyngeal sclerite length 0.42–0.50 mm; indentation index 70–80; narrow, strap-like ventral bridge often bracing anteroventral portions; paired lateral pharyngeal processes rounded, flat, disc-like and free from pharyngeal sclerite; dorsal bridge highly reticulate; dorsal cornua without distinct windows; ventral cornua with posterodorsal window, often subdivided. (Based on 13 specimens).

Puparium. (fig. 12). Main body length 7.13–8.62 mm ($\bar{x} = 7.93$), breathing tube length 4.32–4.98 mm ($\bar{x} = 4.73$); maximum width in dorsal view 1.70–2.08 mm ($\bar{x} = 1.85$). Brown to dark brown; translucent to moderately transparent; entirely rigid. Venter generally arcuate in lateral view, dorsum concave; anterior end flattened dorsally, tapering, and dorsally upcurved. Markings similar to those described for larva. Segment 1 and most of segment 2 invaginated; anterior spiracles arising just behind anterolateral corner of puparium, slightly diverging. Ventral cephalic cap delineated by line of weakness extending laterally along segments 2–5, strongly indented near posterior margin of segment 4, transversing segment 5 dorsally near its posterior margin. Ventral cephalic cap delineated by line of weakness transversing segment 5 near its midlength, proleg (P_1) borne on cap.

Segments 5–8 with deep, dark brown, intersegmental indentations; their prolegs flat to weakly protruding. Segment 9 with proleg moderately protruding; slightly bulging, ovoid tubercle present laterally above each lobe of proleg. Segments 10 and 11 lighter than more anterior segments; prolegs strongly protruding and directed posteroventrad; 2 obliquely arranged tubercles present on each side above proleg, moderately to strongly bulging; each median dorsal tubercle well developed. Terminal proleg fully extended and in various positions, opposed to P_6 or P_7, or unopposed; moderately to well-developed lateral tubercle near its base on each side. Breathing tube position highly variable; light brown and nearly transparent. (Based on 8 specimens).

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A NEW SYNERGUS FROM SOUTHERN CALIFORNIA ASSOCIATED WITH ANDRICUS STELLULUS BURNETT (HYMENOPTERA: CYNIPIDAE)

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ABSTRACT—*Synergus* **stelluli** n. sp., reared from oak galls of *Andricus stellulus* Burnett found growing on *Quercus dumosa* Nuttal[1], is described and illustrated.

While studying leaf galls of *Andricus stellulus* Burnett (1974) on *Quercus dumosa* Nuttal,[1] I discovered a new inquiline species of the genus *Synergus* Hartig emerging from galls in rearing containers. The purpose of this paper is to describe the inquiline thus making its name available for future work on *Andricus stellulus* and associated insects.

Synergus stelluli Burnett, new species

fig. A–I

Holotype Female: *Head*: Slightly wider than thorax; vertex lightly wrinkled in ocellar area (fig. I); cheeks not broadened behind eyes (fig. I); face with yellow pubescence, numerous striae converging at clypeus (fig. H); a subparallel frontal carina, 1 extending dorsally from the posterior edge of each antennal socket toward (but not reaching) a point equidistant between ocular suture and lateral ocellus (fig. H, I); antennae 14-segmented, pedicel longer than broad (fig. E). *Thorax*: Mesoscutum minutely wrinkled with a suggestion of transverse ridges, uniformly pubescent; notaulices anteriorly obsolete; no median groove; anterior parallel lines not obvious, bare, shining, extending posteriorly from anterior mesoscutal margin to ⅓ length of mesoscutum; disk of scutellum rugulose; foveal pits transverse, indistinct; mesopleura bare and shining in upper ⅓, aciculate in middle, lower portion pubescent (fig. D); propodeal carinae parallel; wings pubescent, margins ciliate, veins light brown, areolet equal to ⅕ length of Rs + M projected to basalis, radial cell closed (fig. A). *Abdomen*: Longer than high in side view, shorter than head and thorax combined; tergites II and III fused, concealing remaining tergites in side view; posterior margin of tergite II + III with triangular punctate area on dorsal midline, remainder of tergite without punctation, bare, shining (fig. G); ovipositor sheath pubescent, visible in side view (fig. G). *Color*: Vertex black; face brown; mesopleura black; abdomen with median-dorsal black area, brown to amber on sides; legs yellow brown. Average length of 18 paratype females 1.61 mm (1.45–1.75).

Allotype Male: *Head*: Wider than thorax, relatively larger than head of female; antennae 15-segmented, 3rd segment laterally excavated (fig. F). *Thorax*: anterior parallel lines ½ length of mesoscutum, bare, shining. *Abdomen*: Rela-

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[1] An unpublished key to *Synergus* females in the U.S. National Museum and in the Weld Collection was prepared by the late L. H. Weld and is in the possession of Mr. Robert J. Lyon of Los Angeles City College.

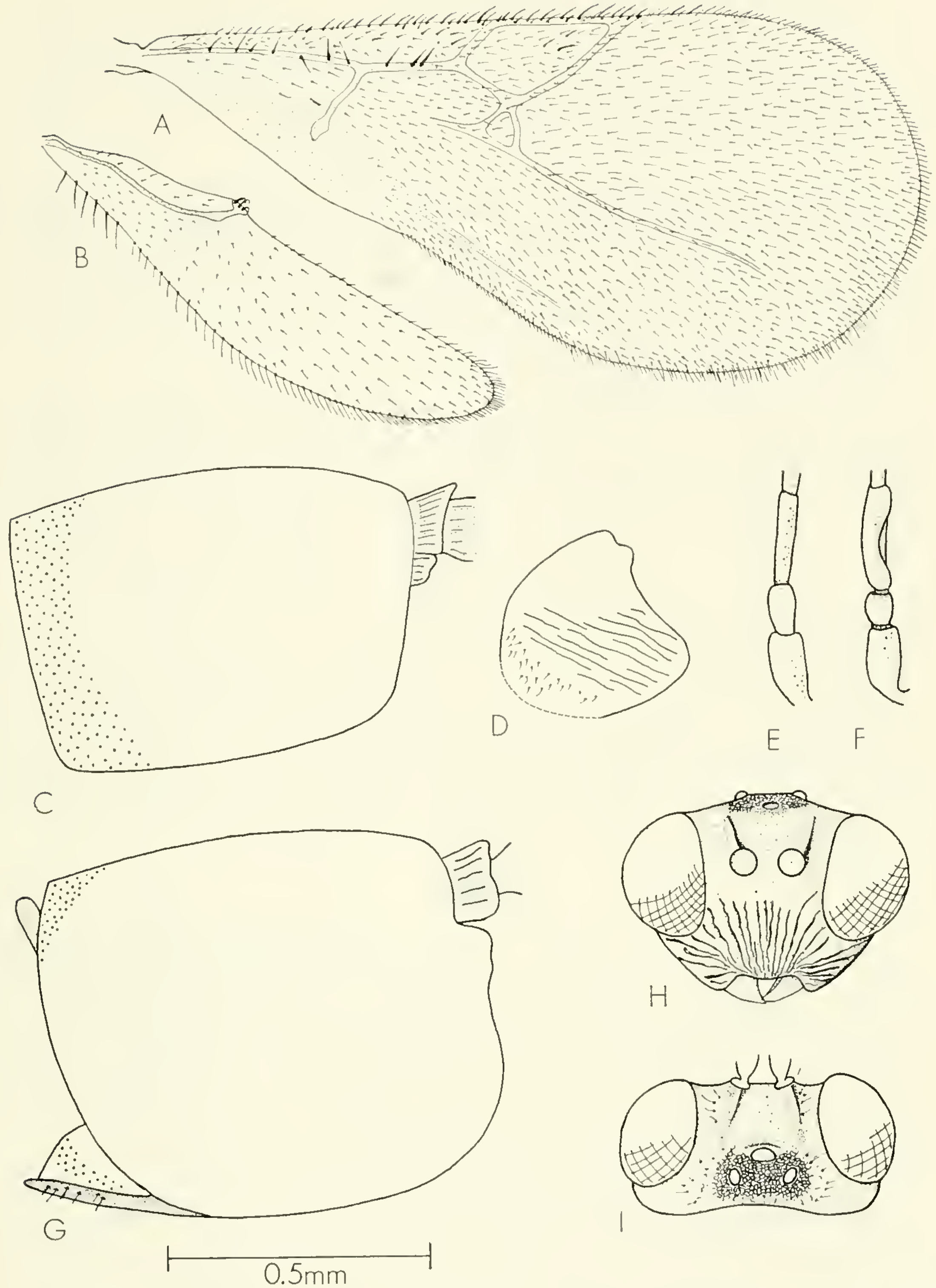

Fig. A–I. *Synergus stelluli.* A, female front wing. B, female hind wing. C, male abdomen. D, female mesopleuron. E, basal segments of female antenna. F, basal segments of male antenna. G, female abdomen. H, female face. I, superior view of female head.

tively smaller than that of female; tergite II + III closely punctate posteriorly with punctures forming a band (subdorsally equal in width to ⅕ total length of abdomen) extending the full depth from dorsal to ventral edge of tergite (fig. C). Color not significantly different from that of holotype. Average length of 26 paratypes 1.33 mm (1.15–1.50).

Variation: The anterior parallel lines of the mesoscutum are absent in some females and the prominence of the frontal carinae is slightly variable in both sexes. Coloration in the type-series is highly variable and ranges from entirely black, except for yellow-brown face and legs, to yellow brown over most of body with black area on vertex mesopleura and dorsum of tergite II + III.

Holotype Female and Allotype Male, Cajon Pass, San Bernardino Co., Calif.; elevation 4,190 feet; emerged 5 March and 3 March, 1974, from galls of *Andricus stellulus* collected from *Quercus dumosa*. Paratypes, 17 ♀♀ and 25 ♂♂, same locality; emerged March 3–9, 1974. Holotype and Allotype are deposited in the U.S.N.M. Paratypes have been placed in the Department of Entomology Museum, University of California, Riverside; Weld collection in the possession of Mr. Robert J. Lyon of Los Angeles City College; California Academy of Sciences, San Francisco, California and with the author.

Females of *Synergus stelluli* key out near *S. variegatus* McCracken and Egbert in Weld's manuscript key to *Synergus* females.[1] Individuals of *S. variegatus* may be distinguished from those of *S. stelluli* by the lighter coloration of thorax and appendages, an almost entire mesopleural aciculation and the scutellum which is anteriorly coriaceous and posteriorly rugose.

BIOLOGY

The type-insects were reared from unisexual-generation leaf galls (galls are described in Burnett, 1974) of *Andricus stellulus* from *Quercus dumosa* at Cajon Pass, California in January and February, 1974. Males appeared first in rearing containers on March 3 and 4, while females emerged on March 5, 6 and 9. No sexual behavior was observed. On 17 March, three females and one male emerged from cynipid leaf galls of *Trichoteras californicum* (Beutenmuller) also found on leaves of *Quercus dumosa* at the type-locality.

All inquiline-inhabited galls dissected contained desiccated larvae of the gall maker, but I was unable to detect any feeding damage on these larvae or to determine the cause of host mortality. In any one gall, only a single inquiline (whose presence is apparently always fatal to the gall maker) was found. However, it seems obvious, because of the thin layer of gall parenchyma which surrounds the relatively large larval capsule and the absence of any secondary chambers, that the inquiline larva moves into the hosts larval capsule early in its development. Host mortality may be due to a greater inquiline growth rate creating abnormal mechanical pressure inside the gall resulting in immobilization and starvation.

Inquiline-inhabited galls of *Andricus stellulus* (when mature) often display a variable amount of yellowish discoloration externally, but no substantial difference in gall size or abnormal structural modifications have been observed. It appears that inquiline-inhabited galls remain on the oak leaves after inquiline-free gall have dropped to the ground as only the former can be found attached to leaves in March and April. The exit hole made by *Synergus stelluli* usually occurs in the thin apical part of the gall while that of the gall maker is considerably larger and through the thicker gall margin (Burnett, 1974).

I am grateful to Mr. Robert J. Lyon of Los Angeles City College for valuable comments and for access to the Weld collection, and to Mr. George C. Steyskal, Systematic Entomology Laboratory, USDA, for nomenclatorial advice. Special thanks go to professors Leland R. Brown and John D. Pinto of the Department of Entomology, University of California, Riverside for critical review of the manuscript.

REFERENCE

BURNETT, J. A. 1974. A new cynipid wasp from California (Hymenoptera). Pan-Pac. Entomol. 50(3):298–302.

A NEW SPECIES OF PODARGOECUS (MALLOPHAGA: PHILOPTERIDAE) FROM TASMANIA[1]

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ABSTRACT—The new species, *Podargoecus* **tasmaniensis**, is described and illustrated from specimens taken off *Aegotheles cristatus* (J. White) (Caprimulgiformes:Aegothelidae) from Tasmania.

The mallophagan genus *Podargoecus* and the two included species were described by Emerson and Price (1966). At that time these workers postulated that *Podargoecus* occurred only on hosts of the avian genus *Podargus* Vieillot (Caprimulgiformes: Podargidae). However, Dr. Theresa Clay, British Museum (Natural History), recently sent me a series of lice taken from *Aegotheles cristatus* (J. White) Caprimulgiformes: Aegothelidae). These lice have proven to represent an undescribed species of *Podargoecus* and I thank Dr. Clay for enabling me to describe and illustrate this new species.

Podargoecus tasmaniensis Price, new species
fig. 1–3

Male: As in fig. 1. Head large, wide, with prominent flatly rounded anterior hyaline margin; dorsal anterior plate as wide as long, shaped as shown. Pronotum with short lateroposterior seta on each side. Metanotum divided medially, posterior margin on each side with 2 clusters of paired very long setae, some extending nearly to end of abdomen. Tergal plates of abdominal segments II–IX divided medially, those on II–IV each with blunt lateroposterior projection. With 4–6 abdominal tergocentral setae on II–V, 2 on VI–VIII; each side of tergite IX with about 5 short marginal setae. Abdomen terminating with narrow median rounded projection. Genitalia as in fig. 2; with thick large curved parameres each bearing minute subapical seta; median structure between parameres slightly concave, with thickened semicircular portion bearing 4 clear circular alveoli or sensilla.

Female: Essentially as for male, except for terminalia (fig. 3) and tendency for several more tergocentral setae on most segments. Tergite IX not divided, all setae on posterior margin long to very long. Pair of small plates posterior to tergite IX. Subgenital plate weakly developed, with all setae short to minute.

Dimensions (in mm): Head width, male 0.45–0.46, female 0.50–0.52; head length, male 0.49–0.51, female 0.54–0.57; prothorax width, male 0.27–0.28, female 0.28–0.31; metathorax width, male 0.38–0.39, female 0.41–0.45; total length, male 1.43–1.44, female 1.77–1.85; male genitalia, width 0.08–0.09, length 0.17–0.18.

Type-host: *Aegotheles cristatus* (J. White).

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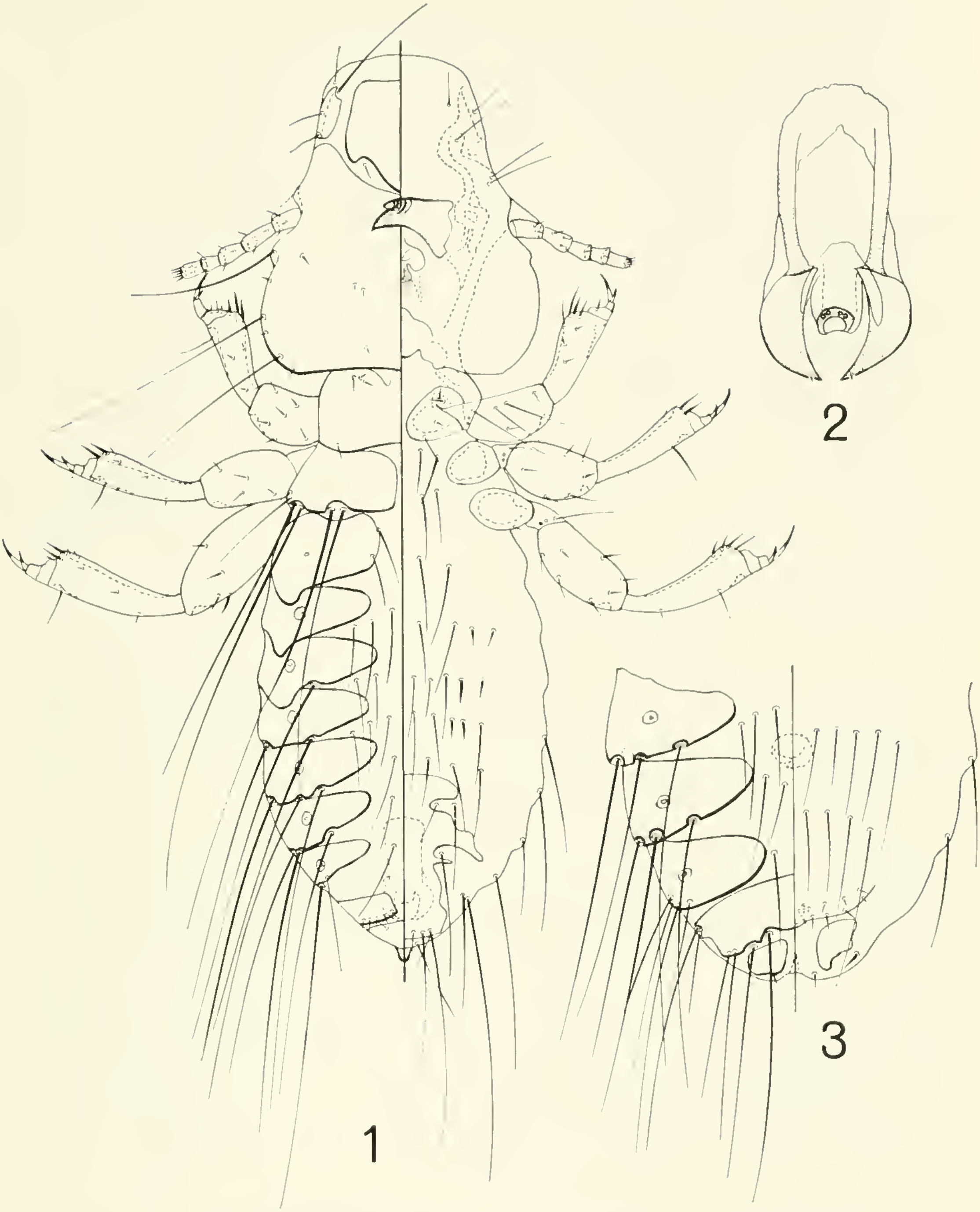

Fig. 1–3. *Podargoecus tasmaniensis.* 1, male. 2, male genitalia. 3, female terminalia.

Type-material: Holotype ♂, Granton, Tasmania, Jan., 1963, B. C. Mollison; in the collection of the Queen Victoria Museum, Tasmania. Paratypes: 3 ♂♂, 4 ♀♀, same data as holotype.

Discussion: This species is closer to *Podargoecus papuensis* Emerson and Price than to *P. strigoides* Emerson and Price. The latter species is known only from a male, but has a much wider head that is anteriorly rounded, more tergal and sternal abdominal setae, tergites II–V with a pointed lateroposterior projection, as well as other dimensional and chaetotaxy differences. *Podargoecus papuensis*, although having head structure, genitalic details, and many other features close to *P. tasmaniensis*, differs significantly from *P. tasmaniensis* by having (1) many dimensions much larger, (2) a long lateroposterior pronotal seta extending completely across metanotum, (3) evenly distributed setae on posterior metanotal margin, not distinctly clustered in pairs, (4) tergocentral setae more intimately associated with posterior margin of tergal plates, (5) male with very long seta among short setae on each side of tergite IX, (6) male abdomen not terminating in narrow projection, and (7) female tergite IX with short seta on each side among very long setae.

The discovery of a species of *Podargoecus* from a caprimulgiform family other than Podargidae indicates a wider distribution than previously anticipated. Unfortunately there have not been enough Mallophaga collections from this host order to speculate on just how broad this distribution may eventually prove to be.

REFERENCE

Emerson, K. C. and R. D. Price. 1966. A new genus and two new species of *Ischnocera* occurring on frogmouths (Podargidae). Proc. Entomol. Soc. Wash. 68:224–227.

DESCRIPTIONS AND NOTES ON THE PUPAE AND PUPAL CASES OF TEN SPECIES OF WYOMING ROBBER FLIES (DIPTERA: ASILIDAE)[1]

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ABSTRACT—The pupal cases of 3 species of Dasypogoninae and 7 species of Asilinae are described. The Dasypogoninae are: *Comantella fallei* Back, *Heteropogon wilcoxi* James and *Stenopogon inquinatus* Loew. The Asilinae are: *Efferia benedicti* (Bromley), *E. frewingi* Wilcox, *E. helenae* (Bromley), *Machimus* sp., either *callidus* (Williston) or *occidentalis* (Hine), *Mallophorina guildiana* (Williston), *Proctacanthella cacopiloga* (Hine) and *Proctacanthus micans* Schiner. Notes on the emergence of the adults are also presented for *Comantella fallei*, *Heteropogon wilcoxi*, *Stenopogon inquinatus* and *Machimus* sp., either *callidus* or *occidentalis*.

In the literature there is a scarcity of information concerning the immature stages of Asilidae. Of the approximately 5,000 described species of robber flies only about 100 are known in any immature stage (Knutson, 1972).

The pupae of robber flies, like the larvae, are found in soil or decaying wood. All species for which pupal cases or skins are described in this paper are soil inhabitants in the immature stages. Pupae were typically located protruding 6–12 mm above the soil surface prior to the emergence of the adult, as the adult was emerging or immediately after the adult had emerged (fig. 1). Several pupal cases were also found lying on top of the soil surface after the adult had emerged (fig. 2).

The pupae of Asilidae are typical of primitive groups of Diptera in that they are free (i.e., the final instar larva completely sheds its skin during pupation) and mobile (Hull, 1962; Melin, 1923; Skidmore, 1966). The color is a more or less pale white at the beginning of the pupal period, but gradually passes, depending on the species, into a lighter or darker yellow to brown tint as the pupa matures. Once the adult emerges and the pupal case has been exposed to the sun for 5–6 days, the case becomes somewhat faded and pale.

Morphologically the pupal cases of robber flies are quite similar (fig. 3–6). The head is equipped with 2 sets of antennal processes: (1) a terminal pair of anterior antennal processes which are hornlike, bent ventrally, not fused basally and according to Melin (1923), may

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[2] Res. Assoc. and Prof. Entomol., Plant Science, respectively.

Fig. 1. Pupal case of *Proctacanthus micans* protruding above the soil surface after emergence of the adult.
Fig. 2. Female *Comantella fallei* emerging from pupal case.

have a basal bristle and (2) a group of 3–5 basally fused posterior antennal processes located ventrolaterally on each side. Pupae in genera, such as *Dioctria*, which appear to have only slight morphological differences, are frequently separated primarily on the basis of the size and shape of the antennal sheaths (Brindle, 1968; Melin, 1923).

The mouthparts, legs and wings have sheaths which are easily recognized on the ventral surface of a pupal case (fig. 3). Mouthpart sheaths often bear terminal tubercles or spine-like processes and wing sheaths may have medial or basal tubercles. Additionally, the sheaths of the mouthparts, legs and wings are either smooth or rugulose.

The thorax has a pair of oval or elongate oval prothoracic spiracles surrounded basally by a thickened ring of cuticle and located midlaterally at the anterior margin (fig. 4). Usually these spiracles are easily visible, but for some species, such as *Mallophorina guildiana* (Williston), the spiracles may be hidden in folded, sclerotized areas of cuticle.

A pair of anterior mesothoracic spines, of varying shape and length, are located on either side of the thorax above the bases of sheaths of the second pair of legs. Additionally, there is usually a short, dull posterior mesothoracic spine on a tubercle at the base of each wing sheath (fig. 4).

The abdomen consists of 8 distinct segments which are frequently bent ventrally. The first segment usually has a dorsal transverse row of long spines, whereas the remaining segments have a combination of long and short spines. Most pupae have bristles located dorsolaterally, behind the 8 lateral spiracles, and on the venter. But some pupae, such as those of *Stenopogon inquinatus* Loew, may lack a complete complement of bristles. The eighth abdominal segment is more or less divided into two sections: an anterior ringlike portion which has a distinctive arrangement of spines and bristles, and a tapered posterior portion which is equipped with a combination of dorsolateral, medial, ventrolateral and ventromedial processes.

Both the spines and the bristles aid the pupa in its rotary movement towards the surface prior to the emergence of the adult. Once the pupa reaches the surface, a T-shaped slit develops on the dorsal surface of the head and thorax. The transverse portion of the slit passes over the occipital area behind the anterior antennal processes and the longitudinal portion passes along the median line of the thorax to the first abdominal segment. The emergence of the adult takes place through this T-shaped slit.

According to Melin (1923), ". . . it is generally possible to distinquish the different sexes in the pupae." Males usually have a pair of knob-shaped processes or tubercles, on the posterior ventral part of the last abdominal segment. However, we found that some female pupal cases, for example those of *Efferia benedicti* (Bromley), may also possess these tubercles. Thus, we believe that sex determination of pupae cannot be based solely on the presence or absence of posterior ventral tubercles.

In the identification of robber fly pupae, good morphological characteristics are provided by the general shape of the body, as well as the antennal processes (as previously mentioned), the mouthparts and wing sheaths, the mesothoracic spines and the arrangement of spines and bristles on the abdominal segments. Although we have included color of the pupal cases in our descriptions, this varies with the weather and amount of exposure to the sun, and is not a reliable characteristic.

The following descriptions were made from several pupal cases for each species, except as noted.

Subfamily Dasypogoninae

Comantella fallei Back

fig. 3–6

Greatest length (including anterior antennal processes), 11.0–13.5 mm; greatest width of thorax, 3.0–2.5 mm; greatest width of abdomen, 2.5–3.0 mm, tapering to 1.0–1.3 mm at greatest width of last abdominal segment. Subshining pale white, spines and processes glistening reddish brown. Head with pair of terminal dorsoventrally flattened anterior antennal processes not joined at base and group of 3 basally fused posterior antennal processes; 2 outermost processes fused basally for greater distance and thus appearing shorter than innermost process. All 3 posterior processes rounded apically and often grooved on outer basal ¾. Labral sheath with slight keel apically that is rugulose on either side. Hypopharyngeal sheath with posterior medial tubercle, slightly rugulose at base. Maxillary and anterior coxal sheaths entirely smooth, except for posterior tip of anterior coxal sheaths which may be rugulose. Paired prothoracic spiracles elongate oval, surrounded by basal ring of thickened cuticle. Pair of anterior mesothoracic spines of about same size on either side of thorax. Inner spine apically blunt and flattened, outer spine antler shaped with anterior palmate point and 1–3 posterior points. Short apically rounded posterior spine on tubercle at base of each wing sheath. Posterior tip of wing sheaths may be somewhat rugulose, rest of wing sheaths and thoracic area above wing sheaths not rugulose. Sheaths of 3rd pair of legs reaching between anterior margin and middle of abdominal segment 3. First abdominal segment with dorsal transverse row of 12–14 long, subequal, apically recurved spines along anterior margin. Second segment with median transverse row of alternate 7 short and 6 long straight to slightly apically recurved spines dorsally. Third through 7th abdominal segments similar to 2 dorsally, except for occasional 2 short spines in middle of segments and outer short spines missing on segments 6 and 7. No (rarely 1) dorsolateral bristles on segments 1–6, 7 with 1–3 yellowish-white bristles. Lateral spiracles of segments 1–6 with

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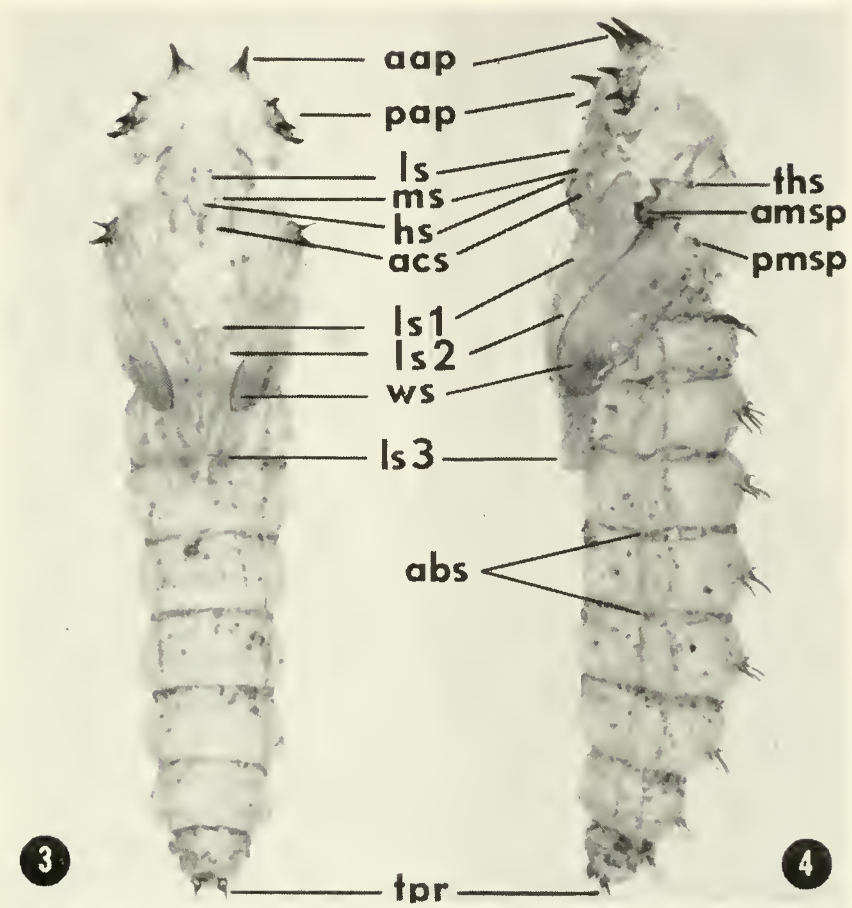
Fig. 3–6. Pupal case of *Comantella fallei*. 3, ventral view. 4, lateral view. 5, dorsal view. 6, last abdominal segment (aap, anterior antennal process. abs, abdominal spiracles; acs, anterior coxal sheath; amsp, anterior mesothoracic spines; hs, hypopharyngeal sheath; ls, labral sheath; ls 1, leg sheath 1; ls 2, leg sheath 2; ls 3, leg sheath 3; ms, maxillary sheath; pap, posterior antennal processes; pmsp, posterior mesothoracic spine; ths, thoracic spiracle; tpr, terminal processes; ws, wing sheath).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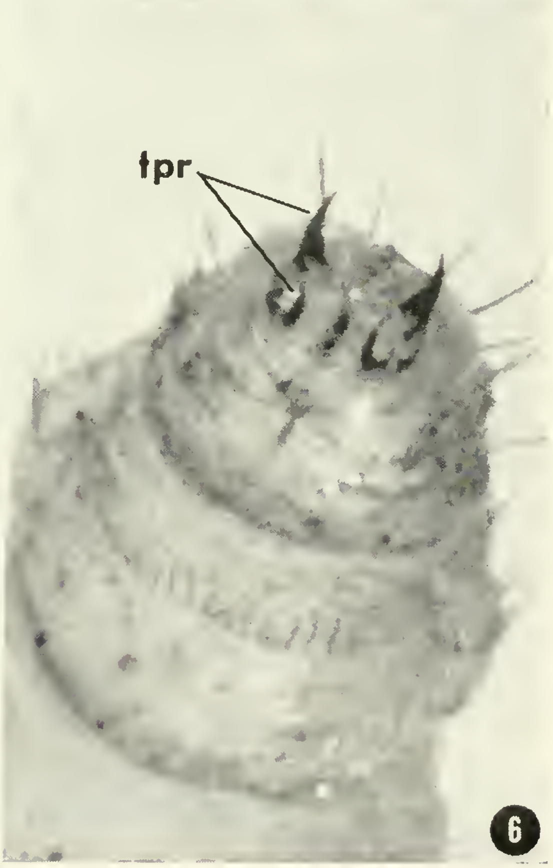
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1–4 (usually 3) medial yellowish-white bristles behind, segment 7 with 6–9 bristles behind spiracle. Venter of segment 1 obscured, segments 2–6 without bristles, 7 with medial transverse row of 8–13 yellowish-white bristles. Abdominal segment 8 composed of ringlike anterior portion with lateral short spines and 4–6 medial subequal long spines dorsally, 2–4 (usually 2) dorsolateral bristles and 10–18 bristles in transverse row ventrally. Spiracles with 5–8 medial bristles behind. Tapered posterior portion with pair of long dorsolateral processes with 1–2 fused or free small posterior basal processes; pair of short medial lateral processes and pair of medium length (½–¾ as long as dorsolateral processes) ventrolateral processes which often have 1–2 lateral or dorsal, basally fused or free, short processes. Posterior part of segment 8 smooth and without midventral tubercles.

On Oct. 11, 1972, the following observations were made as a female was emerging from her pupal case between 9:50 and 11:29 AM (fig. 2):

9:50 Female *C. fallei* lying on the ground on her dorsum, ¾ the way out of her pupal case; both the female and the pupal case are a pale white; soil surface temperature 16.7°C; temperature just beneath the soil surface by pupa hole 14.4°C; wind gusting 8.0–24.0 km/hr out of the south.

9:51 Female turned over and is standing up on all 6 legs; female's wings are still wrinkled and lying alongside of her body.

9:57 Female crawled forward 1.2–2.5 cm and is almost free of her pupal case; female flattened body against substrate, presumably to gain warmth from the soil surface; wings are now starting to unfold.

9:58 Female crawled forward 2.5 cm and is free of her pupal case.

10:01 Female stood up on her fore tarsi; wings are completely unfolded and spread at a 45° angle to her body; body has started to darken in color.

10:08 Female's wings are now only slightly spread.

10:20 Female's wings are completely folded over her dorsum; body and wings are becoming darker in color.

10:30 Female leaned over on her left side and raised her right side to the sun.

10:40 Female leaned over on her right side and raised her left side to the sun; female's body now brownish black and wings hyaline; spots on distal cross veins of wings light black.

11:23 Female now grayish black and starting to crawl around more on the soil surface.

11:24 Female crawled forward 7.5 cm, then flew 1.5 m, 15.0–17.5 cm above the ground and landed on the ground; almost immediately the female flew onto the vegetation 7.5 cm above the ground and then back to the ground.

11:26 Female flew 2 m, 15.0–20.0 cm above the ground and landed head-up on the vegetation, 10.0 cm above the ground, with her body at a 30–45° angle to the vertical.

11:29 Female began exhibiting foraging behavior and was lost in the waving vegetation as she flew east.

Heteropogon wilcoxi James

fig. 7–10

Greatest length (including anterior antennal processes), 15.0 mm; greatest width of thorax, 3.0 mm; greatest width of abdomen, 3.0 mm, tapering to 1.5 mm at greatest width of last abdominal segment. Subshining yellow brown, spines and processes glistening reddish brown. Head with pair of dorsally flattened terminal anterior antennal processes not joined at base and group of 3 basally fused posterior antennal processes, 2 outermost processes fused basally for greater distance and thus appearing shorter than innermost process. Two innermost processes apically curved and with long slender points, outermost process laterally flattened and terminating in 2 short points. Labral sheath rounded, minute tubercle posteriorly, smooth to slightly rugulose. Hypopharyngeal sheath with median furrow, minute tubercles on either side of furrow posteriorly. Maxillary sheaths smooth to slightly rugulose posteriorly along hypopharyngeal sheath, medially overlapping posterior area of labral sheath. Anterior coxal sheaths smooth to slightly rugulose anterior ⅔. Paired elongate oval prothoracic spiracles, surrounded basally by ring of thickened cuticle. Pair of subequal, straight to apically curved, acute, anterior mesothoracic spines on either side of thorax above bases of sheaths of 2nd pair of legs. No posterior mesothoracic spine, but tubercle at base of each wing sheath with 2 long curved bristles, 1 anteriorly and other dorsolateral of tubercle. Two medial, long, curved bristles on either side of midline on dorsum of thorax. Wing sheaths rugulose, thoracic area above wing sheaths smooth to slightly rugulose. Sheaths of 3rd pair of legs reaching slightly beyond anterior margin of 3rd abdominal segment. First abdominal segment with dorsal transverse row of 17 apically recurved spines; 3 middle spines and 2 dorsolateral spines are shorter than rest and middle spines have 1 very long spine on either side. Segment 2 with spines arranged in 2 rows, posterior row of 6 straight to apically recurved long spines with expanded anterior basal part and anterior row of 8 short spines (there are 2 medial short spines) in front of spaces between long spines. Abdominal segments 3–5 similar to 2, but with only 1 medial short spine. Sixth segment with dorsal transverse row of spines as above, but medial short spines completely absent. Segment 7 with dorsal transverse row of 6 long straight to apically recurved spines. Abdominal segment 8 composed of ringlike anterior portion with pair of long dorsomedial spines. Tapered posterior portion with pair of long dorsolateral processes and pair of short medial processes at bases of cuticular areas surrounding long processes. Pair of minute tubercles midventrally on posterior part of segment 8. Complete absence of all dorsolateral and ventral bristles, and bristles behind lateral spiracles, on all abdominal segments.

The above description was made from the pupal case of a male *H. wilcoxi* which was reared in the laboratory. The larva was found on May 12, 1960, in a field of rye (*Secale cereale* L.) between Wheatland and Glendo, Wyoming by R. J. Lavigne. After the larva was taken into the laboratory, it pupated on June 2, and the adult emerged on June 17.

Stenopogon inquinatus Loew
fig. 11–14

Greatest length (including anterior antennal processes and posterior dorsolateral processes of abdominal segment 8) 16.0–24.0 mm; greatest width of thorax 4.0–5.0 mm; greatest width of abdomen, 3.5–4.0 mm, tapering to 1.8–2.5 mm at greatest width of last abdominal segment. Subshining translucent grayish brown, spines and processes glistening reddish brown. Head with pair of apically

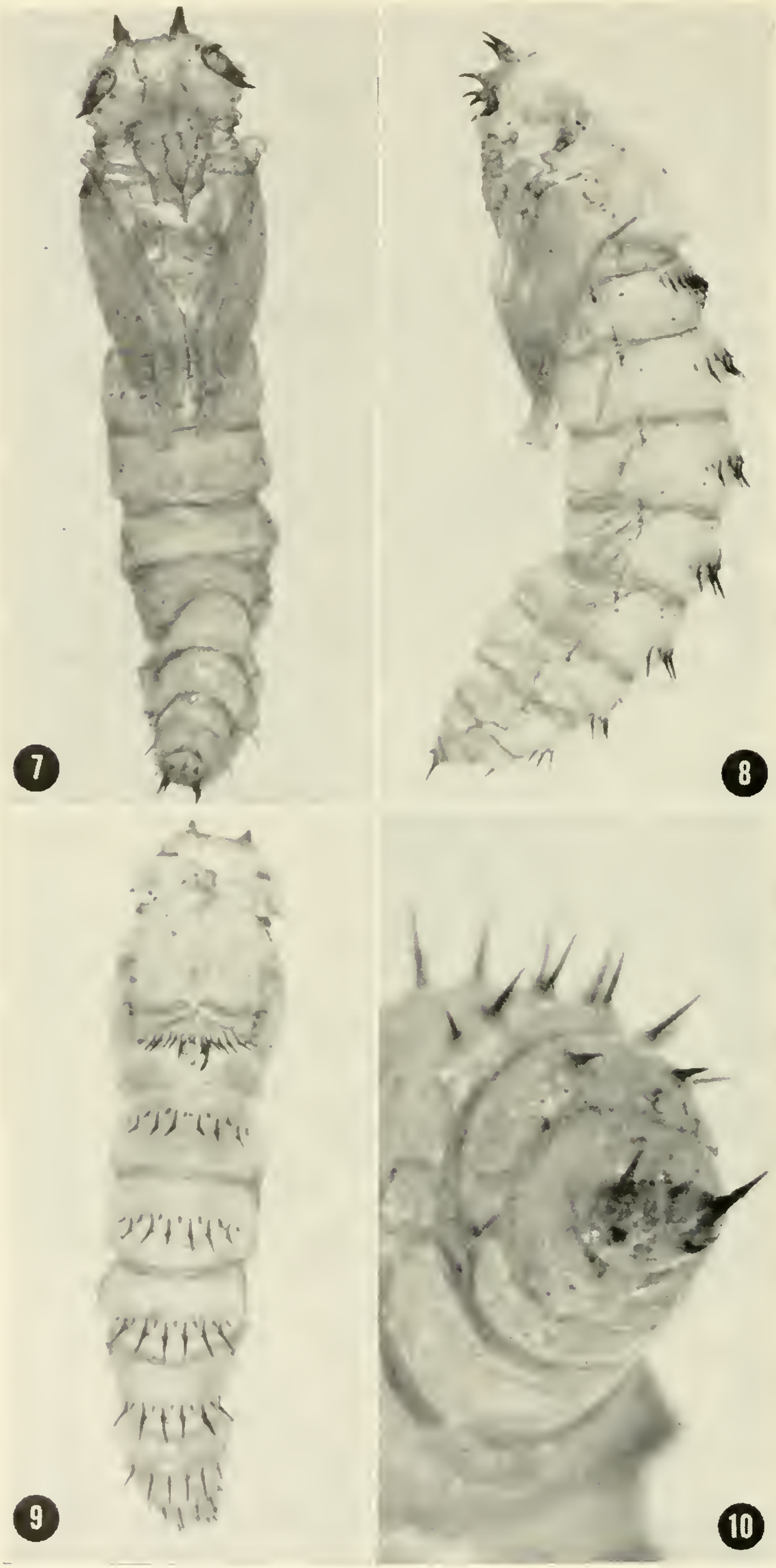

Fig. 7–10. Pupal case of *Heteropogon wilcoxi.*

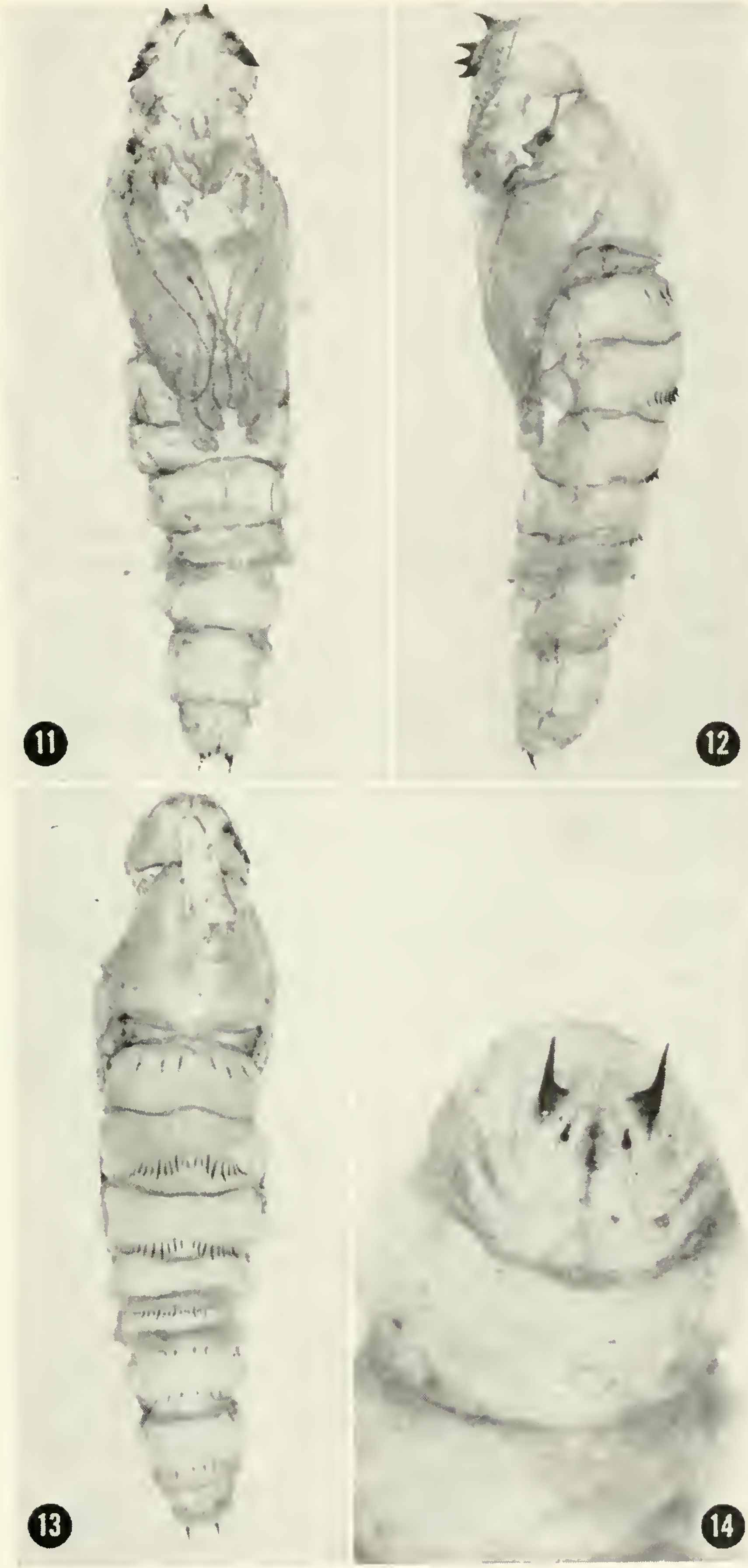

Fig. 11–14. Pupal case of *Stenopogon inquinatus.*

flattened terminal anterior antennal processes not joined at base and group of 3 basally fused subequal posterior antennal processes. Posterior antennal processes usually rounded apically with middle process often more acute. Labral sheath with slight keel apically that is smooth to slightly rugulose on either side. Hypopharyngeal sheath with medial furrow and minute tubercle on either side posteriorly. Maxillary sheaths rugulose, anterior coxal sheaths smooth to rugulose. Paired elongate oval prothoracic spiracles surrounded anteriorly and laterally by thickened cuticle basally. Pair of short, apically rounded, anterior mesothoracic spines on either side of thorax above bases of sheaths of 2nd pair of legs. Posterior mesothoracic spine absent, tubercle at base of each wing sheath yellowish to yellowish brown apically. Wing sheaths rugulose, thoracic area above wing sheaths smooth to slightly rugulose. Sheaths of 3rd pair of legs reaching between middle and posterior margin of 3rd abdominal segment. First abdominal segment with transverse row of 6 (3 on either side of midline) long, straight to apically recurved spines dorsally along anterior margin and 3 yellowish-white bristles behind lateral spiracle, venter obscured. Second segment with median transverse row of 26–28 straight spines, outer 7–9 spines and 2 medial spines shorter than rest. Third through 5th abdominal segments similar, with medial transverse row of 28–32 spines. Sixth segment with medial transverse row of 18–21 spines, often with middle 5 spines on either side of midline alternately long and short. Segment 7 with 6–12 spines on either side of midline, 4–10 lateral spines and sometimes 1–2 medial short spines. Segments 2–7 without dorsolateral and ventral bristles, 2 yellowish-white bristles behind lateral spiracles. Abdominal segment 8 composed of ringlike anterior portion with 4–8 (2–4 on either side of midline) subequal spines dorsally; dorsolateral bristles, bristles behind lateral spiracle and ventral bristles absent. Tapered posterior portion with pair of long dorsolateral processes and pair of short medial processes.

It is of interest to note the tendency of the pupal case of *S. inquintatus* to fold like an accordion, between abdominal segments 4 and 6, as the adult is emerging. Thus, it is difficult to determine the number and arrangement of the dorsal spines on the aforementioned segments unless the pupal case is soaked in 75% ethyl alcohol and subsequently stretched out.

Emerging adults of this species have been observed being attacked by western harvester ants, *Pogonomyrmex occidentalis* (Cresson), and subsequently dragged into the ant colony.

Adult *Stenopogon inquinatus* freed themselves from pupal cases, which were still in the soil, by rocking back and forth until they fell to the soil surface. Emerging adults which had pulled their pupal cases out of the soil, walked forward and pulled themselves free.

After the adult has emerged, the asilid's abdomen is swollen and somewhat distended. Within 30 minutes of emergence the adult eliminates 3–6 drops of creamy white fluid through its anus and the adult's abdomen begins to assume its normal shape. According to Melin (1923) the whitish excretion of the adult ". . . probably consists of the exudations of the pupa."

SUBFAMILY ASILINAE

Efferia benedicti (Bromley)

fig. 15–18

Greatest length (including anterior antennal processes), 17.0 mm; greatest width of thorax, 3.0 mm; greatest width of abdomen, 3.5 mm, tapering to 1.0 mm at greatest width of last abdominal segment. Subshining golden brown, spines and processes glistening reddish brown. Head with pair of terminal anterior antennal processes not joined at base and group of 3 basally fused posterior antennal processes; innermost process is thicker basally than 2 outermost processes which are fused basally for greater distance and thus appear shorter than innermost process. Outermost process more dorsoventrally flattened than 2 innermost processes and apically blunt; whereas 2 innermost processes rounded apically. Labral sheath with large tubercle posteriorly and rugulose on both sides. Hypopharyngeal sheath rugulose and with 2 lateral tubercles and 1 medial spinelike process posteriorly. Maxillary sheaths slightly rugulose with posterior tubercles. Anterior half of anterior coxal sheaths rugulose. Paired oval prothoracic spiracles, surrounded by small ring of thickened cuticle basally. Pair of subequal anterior mesothoracic spines on either side of thorax above bases of sheaths of 2nd pair of legs; posterior spine apically blunt and thickened basally, and anterior spine rounded apically and thin basally. Short, dull posterior mesothoracic spine on tubercle at base of each wing sheath. Wing sheaths and thoracic area above wing sheaths rugulose. Sheaths of 3rd pair of legs reaching slightly beyond anterior margin of 3rd abdominal segment. First abdominal segment with dorsal transverse row of 12 long, subequal, apically recurved spines along anterior margin and 3 yellowish-brown bristles behind lateral spiracle, venter obscured. Second through 7th abdominal segments with straight to apically recurved spines arranged in 2 rows. Anterior short spines in front of spaces between posterior long spines. Segment 2 with 6 (3 on each side) dorsolateral short spines, 6 long posterior spines and 6 short anterior spines (there are 2 medial short spines); short row of 3 yellowish-brown bristles dorsolaterally, 5 bristles behind lateral spiracle and 3–5 bristles ventrally on either side of sheaths of 3rd pair of legs. Segments 3 and 4 similar to 2, but with 8 (4 on each side) dorsolateral short spines and only 1 medial short spine. Segment 5 similar to 2, but with only 1 medial short spine. Sixth segment also similar to 2, but with only 2 (1 on each side) dorsolateral short spines and no medial short spines. Segment 7 with alternate row of 7 short and 6 long spines. Segments 2–7 with 2–3 yellowish-brown, dorsolateral bristles and segments 2–6 with 4–6 bristles (usually 5) behind lateral spiracles, segment 7 with 3 bristles. Venter of segments 3–7 with medial transverse row of 15–22 yellowish-brown bristles. Abdominal segment 8 composed of ringlike anterior portion with 2 subequal spines dorsally, 0–1 yellowish-brown bristles dorsolaterally, 3 bristles behind each lateral spiracle and 2 long and 2 short (1 long and 1 short bristle on either side) dorsolateral bristles ventrally with short bristles on outside of long bristles. Tapered posterior portion with pair of long dorsolateral processes, pair of medium length (twice as long as short ventromedial processes) medial lateral processes and pair of short ventromedial processes. No ventrolateral processes, but pair of small tubercles present midventrally on posterior part of segment 8.

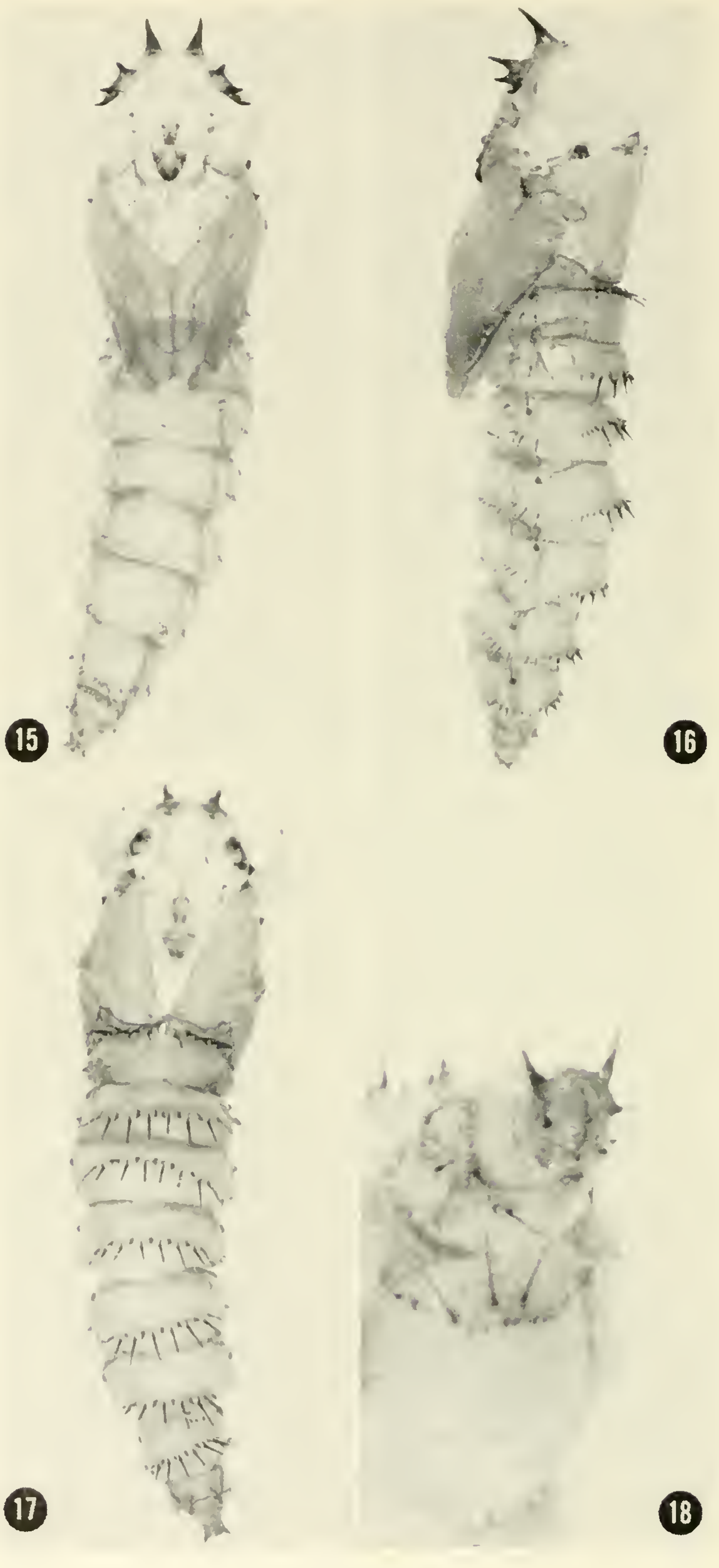

Fig. 15–18. Pupal case of *Efferia benedicti*.

Fig. 19. Newly emerged female *Efferia benedicti* and pupal case.

This description was made from a single female pupal case collected on July 17, 1969, 16 km south of Shoshoni, Wyoming by R. J. Lavigne (fig. 19).

Efferia frewingi Wilcox
fig. 20–23

Length (including anterior antennal processes), 16.5–18.0 mm; greatest width of thorax, 3.6–4.0 mm, tapering to 1.3–1.4 mm at greatest width of last abdominal segment. Subshining golden brown, spines and processes glistening reddish brown. Head with pair of terminal anterior antennal processes not joined at base and group of 3 basally fused posterior antennal processes; 2 outermost processes fused basally for greater distance and thus appear shorter than innermost process. All 3 posterior antennal processes rounded apically, outermost process more so than 2 innermost processes. Both anterior and posterior antennal processes are darker reddish brown apically. Labral sheath with apical keel dark reddish brown apically and rugulose on its sides. Maxillary sheath rugulose and with posterior dark reddish brown process on either side. Hypopharyngeal sheath rugulose with median dark reddish brown to black process posteriorly and with 3–8 minute dark reddish brown to black tubercles on either side. Anterior coxal sheaths rugulose anteriorly on either side of hypopharyngeal sheath and smooth to rugulose posteriorly. Elongate oval, dark reddish-brown prothoracic spiracles, surrounded by thickened ring of cuticle basally. Pair of subequal, rounded, long, anterior mesothoracic spines, outer one may be sharply bent apically, on either side of thorax above bases of sheaths of 2nd pair of legs. Short, rounded posterior mesothoracic spine on rugulose tubercle at base of each wing sheath. Thoracic area above wing sheaths smooth to somewhat rugulose. Sheaths of legs and basal ¾ of wing sheaths rugulose. Sheath of 3rd pair of legs reaching between posterior margin of abdominal segment 2 and middle of abdominal

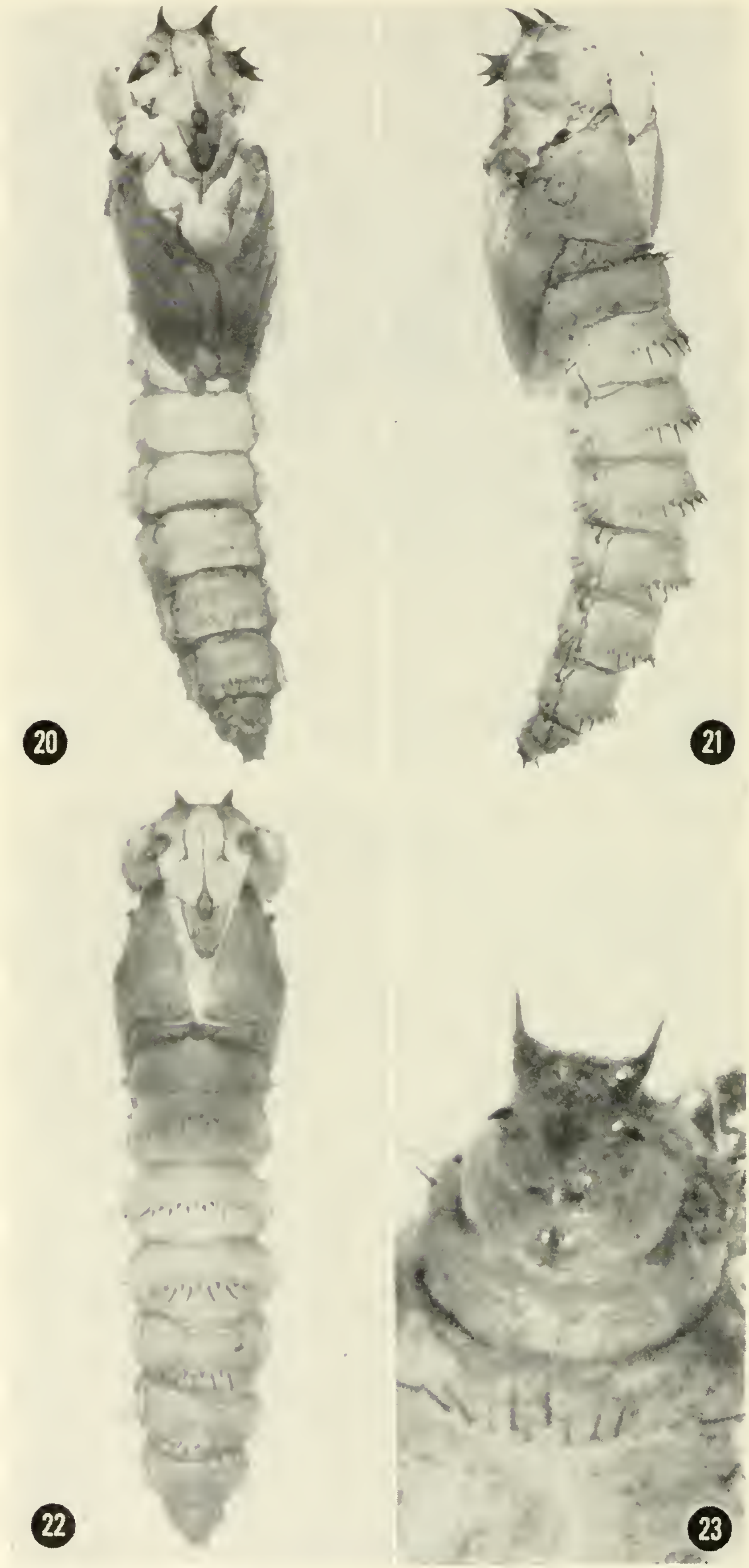

Fig. 20–23. Pupal case of *Efferia frewingi.*

segment 3. First abdominal segment with transverse row of 14 long apically recurved spines dorsally along anterior margin; 2 spines in middle ¼ to ⅓ length of surrounding spines. Three bristles of subequal length behind lateral spiracle of segment 1 and venter obscured. Second segment with median transverse row of straight to slightly recurved spines as follows (from left to right with head and thorax anteriorly): 2–3 short, 1 long, 1 short, 1 long, 1 short, 1 long, 3 short with median spine ½ to subequal in length as 2 surrounding spines, 1 long, 1 short, 1 long, 1–2 short, 1 long, 2–3 short; row of 4–8 bristles dorsolaterally, 3–6 bristles behind lateral spiracle and mesal row of 6 bristles to either side of sheaths of 3rd pair of legs. Segment 3 similar to 2, except 3 lacks 3 short median spines; 4–7 bristles laterally. Segments 4–7 similar with 7 short and 6 long alternate spines, may be 2 short spines on left side of segments 4–6 and right side of segment 4; 2–6 lateral bristles. Spiracles of segments 3–7 with 3–6 (usually 3–4) medial bristles behind. Venter of segments 3–7 with transverse row of 15–18 (usually 18) bristles. Abdominal segment 8 composed of ringlike anterior portion with 2 dorsal subequal spines equidistant from midline, no lateral bristles, 2 medial bristles behind spiracle and transverse row of 14 bristles ventrally. Tapered posterior portion similar to *Efferia benedicti.*

Efferia helenae (Bromley)

fig. 24–27

Greatest length (including anterior antennal processes), 17.5 mm; greatest width of thorax, 3.5 mm; greatest width of abdomen, 3.0 mm, tapering to 1.5 mm at greatest width of last abdominal segment. Subshining grayish brown, leg and wing sheaths darker posteriorly, spines and processes glistening reddish brown to brownish black. Head with pair of dorsally flattened terminal anterior antennal processes not joined at base and 3 basally fused posterior antennal processes, 2 outermost processes fused basally for greater distance and thus appearing shorter than innermost process. Outermost process dorsoventrally flattened and blunt apically, 2 innermost processes rounded apically. Labral sheath with slight keel apically that is smooth to weakly rugulose on either side. Hypopharyngeal sheath smooth with medial tubercle posteriorly and ridge consisting of 4–6 minute tubercles on either side. Maxillary sheaths smooth and posteriorly terminating with spinelike tubercle. Anterior coxal sheaths entirely smooth. Paired elongate oval to oval prothoracic spiracles, surrounded basally by a small ring of thickened cuticle. Pair of long, curved anterior mesothoracic spines. Short, dull posterior mesothoracic spine on tubercle at base of each wing sheath and small medial tubercle on each wing sheath. Wing sheaths and thoracic area above wing sheaths rugulose. Sheaths of 3rd pair of legs reaching almost to middle of 3rd abdominal segment. First abdominal segment with transverse row of 12 long, subequal, apically recurved spines dorsally along anterior margin, no dorsolateral bristles and 3 light reddish-brown bristles behind lateral spiracle on either side, venter obscured. Second segment with median transverse row of 3–4 short dorsolateral spines on either side and row of alternate 6 long and 6 short (paired short medial spines) dorsal straight to slightly apically recurved spines, short row of 5–7 bristled dorsolaterally, 6 bristles behind lateral spiracle and 6–7 ventral bristles on either side of sheaths of 3rd pair of legs. Third through 6th abdominal segments similar, each with 2–4 dorsolateral spines,

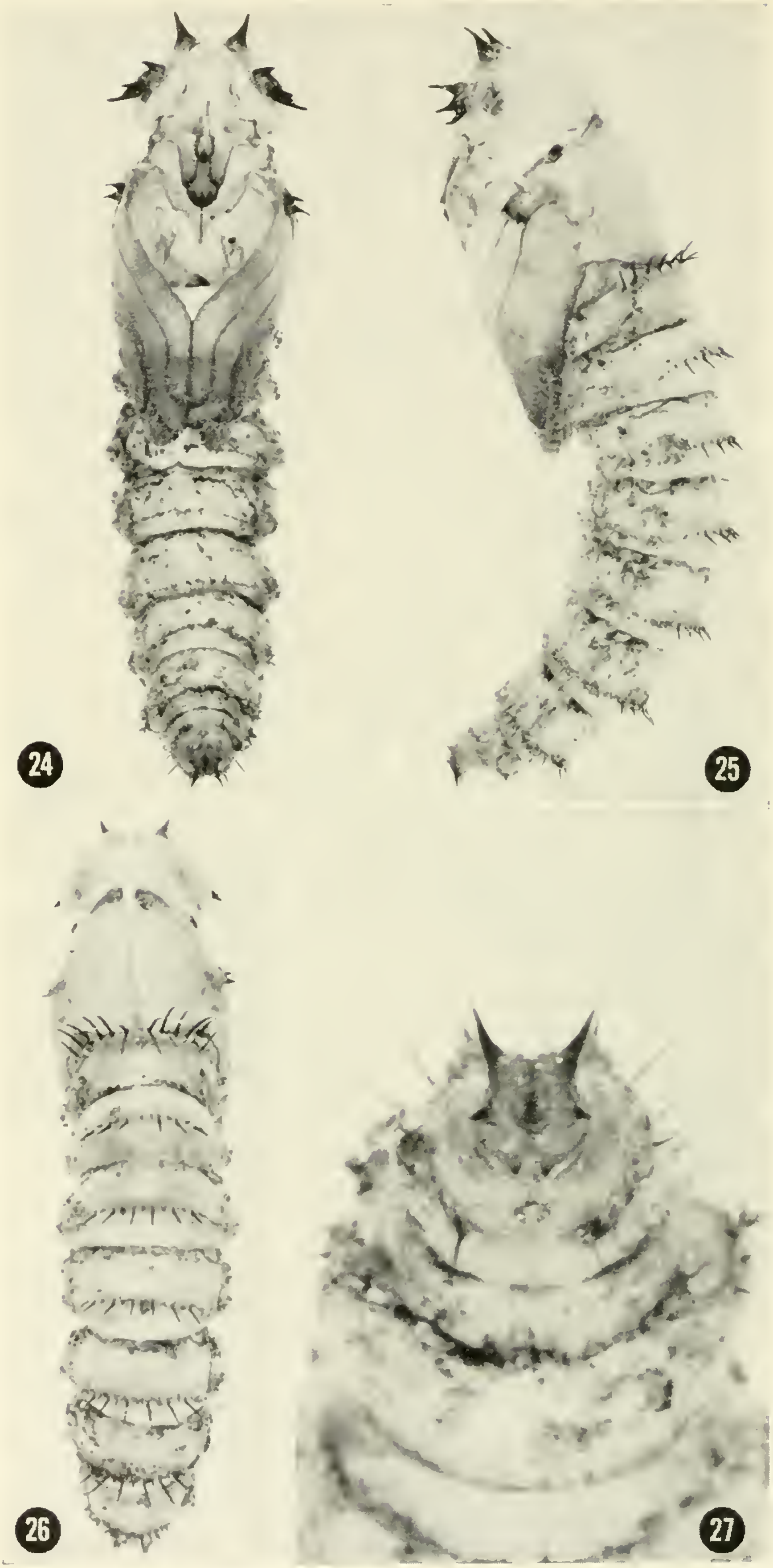

Fig. 24–27. Pupal case of *Efferia helenae*.

dorsal alternate row of long and short spines (single medial spine), 4–5 dorsolateral bristles, 5–6 bristles behind lateral spiracles and complete ventral transverse row of 17–21 bristles. Segment 7 with alternate transverse row of 8 short (paired medial short spines) and 6 long dorsal spines, 2–3 dorsolateral bristles, 4 bristles behind lateral spiracles and venter as segments 3–6. Abdominal segment 8 composed of ringlike anterior portion with 1 small and 1 long spine on either side of midline dorsally, dorsolateral bristles absent, 2–3 bristles behind lateral spiracles and 2 bristles (1 on either side of midline) ventrally. Tapered posterior portion similar to *E. benedicti* and *E. frewingi.* Pair of small tubercles midventrally on posterior part of segment 8 in females; males also have 2 large medioventral tubercles.

Machimus sp., either *callidus* (Williston) or *occidentalis* (Hine)
fig. 28–31

This description is based on a pupal case which was recovered after the emergence of a male. The specific identification of the adult is not known because the fly was lost as it flew about its habitat. It was assumed that only one species occurred in this locality, but it was subsequently determined that both *M. callidus* and *M. occidentalis* occur concurrently.

Greatest length (including terminal anterior antennal processes), 18.0 mm; greatest width of thorax, 3.5 mm; greatest width of abdomen, 3.0 mm, tapering to 1.5 mm at greatest width of last abdominal segment. Subshining golden brown, spines and processes glistening reddish brown. Head with pair of terminal, dorsally flattened, anterior antennal processes not joined at base and group of 3 basally fused posterior antennal processes, 2 outermost processes fused basally for greater distance and thus appearing slightly shorter than innermost process. Two outermost processes broadly rounded apically, innermost process more acute. Labral sheath with medial keel apically that is rugulose on either side. Hypopharyngeal sheath with posterior, minute tubercle on either side. Maxillary and anterior coxal sheaths entirely smooth. Paired elongate oval prothoracic spiracles, surrounded by ring of thickened cuticle basally. Pair of anterior mesothoracic spines, posterior spine apically blunt, broader and longer than anterior spine, on either side of thorax. Apically rounded, posterior mesothoracic spine on large tubercle at base of each wing sheath. Lateral margin of wing sheaths rugulose, thoracic area above wing sheaths smooth to slightly rugulose. Sheaths of 3rd pair of legs reaching slightly beyond anterior margin of abdominal segment 3. First abdominal segment with dorsal transverse row of 10 long, subequal, apically recurved spines along anterior margin, no dorsolateral bristles and 9–11 yellowish bristles behind lateral spiracle, venter obscured. Second segment with dorsal median transverse row of alternate 7 short and 6 long, straight spines, short row of 6–8 yellowish bristles dorsolaterally, 9–11 bristles behind lateral spiracle and 6–8 bristles on either side of sheaths of 3rd pair of legs ventrally. Third through 7th abdominal segments similar to 2, but with 1–2 dorsolateral short spines, 5–8 bristles laterally, 7–13 bristles behind each lateral spiracle and complete ventral transverse row of 21–26 bristles. Abdominal segment 8 composed of ringlike anterior portion with 2

28

29

30

31

subequal spines dorsally, no dorsolateral bristles, 5–6 bristles behind lateral spiracles and 18 ventral bristles. Tapered posterior portion with pair of long dorsolateral processes, pair of medium length mediolateral processes and pair of short ventromedial processes. Single tubercle midventrally on segment 8 and 2 midventral tubercles posteriorly.

The following observations were made 1.6 km east of Laramie, Wyoming on July 7, 1972 between 8:35 and 11:53 AM.

8:35 *Machimus* male emerging from pupal case in soil, between 2 sagebrush plants (*Artimesia tridentata* Nutt.); soil surface temperature 18.9°C, temperature just under soil surface next to pupa 18.4°C; pupal case protruding about 8 mm above soil surface.

8:37 Male pulled his forelegs, then his midlegs out of the pupal case and forced himself free of the case; male rested momentarily, then started crawling broadside to the sun; male's wings are very narrow, but about the right length; abdomen slightly swollen.

8:40 Male crawled 10 cm in 3 minutes.

8:42 Male raised his wings from his body and is holding them in the air.

8:43 Wings almost fully expanded.

8:43.5 Wings fully expanded.

8:47 Male crawled another 10 cm and is now facing the sun with his wings held at a 15–20° angle to the verticle; body whitish, dorsum of abdominal segments 1 and 4, and dorsal ornamentation on the thorax dark, leg segments white except for dark tarsi.

8:52 Male disturbed by *Formica* sp. worker which was 1.25 cm away and he crawled 5 cm.

8:53 Male relaxed his wings, so they are held 4–5 mm above his abdomen and slightly separated; genitalia whitish, swollen; claspers held widely separated.

8:58 Wings now folded over dorsum and only slightly separated; body slowly darkening.

9:02 Wings completely folded over dorsum; genitalia relaxed and assuming normal size and position; male has taken a broadside position to the sun and has raised the side facing the sun.

9:19 Male rapidly defecated 10–15 drops of cream colored fluid; abdomen has shrunk considerably to about normal size; body has darkened more; male crawled 10–12 cm; soil surface temperature 24.4°C.

9:24 Claspers of genitalia compressed together, legs almost normal color, wings normal color.

9:29 Disturbed by *Formica* sp. worker and crawled 5 cm onto debris, partly under sagebrush plant.

9:33 Male disturbed by *Formica* sp. worker and is now facing the sun.

9:35 Male has almost assumed normal color; intermittently harassed by *Formica* sp. workers and sort of hops when moves.

9:42 Male partly rotated his head 2 times.

←

Fig. 28–31. Pupal case of *Machimus* sp. either *callidus* or *occidentalis*.

9:43 Disturbed by *Formica* sp. workers and hopped away using wings to help give him lift; soil surface temperature 28.9°C.

9:45 Male raised his body up on his legs, possibly in response to the increased temperature of the substrate; soil surface temperature 30.6°C; male rubbed fore tarsi together and then groomed his eyes; color of body about normal.

9:47 Male is making a peculiar up and down motion with his body; appears very alert and is still standing up on legs; body of normal proportions now; soil surface temperature 32.2°C.

9:55 Harassed by *Formica* sp. worker and hopped onto dead twig; male landed broadside to the sun and almost immediately turned to face the sun; surface temperature on twig 34.5°C.

9:59 Disturbed by *Formica* sp. worker and flew 15 cm, 2.5 cm above the ground and landed on vegetation.

10:04 Male rotated his head.

10:05 Male flew 10 cm and landed on dead twig on soil surface facing the sun with most of his body resting on the soil surface.

10:05.5 Male stood up on his legs.

10:15 Wind is gusting 5–7 km/hr; soil surface temperature 37.2°C; male no longer responds to ants which are crawling near him; perhaps the male has become habituated to the ants' activity.

10:33 Male resting in same position with genitalia lying on soil surface, in shade of own body; soil surface temperature 38.3°C.

10:35 Male flew 12.5 cm and landed, semi-broadside to the sun, on dead tumbleweed twig 10 cm above the ground; soil surface temperature 39.4°C; air temperature at male's height 32.2°C.

10:42 Male flew to soil, landed standing up on his legs and facing the sun; rubbed hind tarsi together.

10:48 Male vigorously groomed his head with his fore tarsi, rubbed his hind tarsi together, then groomed his abdomen and wings with his hind tarsi; male is partially in the shade of a tumbleweed.

10:54 Male made a 25 cm wavering flight, 5 cm above the ground and landed in the shade on a dead tumbleweed branch, 2.5 cm above the ground; a small insect flew within 1.25 cm of the male's eyes, but was ignored.

11:01 Asilid flew 12.5 cm and landed on a dead tuft of grass.

11:18 Male is in same position; soil surface temperature 42.2°C.

11:21 Male made a 15 cm flight to a dead tumbleweed twig and landed 3.75 cm above the ground in the shade; air temperature at asilid's height in shade is 30°C.

11:28 Rotated head; soil surface temperature 43.9°C.

11:43 Soil surface temperature 46.1°C; sun has been obscured by clouds; male made three short flights, at the termination of the first two he landed on the vegetation and after the last one he landed on the soil surface.

11:45 Soil surface temperature has dropped to 40°C.

11:50 Soil surface temperature 33.9°C; male's body is its normal color.

11:53 Male flew 35 cm into some sagebrush and was lost.

In addition to the above male being harassed by *Formica* sp. workers, one *Machimus* sp. was observed being attacked by ants as it was emerging from its pupal case.

Mallophorina guildiana (Williston)

fig. 32–35

Greatest length (including anterior antennal processes), 16.5 mm; greatest width of thorax, 4.0 mm; greatest width of abdomen, 3.5 mm, tapering to 0.75 mm at greatest width of last abdominal segment. Head, thorax, dorsum of 1st abdominal segment and posterior ¾ of 8th abdominal segment subshining golden brown; venter and sides of 1st abdominal segment, abdominal segments 2–7 and anterior ¼ of 8 yellow tan; darker mottling on dorsal and ventral surfaces of abdominal segments. Spines, processes and bristles glistening reddish brown. Head with pair of dorsally flattened terminal anterior antennal processes not joined at base and group of 3 subequal basally fused posterior antennal processes; outermost process slightly curved, all 3 processes rounded apically. Labral sheath with slight keel apically that is minutely rugulose on either side. Hypopharyngeal sheath with 2 minute tubercles posteriorly and rugulose. Maxillary sheaths each with posterior apically rounded process, thicker but slightly smaller than posterior antennal processes. Anterior ½ of anterior coxal sheaths rugulose. Prothoracic spiracles hidden in folded, sclerotized areas of cuticle. Pair of subequal, blunt, straight, anterior mesothoracic spines, on either side of thorax above bases of sheaths of 2nd pair of legs. Minute posterior mesothoracic spine on large tubercle at base of each wing sheath. Wing sheaths rugulose with short spine near base ("in front of" the posterior mesothoracic spine) and shorter spine medially. Thoracic area above wing sheaths rugulose. Sheaths of 3rd pair of legs reaching slightly beyond posterior margin of 2nd abdominal segment. First abdominal segment with dorsal transverse row of 22 dorsoventrally flattened apically recurved spines along anterior margin; all spines long, some apically bifurcate, with broad base and small basal anterior projection, except for middle pair of spines which are ¼–⅓ as long and dorsolateral spines which are ½ as long; dorsolateral bristles absent, 5–6 bristles behind lateral spiracle and venter obscured. Second segment with dorsal spines arranged in 2 rows, anterior row of 6 small spines (some small spines may occur in pairs) aligned with spaces between posterior row of 5 large spines; row of 9–10 dorsolateral bristles, 9–10 bristles behind lateral spiracle and 5–7 bristles on either side of sheaths of 3rd pair of legs. Segments 2–4 with dorsoventrally flattened spines. Segments 3 and 4 with dorsal spines arranged in 2 transverse rows; spines on all other segments aligned in single row. Third and 4th abdominal segments with 1–4 outer small spines, anterior row of 3–4 short spines in front of spaces between 4–5 long spines. Segments 5 and 6 with 6–7 large subequal spines and 1–2 dorsolateral small spines. Seventh segment with median bifurcate small spine and 1 large spine on either side. Segments 2–7 with 6–11 dorsolateral bristles on either side, outermost bristle of 3–7 usually bifurcate; 7–12 bristles behind lateral spiracles and complete row of 18–25 bristles ventrally. Abdominal segment 8 composed of ringlike anterior portion with 2 dorsal spines, 2 dorsolateral bifurcate spines (1 on each side), 6 lateral spines (3 on each side), 2 ventrolateral spines (1 on each side) and 2 medial tubercles between the ventrolateral spines. Tapered posterior portion with a pair of long dorsolateral processes and a pair of shorter ventrolateral processes which are fused basally to the dorsolateral processes so that an oval depression is formed basally on the posterior

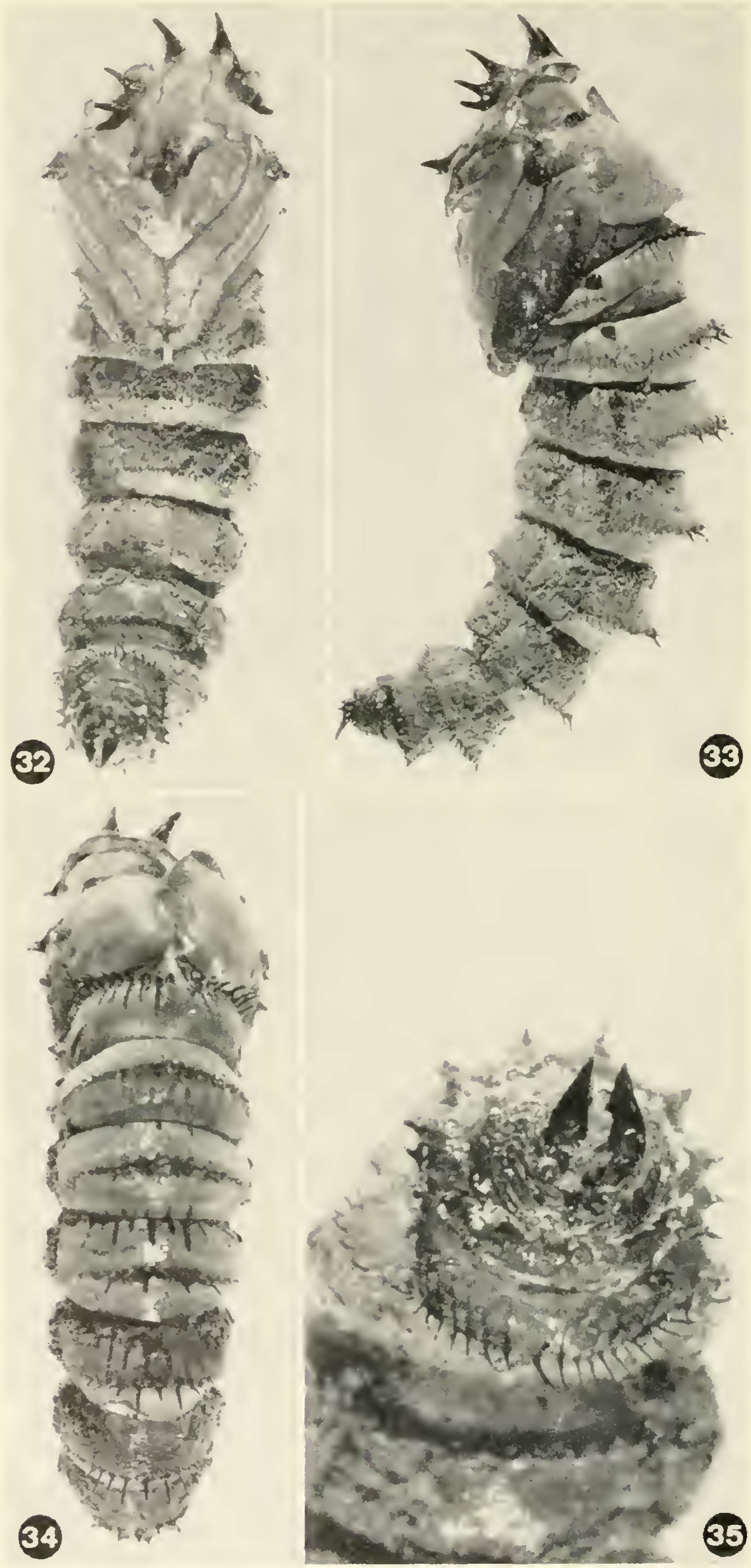

Fig. 32–35. Pupal case of *Mallophorina guildiana.*

side of the latter. A pair of medial and lateral tubercles midventrally on posterior part of segment 8 and rugulose area anterior.

The above description was made from a male pupal case which was found 37 km north of Wheatland, Wyoming on July 29, 1973 by S. Dennis.

Proctacanthella cacopiloga (Hine)

fig. 36–39

Greatest length (including anterior antennal processes), 11.0–13.5 mm; greatest width of thorax 3.0–3.5 mm; greatest width of abdomen, 2.5–3.0 mm, tapering to 1.0–1.3 mm at greatest width of last abdominal segment. Subshining golden brown, spines and processes glistening reddish brown. Head with pair of terminal dorsoventrally flattened anterior antennal processes not joined at base and group of 3 basally fused subequal posterior antennal processes; outermost process flattened more dorsoventrally than other 2 processes, often with 2 apical points and appears to be attached to side of middle process; 2 innermost processes rounded apically. Labral sheath with small tubercle apically, projecting from slight keel that is rugulose anteriorly and on both sides. Hypopharyngeal sheath with posterior medial blunt spinelike process, pair of low medial tubercles anterior of process and rugulose around process and anteriorly towards labral sheath. Maxillary sheaths with small tubercles posteriorly on either side (medially) of hypopharyngeal sheath. Paired prothoracic spiracles elongate oval, surrounded by ring of thickened cuticle basally. Pair of anterior mesothoracic spines, subequal in length, blunt and often curved apically, on either side of thorax above bases of sheaths of 2nd pair of legs. Short, apically rounded posterior mesothoracic spine on tubercle at base of each wing sheath. Wing sheaths with 2 small medial tubercles. Rugulose area on thorax around anterior and posterior mesothoracic spines and above wing sheaths. Sheaths of 3rd pair of legs reaching to or slightly beyond anterior margin of 3rd abdominal segment. First abdominal segment with dorsal transverse row of 14–18 long, subequal, apically recurved spines along anterior margin. Second segment with dorsal median transverse row of alternate 7 short and 6 long straight, apically curved or recurved spines. Third through 7th abdominal segments similar to 2 dorsally, middle short spines may occur in pairs. Dorsolateral bristles absent on segments 1, 2–6 with 4–8 dorsolateral brownish-yellow bristles. Lateral spiracle of segment 1 with 1–5 brownish-yellow to reddish-brown bristles behind, segments 2–7 with 6–8 bristles behind spiracles. Venter of segment 1 obscured; segment 2 with 4–8 brownish-yellow to reddish-brown bristles on either side of sheaths of 3rd pair of legs; segment 3 with 18–21 bristles, middle 6–7 bristles shorter and separated from lateral bristles; segments 4–7 with 18–24 bristles of subequal length. Abdominal segment 8 composed of ringlike anterior portion with 6–8 subequal in length dorsal spines, no dorsolateral bristles and 2–8 bristles to side of spiracle. Venter of 8 without bristles, rarely with 4 bristles on either side of midline, 4–6 low tubercles midventrally on posterior part of segment with rugulose area around tubercles and laterally. Tapered posterior portion with pair of low tubercles between 2 long dorsoventrally flattened dorso-

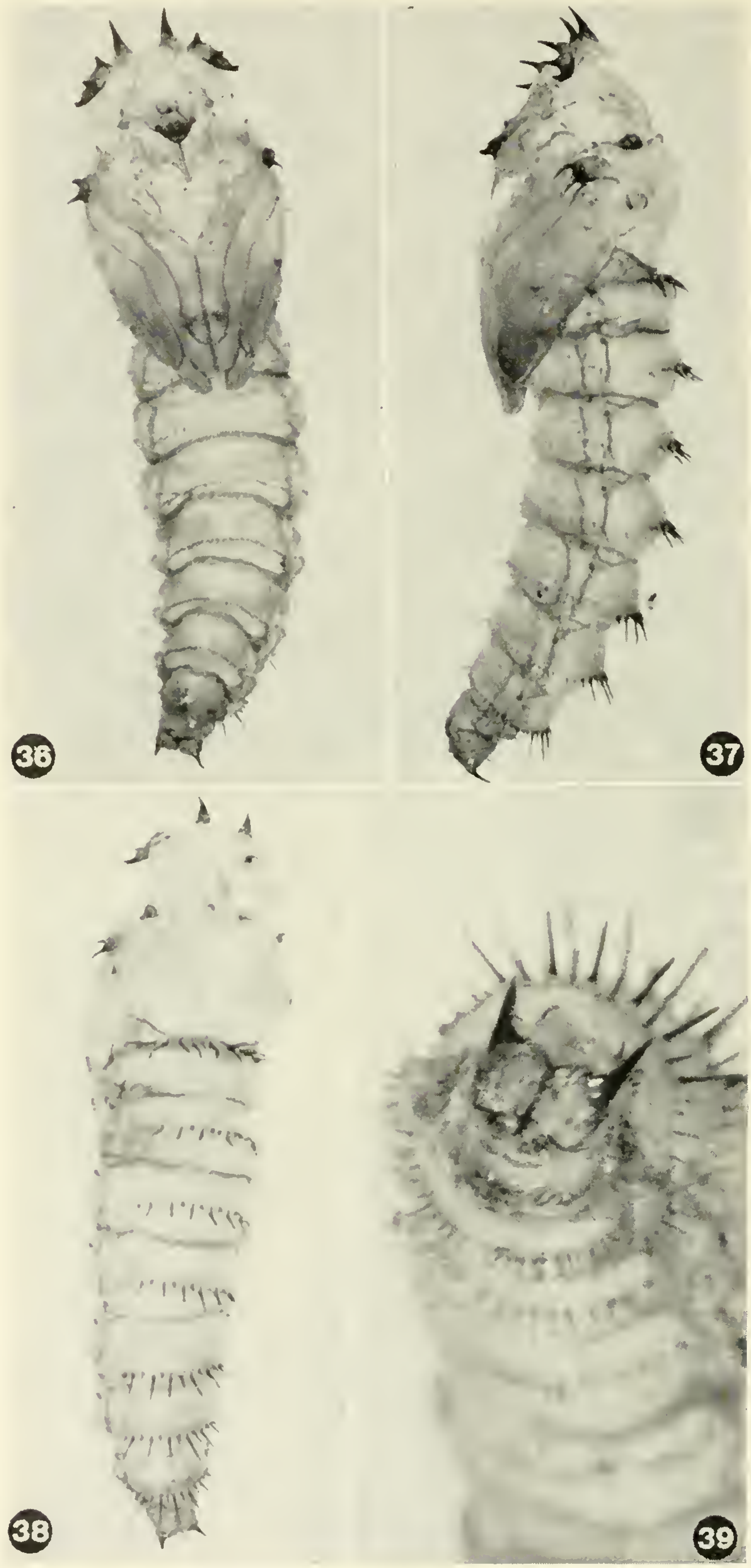

Fig. 36–39. Pupal case of *Proctacanthella cacopiloga.*

lateral processes and pair of ventrolateral and ventromedial tubercles. Ventrolateral tubercles may be situated slightly in front of ventromedial tubercles.

Proctacanthus micans Schiner

fig. 40–43

Greatest length (including anterior antennal processes), 27.0–29.5 mm; greatest width of thorax, 6.0–8.0 mm; greatest width of abdomen, 5.0–6.0 mm, tapering to 1.8–2.0 mm at greatest width of last abdominal segment. Subshining dark golden brown, spines and processes glistening reddish brown. Head with pair of terminal, dorsally flattened, anterior antennal processes not joined at base and group of 3 basally fused posterior antennal processes; 2 outermost processes fused basally for greater distance and thus appear shorter than innermost process. Outermost process dorsoventrally flattened and blunt apically; 2 innermost processes dorsally flattened and rounded apically. Labral sheath with small apical tubercle projecting from keel that is rugulose on both sides. Hypopharyngeal sheath with posterior medial, blunt, reddish-brown to black tubercle; rugulose about tubercle and anteriorly towards labral sheath. Maxillary sheaths with small tubercles posteriorly on either side (medially) of hypopharyngeal sheath. Paired elongate oval prothoracic spiracles, surrounded by ring of thickened cuticle basally. Pair of anterior mesothoracic spines subequal in length on either side of thorax above bases of sheaths of 2nd pair of legs; posterior spine more dorsoventrally flattened and blunt than apically rounded anterior spine. Short, dull posterior mesothoracic spine on tubercle at base of each wing sheath. Wing sheaths rugulose and with 1–2 small medial tubercles and 2–3 smaller tubercles basally. Thorax above wing and leg sheaths rugulose. Sheaths of 3rd pair of legs reaching to about middle of 3rd abdominal segment. First abdominal segment with transverse row of 17–21 long, subequal, apically recurved spines dorsally along anterior margin, no dorsolateral bristles and 4–9 bristles behind lateral spiracle, venter obscured. Second segment with dorsal median transverse row of spines as follows: 3–7 lateral short spines on either side of alternate row of 6 long and 5 short, straight spines; most specimens have pair of medial short spines, but a few may have 4 medial short spines with 2 inner spines being ½ length of surrounding short spines. Third through 7th abdominal segments similar to 2nd dorsally, but with only 2–5 lateral short spines and 1–2 medial short spines (segments 5–7 usually have only 1 medial short spine); 3–11 (usually 6–7) dorsolateral bristles and 9–14 bristles behind lateral spiracles. Venter of segment 2 with complete or incomplete transverse row of 18–34 bristles, segments 3–7 with complete row of 25–40 transverse bristles. Abdominal segment 8 composed of ringlike anterior portion with 4–6 subequal dorsal bristles (2 inner bristles often ½–¾ as long as other bristles), dorsolateral bristles absent and 3–8 bristles behind lateral spiracle. Venter with 4–6 subequal lateral bristles and 2 tubercles medially slightly behind bristles. Tapered posterior portion with 2–4 low tubercles between pair of long dorsoventrally flattened dorsolateral processes, pair of short medial lateral spines and pair of short ventromedial spinelike processes. Entire area behind anterior ringlike portion of 8th segment rugulose.

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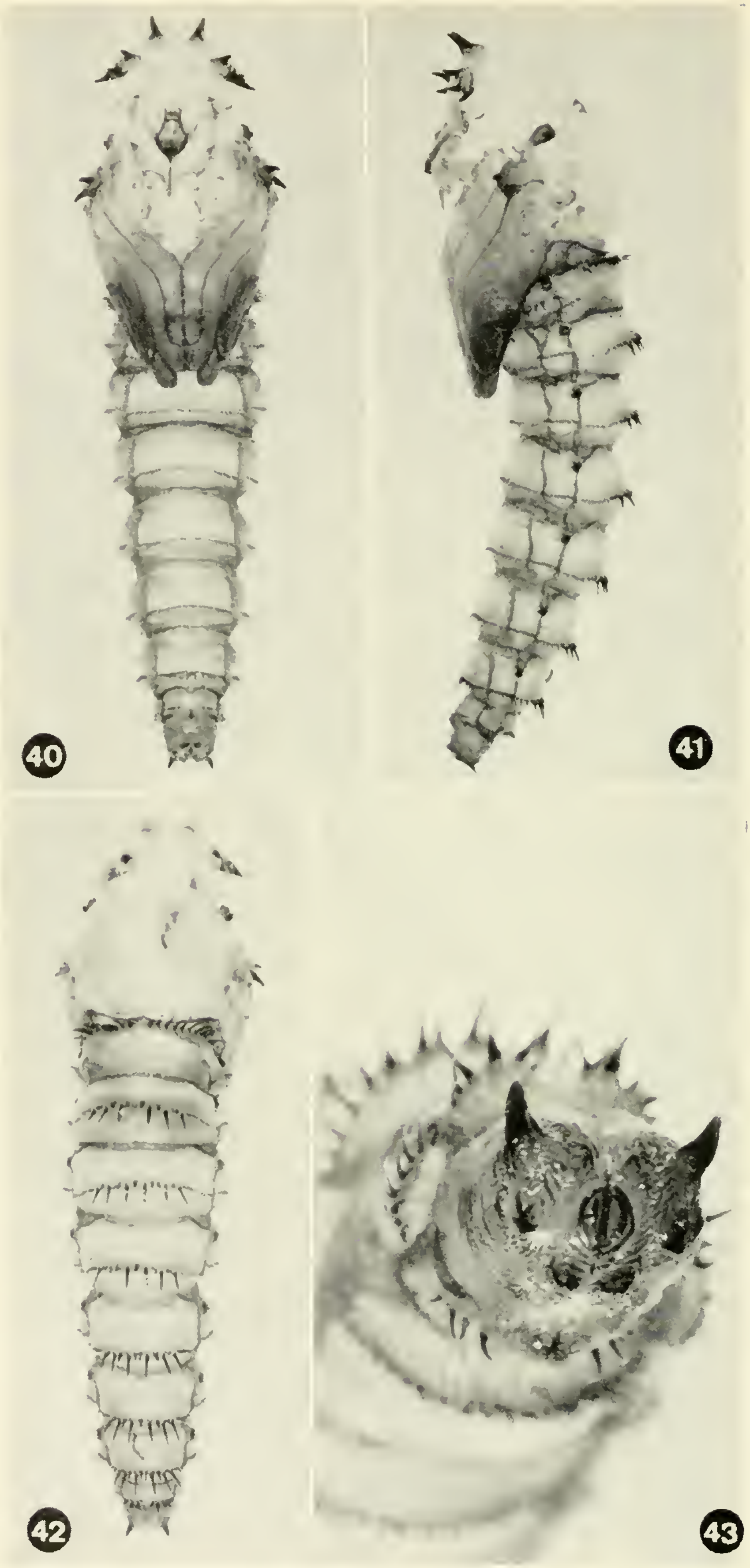

Fig. 40–43. Pupal case of *Proctacanthus micans.*

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A NEW SPECIES OF CLEARWING MOTH (LEPIDOPTERA: SESIIDAE) FROM NORTHERN MEXICO AND SOUTHEASTERN ARIZONA

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ABSTRACT—A new clearwing moth species, *Carmenta* **wellerae**, Duckworth and Eichlin, is described from Chihuahua, Mexico, and the Huachuca Mountains, Arizona.

As was the case in a previous publication by the authors (Duckworth and Eichlin, 1973), the following description results from continuing revisionary studies on the Western Hemisphere Sesiidae and preparations for a fascicle on the Sesiidae for publication in *The Moths of America North of Mexico.*

From Engelhardt (1946) one can see that the clearwing moth fauna of southeastern Arizona and New Mexico is rich in numbers of sesiid species, which are currently known only from this region. During the course of the previously mentioned revisionary studies, it has become increasingly evident that this fauna is most likely an extension of the little known fauna of northern Mexico. The species described below from Chihuahua, Mexico, and southeastern Arizona lends support to this contention. Collectors could make significant contributions to our knowledge of the group by concentrated efforts in this region of Mexico.

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Carmenta wellerae Duckworth and Eichlin, new species
fig. 1–7

Male (fig. 1–2): Antenna slightly clavate, tufted with scales apically, blue-black dorsally but with posterior side orange, ventrally red-orange with fairly long cilia. Proboscis well developed. Labial palpus roughly scaled ventrally, sculptured so as to appear triangular in lateral aspect (fig. 1), blue-black with white distally, mixed ventrally and mixed with pale yellow dorsally (Arizona specimen with palpi mostly white). Head with vertex blue-black, front mostly blue-black but very narrowly white laterad and beneath scape, occipital fringe pale yellow dorsally (strongly mixed with white on some individuals), white laterally. Forewing mostly hyaline with very narrow margins, veins and narrow discal spot blue-black but variously powdered orange (strongly on Arizona specimen) on margins, some veins and on at least distal ½ or more of discal spot, orange powdering much more extensive ventrally. Legs laterally blue-black, with forecoxae white distally and laterally, variously tinted pale yellow, tibiae often powdered yellow or pale orange on basal portion, tufts near spurs yellow, spurs white, tibiae mesally mostly white except distad, with some pale yellow or orange mixed, tarsi white mesally and often laterally as well but blue-black laterally at least on 1st segment. Abdomen mostly blue black, dorsally with narrow yellow or pale yellow bands on posterior margins of segments 2, 4 and 7 and laterally on 6, ventrally with segments 1 and 2 completely pale yellow or white and mostly pale yellow on 4–7, anal tuft very narrowly wedge shaped with pale yellow tipped scales laterally. Male genitalia as in fig. 6. Wing length of male, 8–11 mm.

Female (fig. 3 & 4): Antenna as for male but lacking ventral cilia. Maculation much like male but with forewing having broader apical margin, wings more strongly powdered orange, white areas on legs of male mostly replaced with yellow, except for white tarsal segments which are same as for males, abdomen more robust, also with 3 dorsal bands but last band is on segment 6, anal tuft slightly bushy, blue-black with yellow laterally. Female genitalia as in fig. 5. Wing length of female, 9–11 mm.

Host: Unknown.

Distribution (fig. 7): Presently known only from Cuiteco and Temoris, Chihuahua, Mexico, and the Huachuca Mountains, Cochise County, Arizona.

Types: Holotype: ♂, Cuiteco, Chih., Mex., VIII-9-1969, T. A. Sears, R. C. Gardner, C. S. Glasser, J. C. Weller, (USNM No. 73430), deposited in the USNM. Paratypes 5: 1♀ with same locality, date and collectors as holotype, genitalia slide by J. C. Weller, CDA No. 003, deposited in the USNM; 1♂ with same locality, date and collectors as holotype, deposited in the collection of the University of California, Davis; 1♀ with same locality, date, and collectors as holotype, and 1♂, Mex., mi., Temoris, Chih., VIII-24-1969, T. A. Sears, R. C. Gardner, C. S. Glasser, J. C. Weller, genitalia slide by J. C. Weller, CDA No. 002, both deposited in California Department of Food and Agriculture (CDA) collection; 1♂, Ariz., Cochise Co., Carr Cyn., 5400′, Huachuca Mts., 21–23 Aug. 1972, coll. R. R. Snelling, genitalia slide by J. C. Weller, CDA No. 001, deposited in the Los Angeles County Museum (Natural History), California.

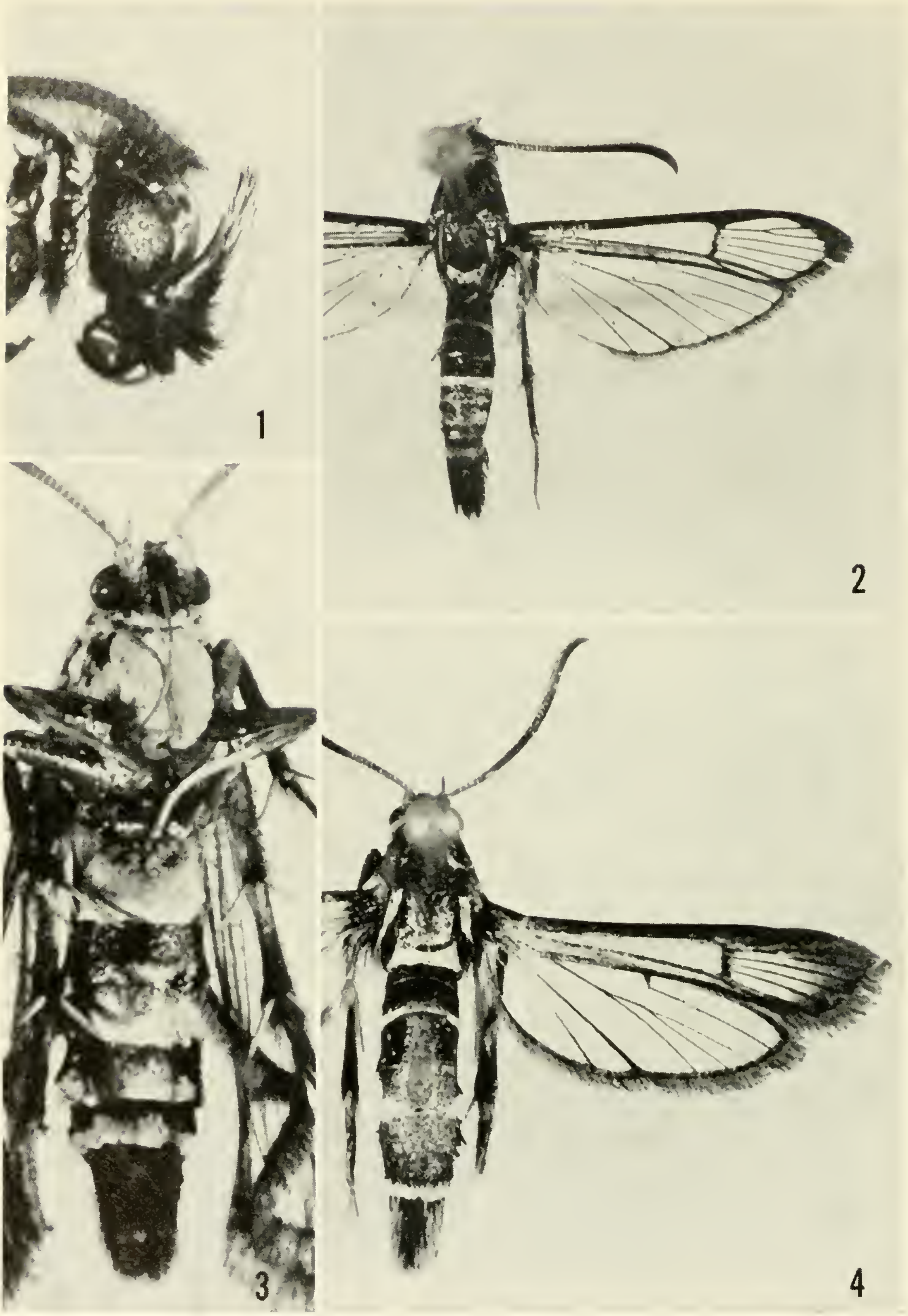
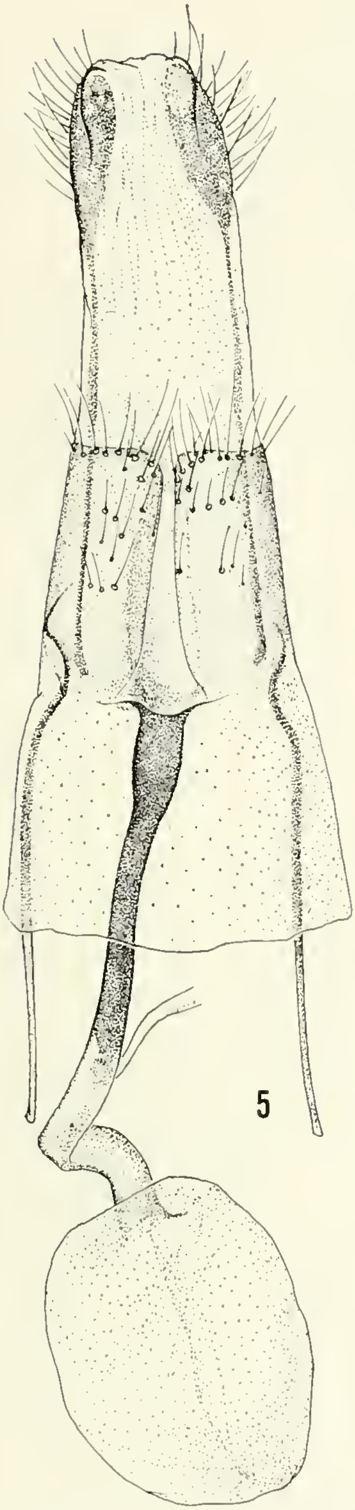


Fig. 1–4. *Carmenta wellerae.* 1, lateral view of head, ♂ holotype. 2, dorsal view, ♂ holotype. 3, ventral view, ♀ paratype. 4, dorsal view, ♀ paratype.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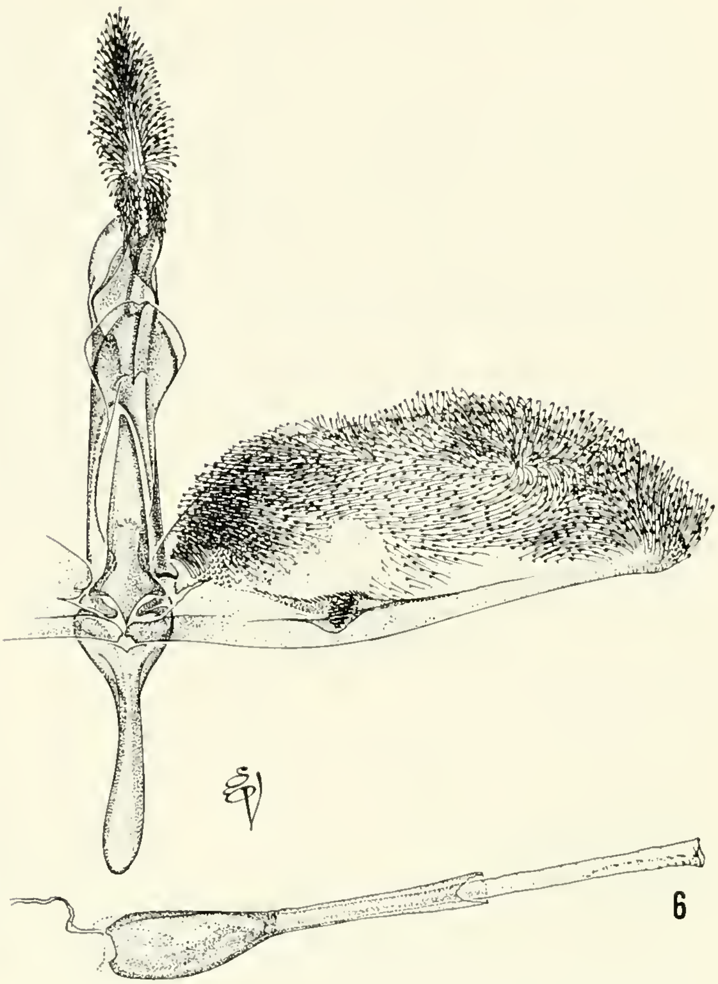
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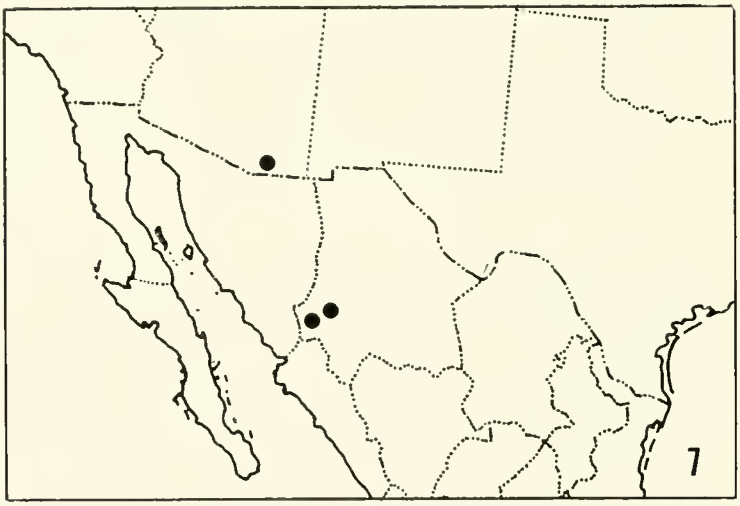
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Fig. 5–7. *Carmentata wellerae.* 5, ventral view of female genitalia. 6, male genitalia, aedeagus removed. 7, distribution.

Discussion: Superficially, this species resembles several species of *Carmenta*. However, *C. wellerae* can be differentiated from the other species in this locality by having the orange powdering on the antennae, the roughened and somewhat triangular appearance in lateral aspect of the labial palpi, the large pale yellow or white area ventrally on the abdomen at the base, the white tarsal segments on the hind tarsi, and the characteristic genitalia of the male.

Nothing is known of its biology, except for the fact that the adults were all captured in mid or late August. All specimens known of *C. wellerae* were captured around 5200–5400 feet elevation.

This species is known only from the type-series of six specimens and one more female from 15 miles north of Temoris, Chihuahua, Mexico, VIII-22-68, which is in poor condition and with the tip of the abdomen missing.

The species is named for Judy Weller, who participated in collecting the original series, but more importantly, for her continuing contributions to our research on Western Hemisphere Sesiidae.

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VERTICAL DISTRIBUTION OF POMERANTZIID MITES (ACARINA: POMERANTZIIDAE)

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ABSTRACT—Vertical distribution patterns of pomerantziid mites in ponderosa-pine-forest soil near Grass Valley, California, and in agricultural soils in the San Joaquin Valley are described. At Grass Valley, 8 samples ranging in total depth from 80.0 to 156.2 cm yielded 207 specimens of *Pomerantzia prolata* Price. The mites were collected between 3.8 and 87.6 cm. No specimens were found in the litter and humus layers, and only 11.6 per cent of the pomerantziid fauna occurred in the upper 11.4 cm of the soil profile.

In the San Joaquin Valley, 6 samples from western Fresno and Merced Counties yielded 20 specimens, all of which were found in the region between 30.5 and 121.9 cm. In 4 additional samples from western Fresno County, which reached depths of 310.8 cm, 313 pomerantziids were collected between 22.9 and 249.8 cm. The dominant species in the San Joaquin Valley samples was *P. benhami* Price; less common were members of an undescribed species closely resembling *P. prolata*.

The family Pomerantziidae Baker (1949) is composed of only 4 known species, all described from North America (Price, 1975b). This little-known and isolated group of prostigmatid mites was placed by Wainstein (1965) in the monotypic superfamily Pomerantzioidea.

Collections we have made in California indicate that pomerantziid mites are relatively common members of the soil fanua. The collections also reveal that these mites are primarily subterranean, occurring at depths below those normally sampled by acarologists. This observation suggests why these mites are rarely collected and why so few species are known.

This paper presents collection data illustrating vertical distribution patterns of pomerantziid mites at 2 localities in California: a ponderosa-pine-forest habitat at the Boyce Thompson Institute Forest Research Laboratory at Grass Valley, and an agricultural region of the San Joaquin Valley in western Fresno and Merced Counties. Crops commonly grown in this region are cotton, barley, and alfalfa. Incidental collection data from several other areas also are presented.

In a previous study at the Grass Valley site (Price, 1973), 11 corings extending to depths of 24.1 cm and 4 corings extending to 29.2 cm yielded 97 specimens of *Pomerantzia prolata* Price (1971). Of these, only 2 specimens were collected from the 3.8-cm-thick litter and humus layers. The numbers collected from each 5.1 cm stratum of the underlying subsoil were, in order of increasing depth: 3, 15, 23, 35, and 19. The number in the deepest stratum was probably low because only 4 of the 15 corings included this soil layer.

These data indicated that this species is predominantly subterranean, and that samples deeper than 29.2 cm would be required to determine its total vertical range at this site. However, because of the dense, rocky nature of the subsoil, we could not sample soil depths greater than about 30 cm with conventional coring tools. Thus, in order to explore the depth distribution of *P. prolata*, we were obliged to dig pits and to obtain samples from the sides of the exposed profiles. The data from the Grass Valley site and from certain fields in the San Joaquin Valley reported in this paper were obtained in this manner. Also, we were able to obtain some additional samples in the San Joaquin Valley from profiles exposed in deep trenches being excavated to receive pipes for an irrigation project.

METHODS

The study site and sampling procedures at Grass Valley were described by Price (1975a). Pits ranging in depth from 80.0 to 156.2 cm were dug on each of 8 sampling dates between March 28, 1973, and April 8, 1974. A vertical soil profile on 1 side of the pit was selected for study, and subsamples composed of the litter and humus layers—treated as a subsample unit—and of each 7.6 cm stratum of the underlying mineral subsoil were obtained with a hand trowel. The litter and humus layers were only about 3.8 cm thick, or ½ that selected for each of the subsoil strata. To obtain data equivalent to a single coring, we took a volume of litter and humus ½ that taken from each subsoil layer. These volumes were approximately 825 and 1,650 cm^3, respectively, the equivalent of a single coring with a surface area of 216.5 cm^2.

A battery of Berlese funnels was used to extract arthropods from both the Grass Valley and San Joaquin Valley samples (Benham, 1975). Each soil stratum was placed in a separate unit of the funnel apparatus.

Two kinds of samples were taken from agricultural fields in the San Joaquin Valley. The 1st was taken from the sides of 6 pits dug in 2 fields between February 2, and November 3, 1974. Five pits were dug in a field 8 miles southwest of Five Points (Fresno County), and 1 pit was dug in a field 10 miles southwest of Los Banos (Merced County). Two additional pits were sampled in a 3rd field in Fresno County, but pomerantziid mites were not collected. A single profile on 1 side of each pit was sampled in the same manner described for the Grass Valley site. Each pit was sampled to a depth of 121.9 cm. Since there were no litter or humus layers, the profile was divided into 16 equal 7.6 cm strata. The soil volume taken from each stratum was 3,250 cm^3.

The 2nd set of samples from agricultural soils was obtained from four 310.8 cm profiles exposed in a series of trenches dug by a construction company to receive irrigation pipes. These deep parallel trenches were excavated by machine at 2-mile intervals eastward from the San Luis Canal, a large aqueduct, and extended from 6 to 20 miles into the agricultural region of western Fresno County. Our samples were taken in the area between the towns of Five Points on the north and Huron on the south.

We were permitted to take samples from the trenches immediately after they had been dug, for which we acknowledge the cooperation of the Granite Construction Company, Watsonville, California. The profiles studied, therefore, had been exposed for short time periods, in most cases not exceeding 2 hours. Sixteen samples were taken. Pomerantziid mites, however, were found in only 4: those taken on July 9 and November 1, 1973; and on May 24 and August 9, 1974. Subsamples were taken at intervals on the sides of the trenches as indicated in Table 1. The top 30.5 cm was divided into 4 equal strata. Below this level, subsamples at each depth were obtained from a hole approximately 12.0 cm in diameter which was dug directly into the sides of the profile.

Results and Discussion

Table 1 gives the number of pomerantziid mites collected from each soil stratum at the Grass Valley site and from the pits and trenches in Fresno and Merced Counties. The data represent the total numbers collected from 8 profiles at Grass Valley, from 6 pits dug in 2 agricultural fields, and from 4 profiles in the trenches.

At Grass Valley, 207 specimens of *P. prolata* were collected in the subsoil between 3.8 and 87.6 cm. None were found in the litter and humus layers. In the agricultural fields, 20 pomerantziids were obtained from the pits at depths between 30.5 and 121.9 cm. The trench profiles yielded 313 pomerantziids, collected between depths of 22.9 and 249.8 cm.

Two species were collected in the agricultural sites. The dominant form was *P. benhami* Price (1974), although a second, undescribed species related to *P. prolata* also occurred. The two species did not exhibit any noticeable differences in vertical distribution. All the adult mites examined from both the Grass Valley and the San Joaquin Valley sites were females. To date, male Pomerantziidae have not been discovered.

The statistics termed "mean depth" and "depth deviation" in Table 1 were proposed by Usher (1970) to describe vertical distribution patterns of soil arthropods. These statistics also were used by Price (1975a) in a study of major arthropod taxa at the Grass Valley site. The mean depth provides a measure of the weighted mean or center of gravity of a number of individuals arranged spatially in a vertical soil profile. The depth deviation is a measure of the spread of these individuals about the mean depth.

It is unusual for workers in soil zoology to sample soil layers below about 15 to 20 cm from the surface. This is not only because there are obvious sampling problems, but also because most arthropod species and individuals occur in the uppermost soil layers (Wallwork, 1970). Faunal diversity declines rapidly with soil depth. Nonetheless, in every habitat there probably are species which compose a distinctive subterranean fauna.

Table 1. Numbers of pomerantziid mites collected from soil depths indicated in a ponderosa-pine-forest habitat near Grass Valley, California; and in an agricultural region of western Fresno and Merced Counties, California.

Grass Valley		Western Fresno and Merced Counties			
Pits		Pits		Trench	
Depth interval (cm)	No.	Depth interval (cm)	No.	Depth interval (cm)	No.
0 – 3.8[a]	0	0 – 7.6	0	0 – 7.6	0
3.8– 11.4	24	7.6– 15.2	0	7.6– 15.2	0
11.4– 19.1	41	15.2– 22.9	0	15.2– 22.9	0
19.1– 26.7	50	22.9– 30.5	0	22.9– 30.5	7
26.7– 34.3	38	30.5– 38.1	1	39.7– 51.7	123
34.3– 41.9	21	30.5– 45.7	6	55.0– 67.0	76
41.9– 49.5	15	45.7– 53.3	3	70.2– 82.2	40
49.5– 57.2	10	53.3– 61.0	2	85.4– 97.4	21
57.2– 64.8	4	61.0– 68.6	1	100.7–112.7	13
64.8– 72.4	1	68.6– 76.2	2	115.9–127.9	22
72.4– 80.0	2	76.2– 83.8	1	146.4–158.4	7
80.0– 87.6	1	83.8– 91.4	0	176.9–188.9	2
87.6– 95.3	0	91.4– 99.1	1	207.4–219.4	1
95.3–102.9	0	99.1–106.7	1	237.8–249.8	1
102.9–110.5	0	106.7–114.3	1	268.3–280.3	0
110.5–118.1	0	114.3–121.9	1	298.8–310.8	0
Total	207[b]		20		313
Mean Depth	27.4		63.2		68.3
Depth Deviation	14.7		24.9		31.0

[a] Litter and humus layers.

[b] Five 7.6 cm strata between 118.1 and 156.2 cm did not contain Pomerantziidae.

The data in Table 1 indicate that pomerantziid mites at the study sites are common deep-soil inhabitants. The Grass Valley data can be used to make an estimate of 1,195 Pomerantziidae per m^2. Shallow corings, even to depths of 20 cm, would provide estimates of only a fraction of this number. In the San Joaquin Valley sites, corings to depths of 20 cm would not even enter the habitat of these mites.

In another study, we took samples to depths of 15.2 cm from a field near Parlier in eastern Fresno County. No pomerantziid mites were obtained. In a few deep samples from this field, however, we collected 5 specimens of *P. benhami* at depths ranging from 30.5 to 106.7 cm. We also collected specimens of *P. prolata* from grassland soils below 30.5 cm in Contra Costa County, California. *Pomerantzia* *kethleyi* Price (1975b) was described from 7 specimens collected by Dr. John B. Kethley at depths ranging between 35 and 65 cm in prairie grassland soil in Indiana.

Further knowledge of the Pomerantziidae will not be gained easily. The difficulties of acquiring observational and sampling data on population densities, spatial distribution patterns, habitat requirements, life histories, food preferences, etc., are evident. To obtain samples from the sides of exposed soil profiles in the manner described is not only laborious but also highly disruptive to the habitat studied. Replication of subsamples distributed in a random manner within a study area is almost impossible to accomplish. Coring tools designed to sample the subterranean fauna are needed. Until then, however, workers willing to obtain samples from unconventional depths could be rewarded not only with pomerantziid mites but also, perhaps, with members of other little-known arthropod groups.

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DESCRIPTION OF THE PUPA, LARVA, AND LARVAL HABITAT OF ALLUAUDOMYIA PARVA WIRTH (DIPTERA: CERATOPOGONIDAE)[1]

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ABSTRACT—The pupa and larva of *Alluaudomyia parva* Wirth are described and illustrated. The larval habitat is described and rearing records are listed.

The known breeding habitats of most species of Nearctic *Alluaudomyia* are aquatic. Thomsen (1935, 1937) reared *A. needhami* Thomsen from blanket algae in New York, and in 1937 reared *A. bella* (Coquillett) from algae, decaying leaves, and mud from ponds in New York. Williams (1953) captured *A. bella* and *A needhami* in Georgia, in recovery cages as they emerged from soil that had previously been inundated with water. Williams (1956) described *A. megaparamera* and *A. wirthi* from single male specimens captured in recovery cages placed in bogs in Michigan.

Wirth (1952) described *A. parva* from Florida, and it has since been collected in many eastern states but nothing has been recorded on its breeding habitat. Except for those reared by Bystrak, the following rearing records and descriptions are based on specimens in the National Museum of Natural History (USNM). These records indicate that the larvae of *A. parva* are semiaquatic as most specimens were taken from sphagnum moss.

MARYLAND: *Anne Arundel Co.*, Odenton, P. G. Bystrak, 10 May 1970, 1♂, 1♀, pupae reared from sphagnum, ♂ emerged 21 May, ♀ emerged 25 May; *Garrett Co.*, Cranesville Swamp, 6 Aug. 1960, J. Coulson, 1♀ reared from sphagnum. NEW YORK: *Cattaraugus Co.*, Alleghany St. Park, 28 May–31 June 1963, W. W. Wirth, 1♂, pupa reared from sphagnum bog; *Hamilton Co.*, Blue Mtn. Lake, H. A. Jamnback, 1♂, pupa reared from sphagnum bog 30 May 1958, 1♀, pupa collected from Salmon River marsh and reared from Berlese funnel 14 May 1959. VIRGINIA: Alexandria, 6 June 1951, W. W. Wirth, 6♂, pupae reared from Osmunda fern bog; *Fairfax Co.*, Falls Church, 28 June 1951, W. W. Wirth, 1♂, pupa reared from stream margin. ONTARIO: Algonquin Park, 7 June 1960, W. W. Wirth, 1♂ reared from sphagnum.

Pupa: Operculum (fig. 1a) about as long as wide, covered with small, coarse, round tubercles; anterior end rounded; central portion with 2 large sclerotized

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[1] Scientific Article No. A2103, Contribution No. 5060, of the Maryland Agricultural Experiment Station.

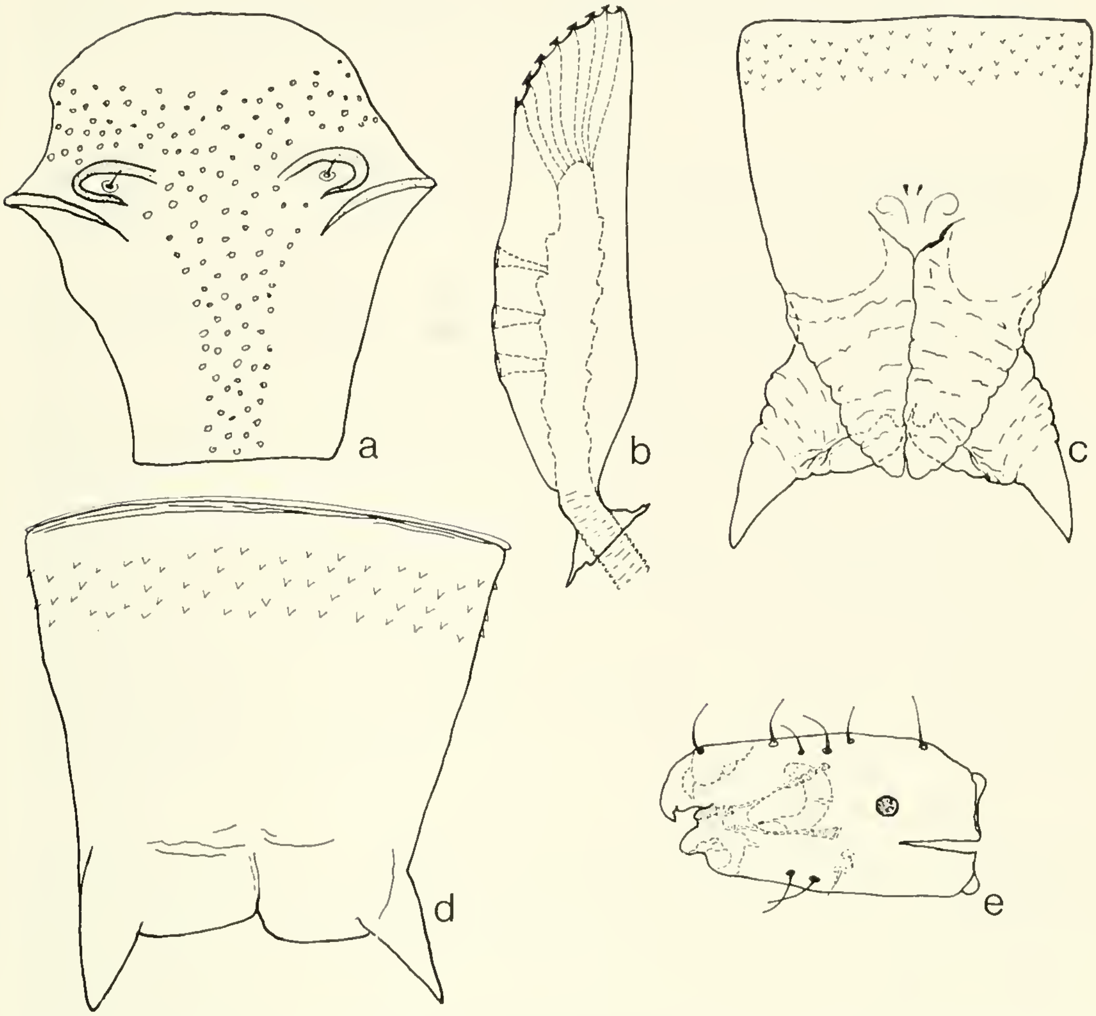

Fig. 1. Pupa and larva of *Allnaudomyia parva.* a–d. pupa. a, operculum, b, respiratory organ. c, male anal segment. d, female anal segment. e, larval head capsule.

tubercles each bearing a single small seta, margins expanded laterally with curved sclerotized ridge; posterior end truncate. Respiratory organ (fig. 1b) about 4 times longer than broad; apex with double row of 7 spiracular papillae; lateral margin with 2–3 spiracular papillae; posterior portion tapered, base broadened. Male anal segment (fig. 1c) about 1.3 times longer than broad; anterior portion covered with fine pointed tubercles; processes wrinkled, tightly appressed; cerci bases wrinkled, apices smooth, widely divergent. Female anal segment (fig. 1d) slightly longer than broad; anterior portion covered with fine pointed tubercles; cerci smooth, widely divergent.

Larva: Head capsule (fig. 1e) about twice as long as broad; dorsal surface with 6 setae; ventral surface with 4 setae; eye well developed, lightly sclerotized.

Discussion: The pupa of *A. parva* is readily distinguished by its smooth respiratory organ from the only other two described Nearctic species, *A. bella* and *A. needhami,* both of which have respiratory organs covered with scales.

We are indebted to Willis W. Wirth, Systematic Entomology Laboratory, USDA, for the loan of specimens and for review of the manuscript.

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NOTES ON MYRMECOBLATTA WHEELERI FROM COSTA RICA (BLATTARIA: POLYPHAGIDAE)

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ABSTRACT—Myrmecophilous cockroaches have not previously been recorded from Costa Rica. Material collected in 1974 at 4 localities in nests of *Camponotus abdominalis* (F.) ants has been identified as *Myrmecoblatta wheeleri* Hebard based on comparison with the male types of *M. wheeleri* and *M. rehni* Mann. The female of *M. wheeleri* is described for the first time and additional morphological data on the male are provided.

In 1914, W. M. Mann proposed the new genus and species *Myrmecoblatta rehni* Mann from a single male and several females and nymphal cockroaches collected in 1913 from ant nests (*Formica* and *Camponotus*) at Guerrero Mill, Hidalgo, Mexico. Hebard (1917) described *Myrmecoblatta wheeleri* Hebard from 2 males and 2 nymphs collected by W. M. Wheeler in 1912 in a colony of the ant, *Solenopsis gemmata* (F.) at San Lucas Toliman, Solola, Guatemala. No additional records for either species have been published although additional collections have been made.

In February, 1974 a single male cockroach was collected (by FWF) near Cachí, Prov. Cartago, near a nest of *Camponotus* sp. ants. Later a number of cockroach specimens of all life stages were taken (by FFB) at San Juan de Dios de Desamparados, Aserri, and Campus, University of Costa Rica, San Pedro, Prov. San Jose in the nests of *Camponotus abdominalis* (Fabricius). The cockroaches were tentatively identified as *Myrmecoblatta wheeleri* and type-material of the two known species was secured for comparison. Examination of the types confirms the identification in most every detail. The 2 species of *Myrmecoblatta* may be readily separated from each other and from the myrmecophilous genus *Attaphila* Wheeler (1900) by means of the following key which refers to both the brachypterous males and the apterous females, unless males are specifically mentioned.

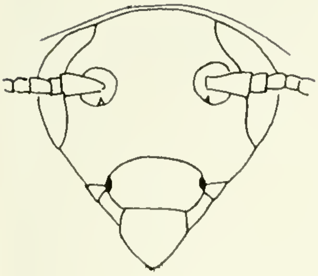
Key to Certain Myrmecophilous Cockroaches

1. Cerci ovoid, unsegmented. Epistomal suture absent; labrum wider than long. Large arolia present .... *Attaphila* Wheeler
— Cerci stout, but longer than wide, tapering to acute tip, segmentation evident or very poorly marked. Epistomal suture at base of clypeus and clypeus present; labrum spadelike, longer than broad. Arolia absent. (*Myrmecoblatta* Mann) 2
2. Adults and nymphs with epistomal suture markedly arched; clypeus with its proximal (frontoclypeal) margin broadly convex (fig. 1). Cerci relatively slender. Males with tegmina broadly oval in shape, reaching to abdominal tergum VII (fig. 2) .... *rehni* Mann
— Adults and nymphs with epistomal suture transverse, at about level of anterior tentorial pits; clypeus with its proximal (frontoclypeal) margin sinuous, slightly convex laterally, concave medially (fig. 3). Cerci stout, tapering sharply at tips. Males with tegmina truncate behind, reaching abdominal tergum V (fig. 4) .... *wheeleri* Hebard

Hebard (1917) noted other valid distinguishing characters separating the 2 species of *Myrmecoblatta* but unless comparison material is at hand they are not readily diagnostic.

The male genitalia from Costa Rican specimens were partially cleared in KOH or NaOH and studied. They are difficult to homologize with other cockroach species, but come closest to McKittrick's (1964) drawings of the male genitalia of *Hypercompsa fieberi* (Brunner). They show an even closer affinity to the genitalia of *Compsodes schwarzi* (Caudell) and *C. cucullatus* (Saussure & Zehntner) which were prepared for comparison. Using the notation of McKittrick (1964) we note the non-retractable genital hook, L3, which ends in a sharp "fishhook". L2-d appears to arise near the base of the left phallomere and at its distal end extends both left and right. The lightly sclerotized left extension links up with the base of L3, while the right (medial) extension is slender, short, strongly sclerotized and narrows to a smoothly pointed tip. Like L3 it can often be seen protruding from uncleared specimens. Another, more proximal, median sclerotized process with roughened, posterior-projecting tip may represent either L1 or R1. In partially cleared specimens it appears to arise from the right side but in fully cleared examples mounted on microscope slides by FFB its origin appears to be on the left side. The sclerites of the right phallomere are generally poorly sclerotized and difficult to make out, although a small pigmented area which may be a portion of R2 is often evident in untreated or partly cleared specimens.

The exposed male genitalia of the type-specimens of *Myrmecoblatta wheeleri* and *M. rehni* were examined, but without clearing in KOH. The hooked L3 of *M. rehni* was similar to *wheeleri* but the projecting portion of L2-d differed in bearing a small slender spine extending from a blunt, rounded tip. The tip of *M. wheeleri* differed from our



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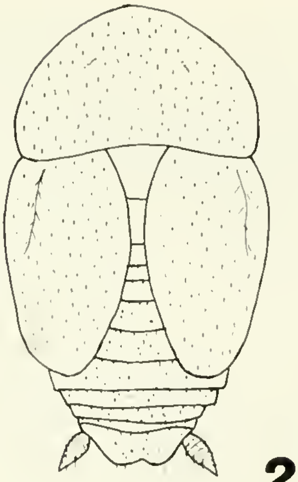

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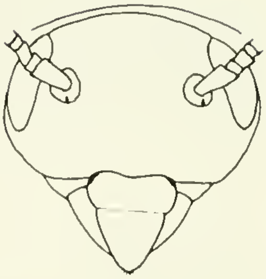

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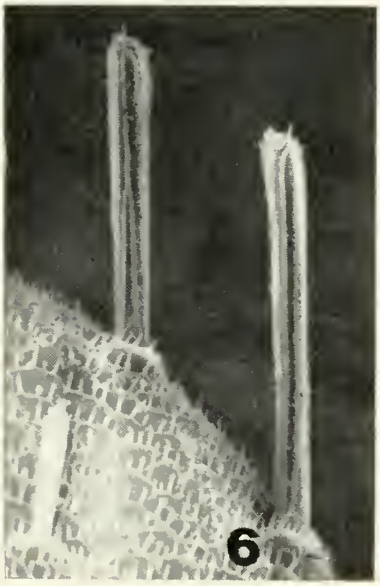

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Fig. 1–2. *Myrmecoblatta rehni*, male. 1, front view of head showing epistomal suture. 2, dorsal view. Fig. 3–6. *Myrmecoblatta wheeleri*. 3, female, front view of head showing epistomal suture. 4, male, view through compound microscope. The tegmina normally lie with their medial margins contiguous or slightly overlapping. Note tergal gland, appearing in photo between trochanters of hind legs. 5, female, ventral view. 6, nymph, SEM photo of blunt setae on cercus, 700× enlargement.

male specimens in that the right (medial) extension of L2-d appears to have the pointed tip broken off.

On the basis of similarities in male genitalia, female genitalia, proventriculus (fig. 10), and epistomal suture, the genus *Myrmecoblatta* appears to be close to the polyphagid genus *Compsodes.*

A feature of the male *Myrmecoblatta wheeleri* which is only revealed in cleared or dissected specimens and that has not been described is a small median tergal gland (fig. 4, 7) which projects anteriorly from the 4th abdominal tergum but is usually completely

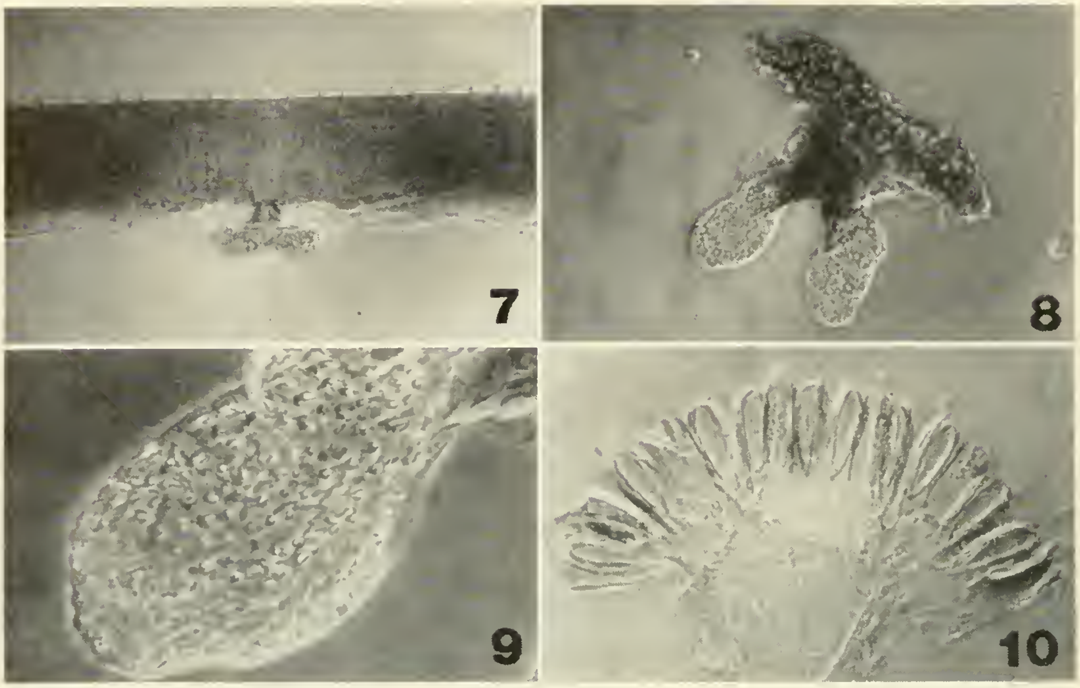

Fig. 7–10. *Myrmecoblatta wheeleri.* 7, male, fourth abdominal tergum showing tergal gland and blunt-tipped setae. 8, male, tergal gland showing cribriform area and gland sacs. 9, male, detail of glandular sac showing microtrichiae. 10, proventriculus, general view.

hidden beneath the 3rd tergum. The gland consists of a cribriform plate with two sacs attached to a common stem (fig. 7, 8). The sacs are lined with numerous very small short microtrichiae arising singly or in groups of two or three, the ones nearer the collar of the sac being larger and stronger (fig. 9).

Abdominal terga II and III also show tergal modifications consisting of narrow cribriform areas along the anterior margin, being more conspicuous towards the sides of the terga. In tergum II there is a slitlike formation on each side. The tergal modifications are more marked on tergum II than on tergum III. Roth (1969) has mentioned that tergal glands are present only in two genera of Polyphagidae, being absent in 19 other genera, indicating also that in one species of *Compsodes* tergum IV is modified. *Myrmecoblatta wheeleri* should be placed in the group of species with male tergal modifications on three abdominal segments, the 2nd, 3rd, and 4th. It was impossible to ascertain whether such a gland exists in the type-males of either *wheeleri* or *rehni* without resorting to destructive procedures. Since females of *M. wheeleri* have not been previously available for description we describe the female as follows.

Female (fig. 3, 5): In nest of *Camponotus abdominalis* (Fabr.), San Juan de Dios de Desamparados, San Jose Province, Costa Rica VIII 4 1974 (FFB, collector). Size minute, form elliptical, apterous. Head reaches anterior margin of pronotum. Face broad, circular. Interocular space decidedly broader than between antennal sockets, compound eyes small, barely emarginate medially. Ocelli absent. Antennae as noted by Hebard with 1st joint larger than succeding joints and 2nd joint smaller than succeeding joints. Anterior tentorial pits well marked, with epistomal (frontoclypeal) suture lying between them. With respect to clypeus this suture is convex laterally and slightly concave medially. Clypeus subquadrate with broadly rounded corners, its width approximately twice its depth. Clypeolabral suture poorly defined; labrum narrowly triangular, spade like, its tip concealing mandibles when in closed position. Maxillary palpi with ultimate joint nearly twice as long as penultimate.

Pronotum semicircular in outline, its posterior margin transverse with lateral angles acutely rounded. Meso- and metanotum subequal in size and shape, their posterior margins broadly concave and lateral angles acutely rounded. Lateral margins of abdominal terga I and II and part of III hidden by metanotum. Terga IV to VII exposed and subequal, their lateral angles becoming increasingly acute, with backward-projecting spines on V, VI and VII. Terga VIII and IX not so deep or as wide as preceding. Supra-anal plate transverse anteriorly, broadly convex behind with hint of median emargination. Cerci, as in male, very stout, very weakly segmented, with tips acute. Abdominal sterna regular, transverse with subgenital plate simple, valvular. Legs relatively stout, most surfaces sparsely covered with scattered fine hairs. Definite spines only at tips of tibiae, tips of meso- and metafemora and outer margins of meso- and metatibiae. Ventroanterior margins of front femora with scattered fine setae mixed with a row of minute setae; ventroposterior margins of all femora with a row of evenly spaced fine setae. Tarsi with claws symmetrical and unspecialized; pulvilli and arolia absent.

Color above and below tan, but with coxae and femora of legs and underparts of thorax very much lighter. Anterior and lateral margins of pronotum, lateral margins of meso- and metanotum and very thin median line on thorax and abdomen lighter than ground color. Surface of body supplied with moderately numerous fine setae, randomly scattered on thorax, more or less lined up on abdominal terga and sterna. In both sexes of this species, but not in *M. rehni*, a number of large setae on abdominal terga and cerci do not taper to a point but appear as fluted columns which end in blunt tips (fig. 6, 7).

Measurements (in mm): Body length 5.5, pronotal length 1.8, pronotal width 3.1, max. body width 3.3, hind tibial length 0.9.

We wish to thank Dr. David C. Rentz, Academy of Natural Sciences, Philadelphia and Ms. Margaret K. Thayer, Museum of Comparative Zoology, Cambridge, MA for the loan of valuable type-material; Dr. Ashley B. Gurney, Systematic Entomology Laboratory, USDA, for advice and permission to examine material in U.S. National Museum Collection; Dr. William L. Brown, Jr., Cornell University, Ithaca, NY for identification of the host ant species; and Dr. Roy T. Furumizo, Acarology Laboratory, Dept. of Entomology, Ohio State University, for taking the SEM photograph, fig. 6. Other photographs by Dr. Mario Vargas V.

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SCALE-COVER FORMATION IN THE DIASPIDIDAE (HOMOPTERA: COCCOIDEA)

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ABSTRACT—The steps involved in the formation of a protective covering by the armored-scale insects are discussed and illustrated. Particular mention is made of cover formation as it occurs in 16 aspidiotine and 6 diaspidine species.

The insects placed in the family Diaspididae are commonly called armored-scale insects because they form a protective covering over and sometimes under their bodies. Other groups of scale insects form protective coverings, but only in the Diaspididae are the first 1 or 2 exuviae made integral parts of the covers. The literature contains bits and pieces of information to full discussions on scale-cover formation. Much of this information is inaccurate or misleading.

This paper presents a detailed treatment of scale-cover formation as I have observed it in the following species: Aspidiotini: *Abgrallaspis ithacae* (Ferris), *A. townsendi* (Cockerell), *Aonidiella taxus* Leonardi, *Aspidiotus cryptomeriae* Kuwana, *A. nerii* Bouché, *Diaspidiotus liquidambaris* (Kotinsky), *D. mccombi* McKenzie, *D. osborni* (Newell and Cockerell), *Hemiberlesia diffinis* (Newstead), *H. lataniae* (Signoret), *Melanaspis obscura* (Comstock), *M. smilacis* (Comstock), *M. tenebricosa* (Comstock), *Pseudoaonidia paeoniae* (Cockerell), *Quadraspidiotus juglansregiae* (Comstock), and *Q. perniciosus* (Comstock); Diaspidini: *Carulaspis juniperi* (Bouché), *Chionaspis americana* Johnson, *Fiorinia externa* Ferris, *Lepidosaphes yanagicola* Kuwana, *Pseudaulacaspis pentagona* (Targioni-Tozzetti), and *Unaspis euonymi* (Comstock).

Aspidiotini and Diaspidini, the two largest diaspidid tribes (Ferris, 1942), differ in their scale-cover formation and thereby further establish a basis for their division into separate tribes. The scale-cover formation of these two tribes will be treated separately.

TRIBE ASPIDIOTINI

Female

fig. 1, 2

The cover of the aspidiotine female is formed in distinct steps and is usually contributed to by all 3 females instars. In *Aonidia* spp. the cover is formed by only the first 2 female instars. The body of the adult female remains enclosed within the cast skin of the 2nd instar, and such species are characterized as being "pupillarial" (Ferris, 1938).

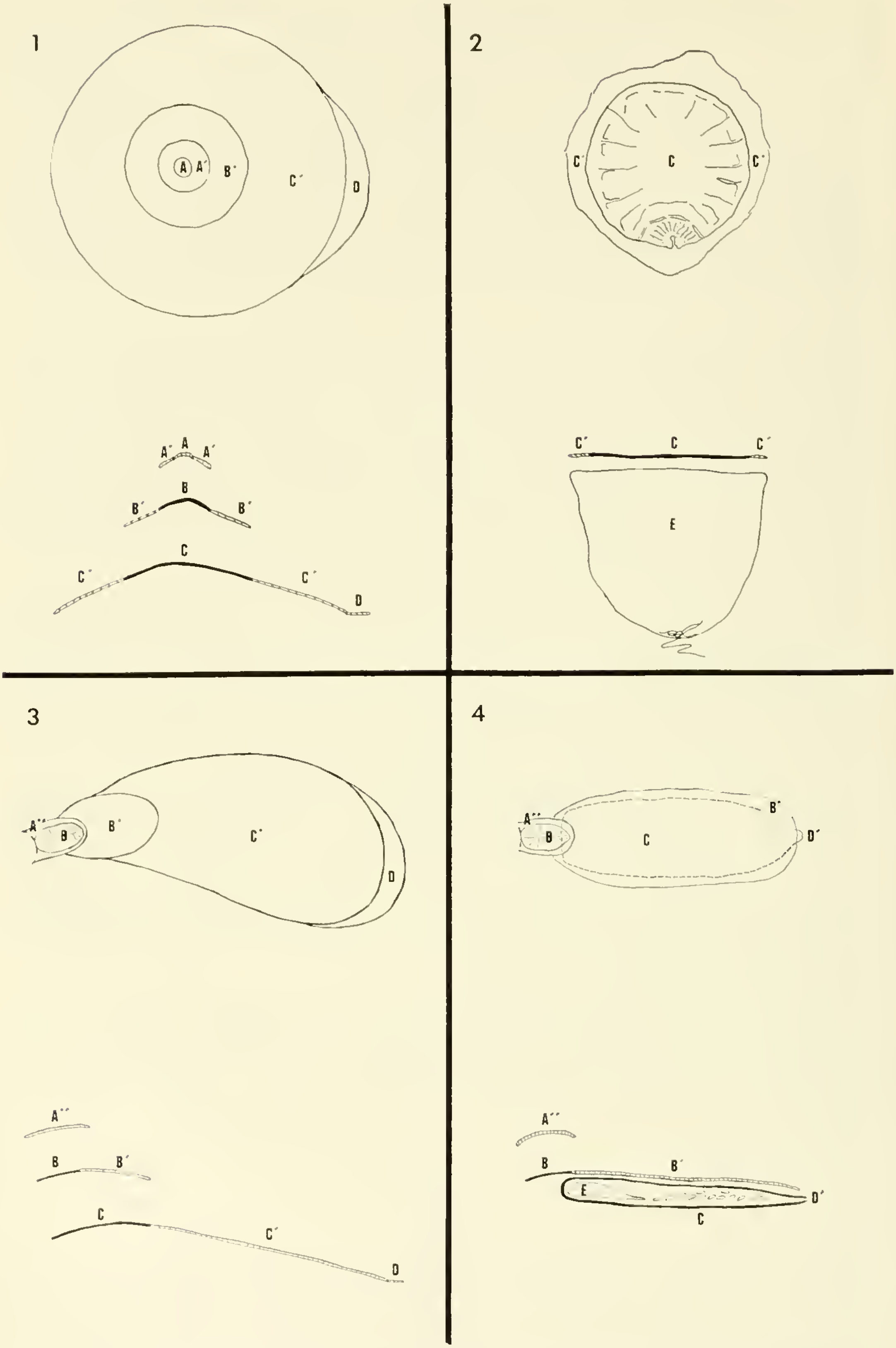

Fig. 1–4. Covers of adult females. 1, aspidiotine scale insect. 2, *Diaspidiotus liquidambaris.* 3, diaspidine scale insect. 4, "pupillarial" diaspidine scale insect. A, cap of secretory material produced by 1st instar; A′, secretory material produced by 1st instar and added to cap; A″, secretory material produced by 1st

First-instar (Crawler) Cover: Whether it settles under the adult-female cover or leaves via the exit flap and settles elsewhere, the 1st instar inserts its mouthparts into the plant and feeds. The crawler secretes numerous fine, white, pliable, waxy filaments which harden and form a circular cap (fig. 1A) over and around its body. According to Baranyovits (1953), a glutinous substance, secreted by the Malphighian tubules, is discharged from the anus and glues the waxy filaments into a solid mass. The cap may remain white (e.g. *Aspidiotus* spp. and *Diaspidiotus* spp.) or it may turn bluish grey (e.g. *Quadraspidiotus perniciosus*), brown (e.g. *Pseudaonidia paeoniae*), or greyish black (e.g. *Melanaspis* spp.). As it grows, the settled 1st instar secretes more material (fig. 1A′) that is attached to the edge of the cap. The circular cover is enlarged gradually as the 1st instar feeds and enlarges. During ecdysis the dorsum of the 1st instar hardens and turns a distinctive color. The color of the hardened dorsal derm in both the 1st and 2nd instars varies among genera but is usually constant within a genus (e.g. yellow in *Aspidiotus* spp., *Diaspidiotus* spp., and *Quadraspidiotus* spp.; blackish orange in *Hemiberlesia* spp.; and black in *Melanaspis* spp.). The venter remains clear and membranous.

Second-instar Cover: After ecdysis the 2nd instar inserts its mouthparts into the plant, feeds, and enlarges. The dorsum and venter of the cast skin of the 1st instar separate along the body margin, the dorsum (fig. 1B) is pushed up against the 1st-instar cover, and the venter is sloughed off and becomes nondescript remains under the body of the 2nd instar. The 2nd instar continually adds secretory material (fig. 1B′) to the edge of the dorsum of the cast skin of the 1st instar and the dorsum of the cast skin becomes an integral part of the usually circular 2nd-instar cover. The cast skin is usually central or subcentral. Fig. 5 is a scanning electron micrograph (2800×) of the venter of the pygidium of a 2nd-instar female of *Aspidiotus cryptomeriae*. Waxy substances, which are produced by dorsal pygidial macroducts, can be seen as long, thin ribbons (A) and a backed-up mass (B) which was formed because a ribbon hit a resistant object as it would in normal scale-cover formation. During ecdysis the dorsum of the 2nd instar hardens and turns the same color as the dorsum of the 1st instar. The venter remains clear and membranous.

Third-instar (Adult) Cover: After ecdysis, the 3rd instar or adult female inserts its mouthparts into the plant and feeds. Usually during this time the adult males are active and mating occurs. The dorsum and venter of the cast skin of the 2nd instar separate along the body margin, the dorsum (fig. 1C) is pushed up against the 2nd-instar cover and the venter remains under the body of the adult female. The adult female adds secretory material (fig. 1C′) to the edge of the dorsum of the cast skin of the 2nd instar, and the dorsum of the cast skin becomes an integral part of the usually circular adult-female cover. In some species, e.g. *Melanaspis tenebricosa* and *M. smilacis*, a hard, ventral cover, consisting of secretory material, is produced so that the adult female

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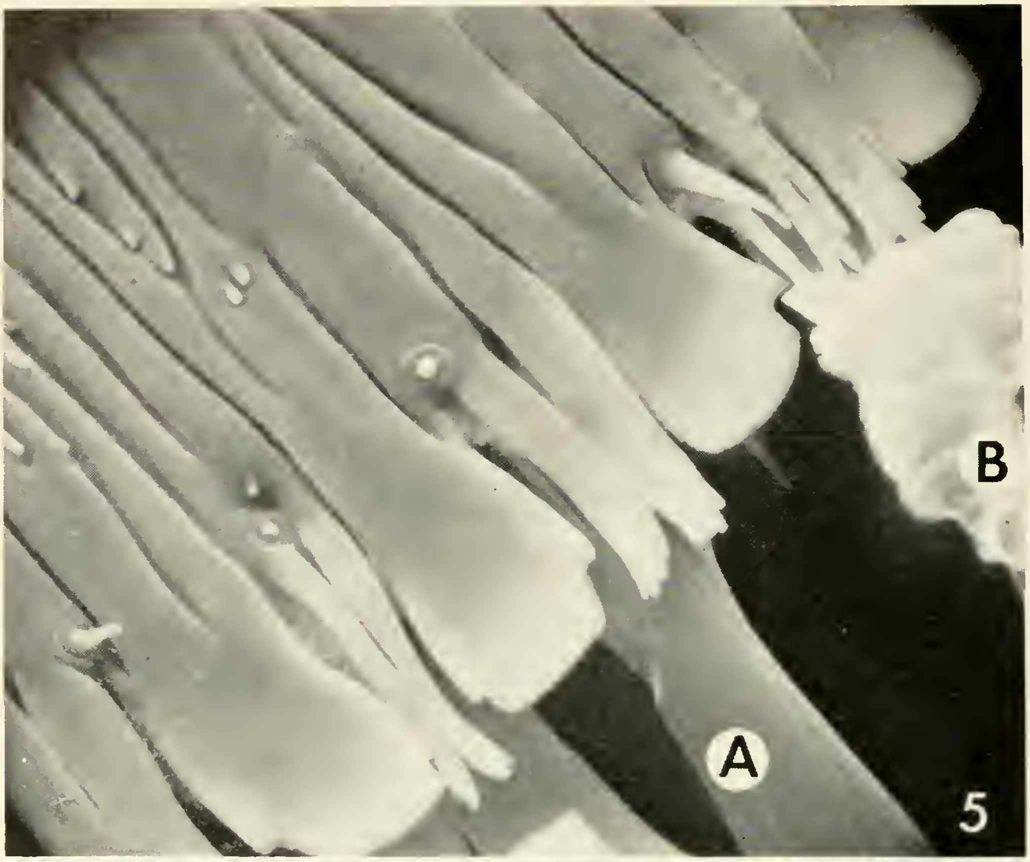
instar, no cap formed; B, cast skin of 1st instar; B′, secretory material produced by 2nd instar; C, cast skin of 2nd instar; C′, secretory material produced by 3rd instar; D, secretory material produced by 3rd instar as exit flap for crawlers; D′, slit in cast skin of 2nd instar and used as exit by crawlers; E, body of adult female.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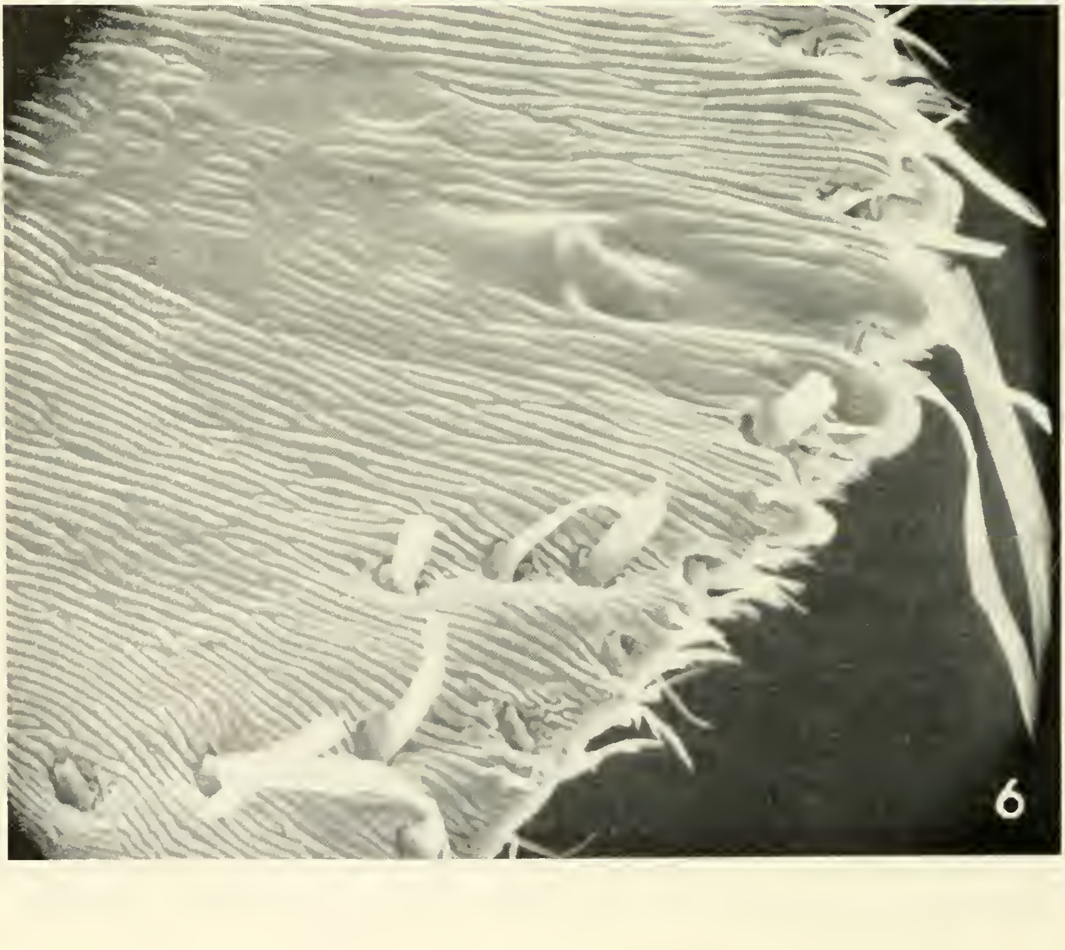
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becomes enclosed within a cover. When the cover reaches its ultimate size, the exit flap (fig. 1D) is added (Stoetzel and Davidson, 1973).

When developing on the stems and branches of *Liquidambar styraciflua* L., the females of *Diaspidiotus liquidambaris* develop covers as described above. However, when developing on the leaves, the females form their covers differently. The 1st- and 2nd-instar covers are formed as described above but disappear after the 2nd ecdysis. The cover (fig. 2) which remains over the adult female (fig. 2E) consists of the dorsum (fig. 2C) of the cast skin of the 2nd instar and a slight fringe of secretory material (fig. 2C′) produced by the adult female. The dorsum of the adult female does not enlarge, but the venter expands deeply into a gall formed on the leaf. The dorsolateral margins become sclerotized and closely attached to the cast skin of the 2nd instar. No exit flap is formed, but the crawlers are able to escape at any point along the periphery of the adult-female cover.

Notes: Takagi and Tippins (1972) illustrated and discussed the relationship between the adult female's body shape and cover-forming movements. They reported that circular covers are usually associated with scale insects with circular bodies, while elongate covers are usually associated with scale insects with elongate bodies. They discussed several deviations from the normal pattern. It may be added that through *Aspidiotus cryptomeriae* is an aspidiotine with a circular body, its cover is elongate oval.

In several immatures of *Melanaspis obscura* found on leaves of *Quercus marilandica* Muenchhausen, the crawlers formed a cover not unlike that formed by crawlers developing on twigs and branches. However, the covers of most of the 2nd instars were composed of white, waxy, loose threads that gave the cover a cottony appearance. As *M. obscura* has but one generation each year, these 2nd instars were not able to complete their development and died with leaf fall.

Male

fig. 7

The cover of the aspidiotine male is usually similar in texture to that of the female but is contributed to by only the first 2 of the 5 male instars.

First-instar (Crawler) Covers: The 1st-instar male forms a cap (fig. 7A) and adds secretory material (fig. 7A') in the same manner as the 1st-instar female.

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Fig. 5. Scanning electron micrograph (2800×) of the venter of the pygidium of a 2nd-instar female of *Aspidiotus cryptomeriae*. A, thin ribbon of wax; B, mass of wax. Fig. 6. Scanning electron micrograph (840×) of the dorsum of the pygidium of a 2nd-instar male of *Abgrallaspis ithacae*.

Second-instar Cover: After ecdysis the 2nd instar inserts its mouthparts into the plant, feeds, and enlarges. The dorsum and venter of the cast skin of the 1st instar separate along the body margin, the dorsum (fig. 7B) is pushed up against the 1st-instar cover, and the venter remains under the body of the 2nd instar. The 2nd instar continually adds secretory material (fig. 7B′) to the edge of the dorsum of the cast skin of the 1st instar, and the dorsum of the cast skin becomes an integral part of the 2nd-instar cover. Fig. 6 is a scanning electron micrograph (840×) of the dorsum of the pygidium of a 2nd-instar male of *Abgrallaspis ithacae.* Ribbons of waxy materials are extruded from dorsal pygidial macroducts. At first the cover is circular; but as the body of the 2nd instar becomes more elongate, the cover is elongated and the 1st-instar cover and cast skin become submarginal. When the cover reaches its ultimate size, a loose escape flap (fig. 7D) is added at the posterior end. The male cover is complete at this point; but male development continues through the prepupal, pupal and adult stages. The exuviae of 2nd-instar, prepupal, and pupal males are sloughed off and are usually pushed out the escape flap but may remain under the cover. Males of *Diaspidiotus liquidambaris* develop covers in this manner whether on stems, branches, or leaves. When escaping from its cover, a winged adult male folds its fully expanded wings over its head as it backs out of its cover. A wingless adult male simply backs out.

Tribe Diaspidini

Female

fig. 3, 4

The cover of the diaspidine female is usually formed by all 3 of the female instars. However, in some species (e.g. *Leucaspis* spp., *Fiorinia* spp., and *Xerophilaspis* spp.) the cover is contributed to by only the first 2 female instars. In the latter case, the body of the adult female remains entirely enclosed within the cast skin of the 2nd instar, and such species are characterized as being "pupillarial" (Ferris, 1942).

First-instar (Crawler) Cover: The diaspidine 1st instar settles, feeds, and forms a cover. In some species, e.g. *Carulaspis juniperi* and *Pseudaulacaspis pentagona*, a few strands of waxy filaments may be secreted over the body, but no definite cover is formed. In other species, e.g. *Chionaspis americana* and *Lepidosaphes yanagicola*, a thin, transparent or opaque cover (fig. 3A″, 4A″) is formed but may be broken away and often is missing from the covers of later instars. During ecdysis the dorsum of the 1st instar hardens and turns a distinctive color (e.g. yellowish in *Carulaspis juniperi*, *Chionaspis americana*, *Fiorinia externa*, *Pseudaudacaspis pentagona* and *Unaspis euonymi* or reddish brown in *Lepidosaphes yanagicola*). The venter remains clear and membranous.

Second-instar Cover: After ecdysis the 2nd instar inserts its mouthparts into the plant, feeds, and enlarges. The dorsum and venter of the cast skin of the 1st instar separate along the body margin, the dorsum (fig. 3B, 4B) is pushed up against the 1st-instar cover, and the venter remains under the body of the 2nd instar. The 2nd instar continually adds secretory material (fig. 3B′, 4B′) to the posterior edge of the dorsum of the cast skin of the 1st instar. The

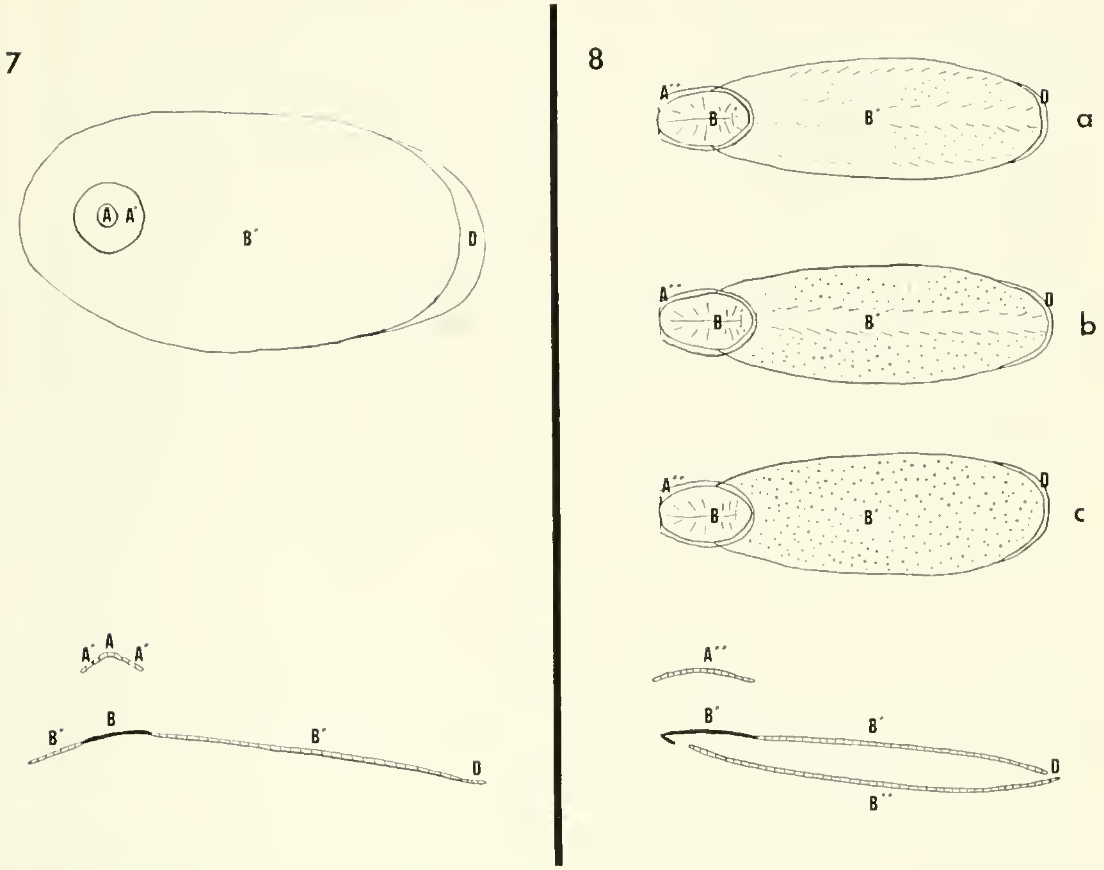

Fig. 7–8. Covers of adult males. 7, aspidiotine scale insect. 8, diaspidine scale insects, a, cover with 3 carinae, b, cover with 1 carina, c, cover without carinae. A, cap of secretory material produced by 1st instar; A′, secretory material produced by 1st instar and added to cap; A″, secretory material produced by 1st instar, no cap formed; B, cast skin of 1st instar; B′, secretory material produced by 2nd instar; B″, secretory material produced ventrally by 2nd instar, may or may not be present; D, secretory material produced by 2nd instar as exit flap for adult male.

dorsum of the cast skin is terminal and becomes an integral part of the usually elongate 2nd-instar cover. During ecdysis the dorsum of the 2nd instar hardens and turns the same color as the dorsum of the 1st instar. The venter remains clear and membranous.

Third-instar (Adult) Cover: After ecdysis the 3rd-instar or adult female inserts its mouthparts into the plant and feeds. Usually during this time the adult males are active and mating occurs. In the case of "typical" diaspidines, the dorsum and venter of the cast skin of the 2nd instar separate along the body margin, the dorsum (fig. 3C) is pushed up against the 2nd-instar cover, and the venter remains under the body of the adult female. The adult female adds secretory material (fig. 3C′) to the edge of the dorsum of the cast skin of the 2nd instar, and the dorsum becomes an integral part of the usually elongate adult-female cover. When the cover reaches its ultimate size, the exit flap (fig. 3D) is added. In the case of "pupillarial" diaspidines, e.g. *Fiorinia externa*, the body of the adult female (fig. 4E) is entirely enclosed within the cast skin (fig. 4C) of the 2nd instar. No distinct crawler flap is formed, but the crawlers are able to move out via a slit (fig. 4D′) in the posterior end of the cast skin of the 2nd instar and then out from under loose material at the posterior end of the 2nd-instar cover.

Notes: Bennett and Brown (1958) reported that unmated adult females of *Pseudaulacaspis pentagona* produce an aberrant cover in addition to their usual cover. The typical cover is dull white and circular or subcircular, whereas the aberrant cover is white, elongate and loose in texture. They reported that "Females which are mated while the new covering is incomplete will cease to produce it on the following day. Later they will add a small lip or shelf under which the eggs will be protected. If not mated by the twentieth day, the female stops work on the new covering, but continues to move so that she may soon be completely exposed." I have not observed this activity in populations of *P. pentagona* on *Prunus* sp.

Male

fig. 8

The cover of the diaspidine male may be similar in texture to that of the female, or it may be a felted or cottony "sac" which may have carinae (ridges). The diaspidine-male cover is contributed to by only the first 2 of the 5 male instars.

First-instar (Crawler) Cover: As in the diaspidine female, a 1st-instar cover (fig. 8A″) may or may not be formed; and if formed, it may be broken away.

Second-instar Cover: After ecdysis the 2nd instar inserts its mouthparts into the plant, feeds, and enlarges. The dorsum and venter of the cast skin of the 1st instar separate along the body margin, the dorsum (fig. 8B) is pushed up against the 1st-instar cover, and the venter is sloughed off except for a fringe at the anterior end. The 2nd instar continually adds secretory material (fig. 8B′) to the posterior edge of the dorsum of the cast skin of the 1st instar. The dorsum of the cast skin is terminal and becomes an integral part of the usually elongate 2nd-instar cover. A slit (fig. 8D) is formed at the posterior end and serves as an escape flap for the adult male. In some species, e.g. *Chionaspis americana*, *Pseudaulacaspis pentagona*, and *Unaspis euonymi*, the 2nd-instar male secretes material (fig. 8B″) ventrally so that the 2nd instar and all subsequent instars are enclosed within a sac which has a felted texture. These felted sacs may have 3, 1, or no ridges or carinae. Males of *Unaspis euonmyi* have felted sacs with 3 usually distinct carinae (fig. 8a). Males of *Chionaspis americana* and *Pseudaulacaspis pentagona* have felted sacs with 1 usually distinct carina (fig. 8b). Males of *Carulaspis juniperi* and *Fiorinia externa* have dull white, nonfelted covers (fig. 8c) that may lack or may have an indistinct median carina and that may have some ventral secretions. Winged and wingless adult diaspidine males escape from their covers as do aspidiotine males.

NOTES

Even though it adds to the protection of the developing instar, the 1st-instar cover or the covers of the 1st and 2nd instars can be lost without damage to the developing instars. When the 1st-instar cover is removed, the dorsum of the cast skin of the 1st instar is exposed. When the 1st- and 2nd-instar covers are removed, the dorsum of the cast skin of the 2nd instar is exposed.

CONCLUSIONS

1. The covers of all 1st instars consist of secretory material only.
2. The covers of all 2nd instars consist of the cast skin of the 1st instar plus secretory material. The cast skin is central or submarginal in aspidiotines and terminal in diaspidines.
3. Typically, covers of adult females are contributed to by all 3 female instars. Covers of adult aspidiotine females are usually circular with 1st- and 2nd-instar covers and cast skins central or subcentral, whereas covers of adult diaspidine females are usually elongate oval with the 1st- and 2nd-instar covers and cast skins terminal.
4. A few aspidiotine and diaspidine adult females are characterized as being "pupillarial" because the body of the adult female remains enclosed within the cast skin of the 2nd instar. In these species, the covers are contributed to by only the first 2 female instars.
5. Covers of adult males are contributed to by only the first 2 of the 5 male instars. Covers of adult aspidiotine males are usually similar in appearance and texture to the covers of the adult females; they are elongate oval, and the 1st-instar cover and cast skin are submarginal. Covers of adult diaspidine males may be similar in appearance and texture to the covers of the adult females, or they may be felted sacs which may have carinae or ridges. The 1st-instar cover, when present, and the cast skin of the 1st instar are terminal on the cover of an adult diaspidine male.

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LECTOTYPE DESIGNATIONS FOR THREE NEW WORLD LIRIS WITH TAXONOMIC NOTES (HYMENOPTERA: LARRIDAE)

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ABSTRACT—Lectotypes are designated for the following three species now placed in *Liris*: *Tachytes murina* Dahlbom, *Larra fuliginosa* Dahlbom and *Larrada dahlbomi* Cresson. *Tachytes murina* is a new synonym of *Liris argentata* (Beauvois); *Liris vinulenta* (Cresson) is a new synonym of *Liris fuliginosa*; and *Liris dahlbomi* is recognized as a subspecies of *L. luctuosa* (Smith). Taxonomic notes are included for the subspecific populations of *vinulenta* and *luctuosa*.

Preparation of a synopsis of the North and Central American *Liris* and of the sections on wasps for the revised edition of the Catalog of Hymenoptera of America north of Mexico required that I examine the types of two species described by Dahlbom whose identities have been uncertain. I am grateful to Dr. E. Königsmann, Zoologisches Museum, Berlin, for the loan of specimens of *Tachytes murina* Dahlbom, to Professor Carl Lindroth, Lund University, Sweden, for the loan of specimens of *Larra fuliginosa* Dahlbom, and Dr. W. Wayne Moss, Academy of Natural Sciences, Philadelphia, for the loan of specimens identified questionably by Cresson as *Larrada fuliginosa* (Dahlbom) to which he also applied the provisional name *dahlbomi*.

Liris murina (Dahlbom), new combination
Tachytes murina Dahlbom, 1843

Dahlbom (1843, p. 132) described *murina* from two females "ex America boreali" from Klug and Erichson material in the Berlin Museum. I have examined these two syntypes and find that both are females of the common, wide-ranging *Liris argentata* (Beauvois), NEW SYNONYMY. One specimen which I have labeled lectotype bears the following labels: a green square with "Nordamerica" in script; a white label with "3908" in script; a red label with "TYPE" in print; and a white label with "Tachytes murina Dahlb." in script. The other syntype bears the following labels: a green square with "Mexico/Deppe" in print; and a red label with "TYPE" in print.

Liris fuliginosa (Dahlbom), new combination
Larra fuliginosa Dahlbom, 1843

Dahlbom (1843, p. 138) described *fuliginosa* from a pair collected in Cuba in 1835 by Lefebvre. I have studied the pair standing under this name in Lund University.

The male, which has line priority over the female in the original description, is the only one which bears a type label, a small red label with "Typ." printed on it. Other labels on the specimen are as follows: a small white square with "♂" printed on it; an oblong white label upon which is printed "Larr. fuliginosa/Dlbm. Sp. ign."; and a larger white oblong label which has "distinguenda/Spin." in script on upper side, and "Torrida/hispan." in script on lower side. I have dissected the genitalia which are quite diagnostic in most species of *Liris*. This male is entirely unlike any of the eight species of Cuban *Liris* sent me by Dr. P. Alayo D. who has collected the wasp fauna of that island very thoroughly. Nor does the male agree with any of the North or Central American species known to me. It does agree with Dahlbom's brief description of three lines, which, however, could apply to a great many species.

The female bears the following three labels: a small white square with "♀" printed on it; a small oblong white label on which is printed "Lefebvre/Ins. Cuba"; and a larger oblong white label bearing "Larra fuliginosa" in script. It also agrees with Dahlbom's brief three line description of that sex, which also could apply to a great many species of *Liris*.

I have selected the female as the lectotype because it bears the correct locality label and because it is the only sex which can be positively identified at this time. The fact that the male is the only specimen which bears a red Typ. label is not germane; Professor Lindroth writes that some old type labels in the Lund collection were carelessly placed. *Larrada vinulenta* (Cresson, 1865, p. 138), of which I have studied the male lectotype (type no. 2001) in the Academy of Natural Sciences, Philadelphia, is identical with *fuliginosa*, NEW SYNONYMY.

The "Torrida/hispan." label on the male suggests that it may be one of the numerous South American species, but the possibility exists that it may be South African. Dahlbom (1846, p. 472), in his key to the three species of *Larra* described earlier, gives the distribution of *fuliginosa* as Cuba, Egypt and Port Natal. Dr. W. J. Pulawski, who has examined the male and who knows the Egyptian fauna well, advises me that it is not from that country.

Liris fuliginosa is a polytypic species. Typical *fuliginosa* is known from Puerto Rico as well as Cuba. *Liris fuliginosa muspa* (Pate), NEW STATUS, occurs in southern Florida. An undescribed subspecies ranges from southern Arizona and Texas to Costa Rica.

Liris dahlbomi (Cresson), new combination
Larrada dahlbomi Cresson, 1865

In his pioneer work on Cuban Hymenoptera Cresson (1865, pp. 137–138) described three specimens which he identified questionably as *Larrada fuliginosa* (Dahlbom). At the end of the description he remarked, "Not being altogether certain of the identity of the specimen before me with Dahlbom's *fuliginosa*, I add a description; should they prove to be distinct, the species above may be called *Larrada Dahlbomi*." Cresson's provisional name must be used for this taxon for it is, indeed, very different from true *fuliginosa*.

I have examined the three females in the collection of the Academy of Natural Sciences, Philadelphia, on which Cresson's description was based. They are conspecific. Each bears a small printed label, "Cuba", and a smaller printed label, "♀". One also bears Cresson's handwritten label "*Larrada fuliginosa* ?? Dalb." At some date subsequent to publication of Cresson's list of types (1916), printed red type and blue paratype labels, bearing no. 2008, were applied to the specimens, the type label to the one bearing Cresson's determination label. Cresson must have assigned this type number when he prepared his list, for the lectotype of the Cuban *Larrada vinulenta* (p. 96) was assigned no. 2001, and that of the Cuban *Tachytes insularis* (p. 95) no. 2011. However, *dahlbomi* was omitted from the printed list of types, so there has been no pervious valid lectotype designation. I have placed my lectotype label on the specimen bearing Cresson's handwritten label, "*Larrada fuliginosa* ?? Dalb."

Liris dahlbomi is a subspecies of *luctuosa* (Smith), NEW STATUS; it occurs only in Cuba and southern Florida. Typical *luctuosa* occurs on Santo Domingo (type-locality) and Dominica (misdet. as *fuliginosa* by Evans, 1972, p. 9); I have not examined the Puerto Rican population of "*fuliginosa*" (Wolcott, 1923, p. 44). A third subspecies, *luctuosa argentifrons* (Cameron), NEW STATUS, ranges from Morelos and Guerrero in southern Mexico south at least to Guatemala. I have not ascertained the subspecific status of a female *luctuosa* sens. lat. from Brazil.

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NOTES ON THE PHYLOGENY OF THE NEARCTIC TETHINIDAE AND A REVIEW OF THE GENUS NEOPELOMYIA HENDEL AND THE TETHINA MILICHIOIDES GROUP (DIPTERA)[1]

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ABSTRACT—The Nearctic genera of the family Tethinidae are keyed and their phylogenetic relationships diagrammed. The genus *Phycomyza* Melander is made a junior synonym of *Tethina* Haliday and its species treated as the *milichioides* species group. The *milichioides* group and *Neopelomyia* Hendel are reviewed with 3 new species described: *Tethina woodi*, *T. steyskali*, and *N. longicerca*. The male genitalia of each group is discussed and figured in detail and species keys for each group are presented.

The family Tethinidae in North America previously consisted of 22 described species in five genera. The present study increases the number of species to 25 while decreasing the number of valid genera to four.

Most Tethinidae can be found in relatively large numbers on ocean beaches and can be collected by sweeping beach grasses, rotting seaweed or algae, or directly on sand. Haliday (1838) and Sturtevant (1923) record *Tethina illota* Haliday, a European species, on flowers of *Cakile maritima* (sea-rocket, Cruciferae) and *Convulvulus soldanella* (bindweed, Convulvulaceae). Other species are found in salt marshes or inland alkaline lakes. A few of the more primitive species are not halophilic. *Pelomyia coronata* Loew, for example, has been recorded by Melander (1952) from "lush forests, meadowlands, and in the desert."

The immature stages of Tethinidae are completely unknown to date. Judging by the habitats, however, it is likely that the larvae of most species are saprophagous (Malloch, 1934), feeding on decaying algae and seaweed. For additional habitat and distributional data, as well as a taxonomic history of the family, see Melander (1952).

Most tethinids are easily recognized by their white or gray pollinose body, wide cheeks and often, whitish wings with dark veins. They are distinguished from other acalyptrate flies by the incomplete subcosta, costal break near end of R_1, convergent postverticals, outwardly directed or reclinate upper fronto-orbitals, distinct oral vibrissae, 1 or 2 presutural dorsocentral bristles and the lack of apical tibial bristles (Melander, 1952).

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[1] Scientific Article No. A2191, Contribution No. 5164 of the Maryland Agricultural Experiment Station.

The following key is based on Melander (1952) and Sabrosky (unpublished key).

1. Cheek bare except for peristomal row of bristles; face with small shiny tubercle above each vibrissa; humerus with several scattered bristles; male surstylus fused with epandrium, located ventrally ......Tethininae, *Tethina*......2
— Cheek with scattered hairs; face without tubercles; humerus with only 1 or 2 strong bristles; male surstylus located more dorsally and not fused with epandrium ....Pelomyiinae......3
2. Head relatively elongate (fig. 9, 10, 11); face short, ⅓ as long as front, deeply concave with strong median carina; antenna decumbent and turned laterally, exposing mesal surface; labellum as long as head; (wet sand zone species) .... *Tethina milichioides* group
— Head short; face usually longer, not deeply concave; antenna porrect; labellum not as long as head; (dry sand zone species) ....*Tethina* (s.s.)
3. Vibrissal angle projecting (fig. 17); eye oblique; orbitals 3 pairs ....*Neopelomyia*
— Vibrissal angle not projecting; eye rounded; orbitals 1 or 2 pairs 4
4. Orbitals 2 pairs; acrostichals absent; face and peristome without shining chitinous stripe ....*Pelomyiella*
— Orbitals 1 pair; few acrostichals present; face below with 2 narrow shining stripes, each continuous with shining peristomal ridge ....*Pelomyia*

PHYLOGENETIC ANALYSIS OF THE NORTH AMERICAN GENERA

The phylogenetic relationships of the North American tethinid genera and those within the genus *Tethina* Haliday are shown in Diagram 1. This phylogeny is tentative as much data are still to be obtained on certain character complexes, such as the male genitalia and the immature stages. Previous work on the family has relied mostly on the external adult characters.

The species examined in the analysis were: *Pelomyia coronata* Loew, *Pelomyiella mallochi* Sturtevant, *P. melanderi* Sturtevant, *Neopelomyia rostrata* (Hendel), *N. longicerca* Foster, *Tethina illota* Haliday, *T. parvula* Loew, *T. horripilans* (Melander), *T. albula* Loew, *T. steyskali* Foster, *T. woodi* Foster, *T. milichioides* (Melander), and *T. angustifrons* Melander.

The numbers appearing in Diagram 1 correspond to the following synapomorphic character states:

1—Those given in the groundplan of Tethinidae (see Griffiths, 1972).
2—Labellum long; shiny facial tubercle present; cheek with peristomal row of bristles only.
3—Dry sand zone inhabiting; epiphallus oblong.
4—Arms of hypandrium separated anteriorly.
5—Postgonites 2-branched posteriorly; no antennal concavities; head about as high as long; epistome not developed.
6—Tip of distiphallus long tapered; cercus recurved and pointed.

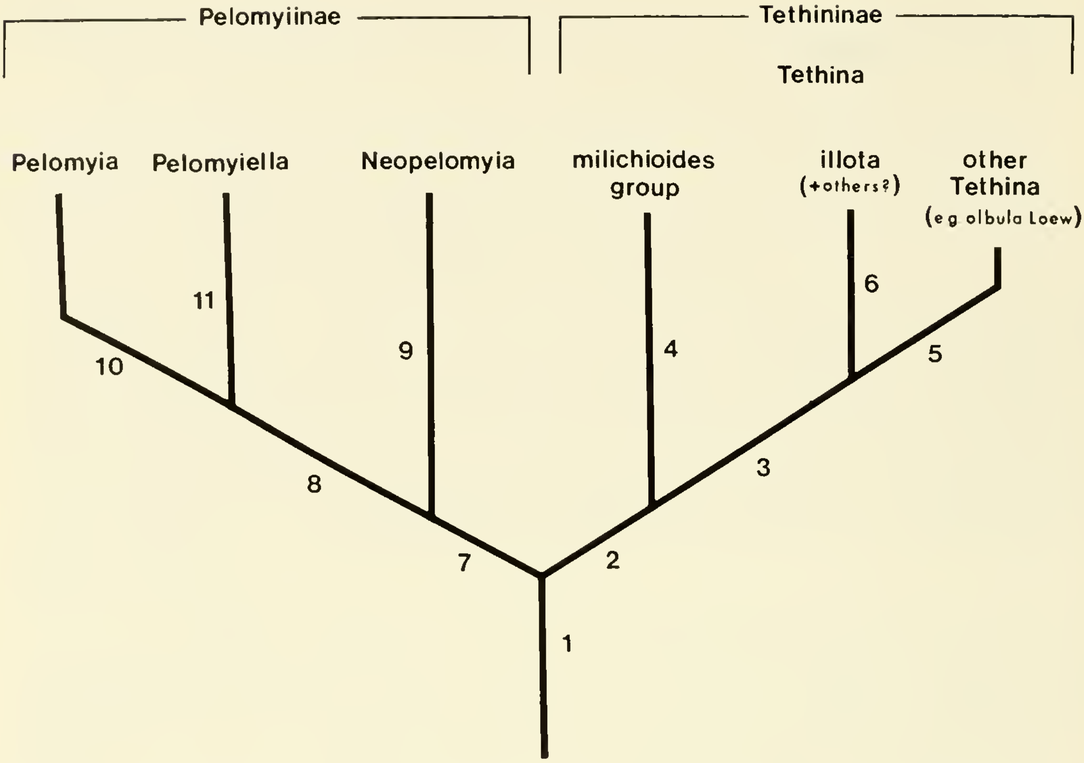


Diagram 1. Phylogenetic relationships of North American tethinid genera and of the species groups of *Tethina* Haliday. See text for explanation of numbers.

7—Surstylus separated from epandrium and located as much dorsally as cercus; 2nd basal cell fused with discal; interfrontals reduced or absent; hind tibia without apical spine.
8—1 or 2 pairs of orbitals; face narrow; acrostichals absent or reduced.
9—Vibrissal angle projecting; labellum elongate; strictly halophilic species.
10—Oral and facial margin with shining chitinous stripe; 1 pair of orbitals.
11—Tip of distiphallus long tapered.

Genus *Tethina* Haliday

Opomyza, subgenus *Tethina* Haliday 1838:188. Type-species, *illota* Haliday, original designation.

Phyconyza Melander 1952:198. Type-species, *Rhicnoessa milichioides* Melander, original designation. (NEW SYNONYM.)

Rhicnoessa Loew 1862:174. Type-species, *cinerea* Loew (by monotypy) = *grisea* (Fallén).

The basic groundplan of the genus *Tethina* includes the following character states: labellum as long as head (apomorphic); shining facial tubercle (apo-); cheek with peristomal row of bristles only (apo-); lobes of epiphallus separated (plesiomorphic); surstylus fused with epandrium and in a ventral position (plesio-); hind tibia with apical spine (plesio-); inner orbital row of bristles present and well developed (plesio-); orbitals greater than 6 in number (plesio-); interfrontals present and well developed (plesio-); 2nd basal cell separated from discal cell (plesio-).

The sister-group of *Tethina* is clearly the subfamily Pelomyiinae which includes three genera: *Pelomyia* Williston, *Pelomyiella* Hendel, and *Neopelomyia* Hendel (Diagram 1).

The genus *Phycomyza* was erected by Melander (1952) for *Rhicnoessa milichioides* Melander (1913). However, the characters which Melander considered to be of generic importance, namely the shortened face, protruding epistome, sunken antennae, elongated head, 5 pairs of short interfrontal bristles and elongated labellum are also present in *illota* Haliday, the type-species of *Tethina.* There are a few differences in the male genitalia between the two species but these I believe do not constitute sufficient grounds for the generic separation of *milichioides* from *illota.*

To make certain of the synonymy of *Phycomyza* and *Tethina* the male genitalia of several species were examined. These included: *Tethina milichioides* (Melander), *T. illota* Haliday, *T. albula* Loew, and an apparently undescribed species near *albula.* I arrived at the right ½ of the cladogram shown in Diagram 1 from the observation of several morphoclines in some of the postabdominal structures, 1.) the aedeagal apodeme ranges from a strong posterior curvature with a pointed posterior tip in *milichioides* through slightly curved and blunt tipped in *illota* to straight and blunt in *albula,* 2.) the postgonites range from relatively thick structures, approximately 40° angle ventrally to the aedeagal apodeme in *milichioides* through a smaller angle to the aedeagal apodeme but still thick in *illota* to almost parallel with the aedeagal apodeme, thinner, and 2-branched in *albula,* 3.) the shape of the hypandrium in lateral view ranges from thick and stout, with the lateral lobes well developed in *milichioides* through thinner and longer, with no lateral lobes in *illota* to even thinner in *albula* and also without lobes, 4.) the hypandrial arms go from separate anteriorly in *milichioides* to fused in both *illota* and *albula,* 5.) the epiphallus ranges from wide and saclike with granular surfaced anterolateral lobes in *milichioides* through more derived, oblong, tapering to a point posteriorly (similar to *Neopelomyia*) in *illota* to much less obvious in *albula* and oblong-tapered.

The above morphoclines indicate to me, as shown in the cladogram, that the species of the *milichioides* group are merely plesiomorphic species of *Tethina.*

Tethina milichioides group

Phycomyza Melander 1952:198. Type-species, *Rhicnoessa milichioides* Melander 1913:299 (original designation).

Body pollinose; all bristles black. Head: Generally prognathous; antenna decumbent, turned laterally, exposing mesal surface, about ⅔ as long as face; arista dark at basal and distal ¼, middle section lighter in color, slightly longer than width of 3rd antennal segment, pubescent; 3rd segment round; 2nd segment with several short, black bristles and 1 longer; 1st segment short, with 1 short bristle dorsally; face short, .4–.5 eye height, concave with median carina; epistome gray, sharply contrasting with yellow face, with conspicuous knob in center projecting farther anteriorly than antenna; vibrissa as long as antenna with small shining tubercle above; frons anteriorly yellow to orange or gray with margins convergent; frontal orbit, ocellar triangle, and occiput light gray, pollinose; cruciate interfrontals 4 pairs; orbit with 2 rows of bristles: inner row of 4–6 (usually 5) inclinate bristles, all shorter than outers, outer row of 5 reclinate-divergent bristles; ocellars strong, proclinate-divergent; ocellar triangle with several short bristles in addition to ocellars; postverticals short, less than ½ length of inner verticals, convergent; inner verticals strong, convergent; outer verticals strong, divergent; cheek .4–.5 eye height, anterior ⅔ yellowish or whitish, posterior ⅓ concolorous with occiput; peristome with row of 5 dorsally curved bristles, posterior-most bristle directed anteroventrally; eye oval, oblique, with anterior facets larger than others; proboscis long, slender, geniculate, labellum as long as middle section of mouthparts and lighter in color; palpus yellowish to whitish.

Thorax: Entirely gray pollinose. Bristles: dc 4, presutural 1, postsutural 3; acrostichal short, in 4 irregular rows; humeral 1 strong and several shorter; presutural 1; notopleural 2; supraalar 1; postalar 2; scutellum with 4 marginals–2 apical, 2 lateral; propleural 2, located just above fore coxa; mesopleural 1 row of several strong bristles along posterior margin, several shorter bristles scattered over surface; pteropleural none; sternopleural 1 or 2 strong, several scattered shorter ones. Halter whitish to yellowish. Legs: Bristly, entirely pollinose except hind femur polished on posterior surface; fore tibia posteriorly with many short, white hairs on distal ½ in addition to black bristles; fore and hind basitarsi posteriorly with mat of short white hairs; all basitarsi yellow; 2nd segment varying from yellow to brown, last 3 segments darker; Wing: Veins yellowish; membrane white to hyaline; costa with short black setulae and broken just before end of R_1; anal vein absent.

Abdomen: Gray pollinose, terga with posterior edges white; male genitalia with surstylus spatulate to backwardly curved; lateral process of hypandrium projecting or rounded (see further discussion below).

Ecology and Distribution: Wet sand zone of ocean beaches of western coasts of North America.

Characters of Phylogenetic Importance: The autapomorphic character state of the *milichioides* group is the anterior separation of the arms of the hypandrium.

CHARACTERS OF THE MALE POSTABDOMEN OF THE *milichioides* GROUP

Epandrium: The epandrium of the *milichioides* group is a simple inverted U-shaped structure with several strong bristles on its exterior surface both dorsally and laterally (fig. 1 Epa). The cerci are simple, pubescent lobes with several strong hairs on their surface in addition to the pubescence (fig. 1 Ce). The surstyli, as in all *Tethina*, occupy a ventral position on the epandrium and are fused with it (fig. 1 Sur). In lateral view they are simple spatulate lobes and in posterior view are boot shaped and turned mesally with the heel directed

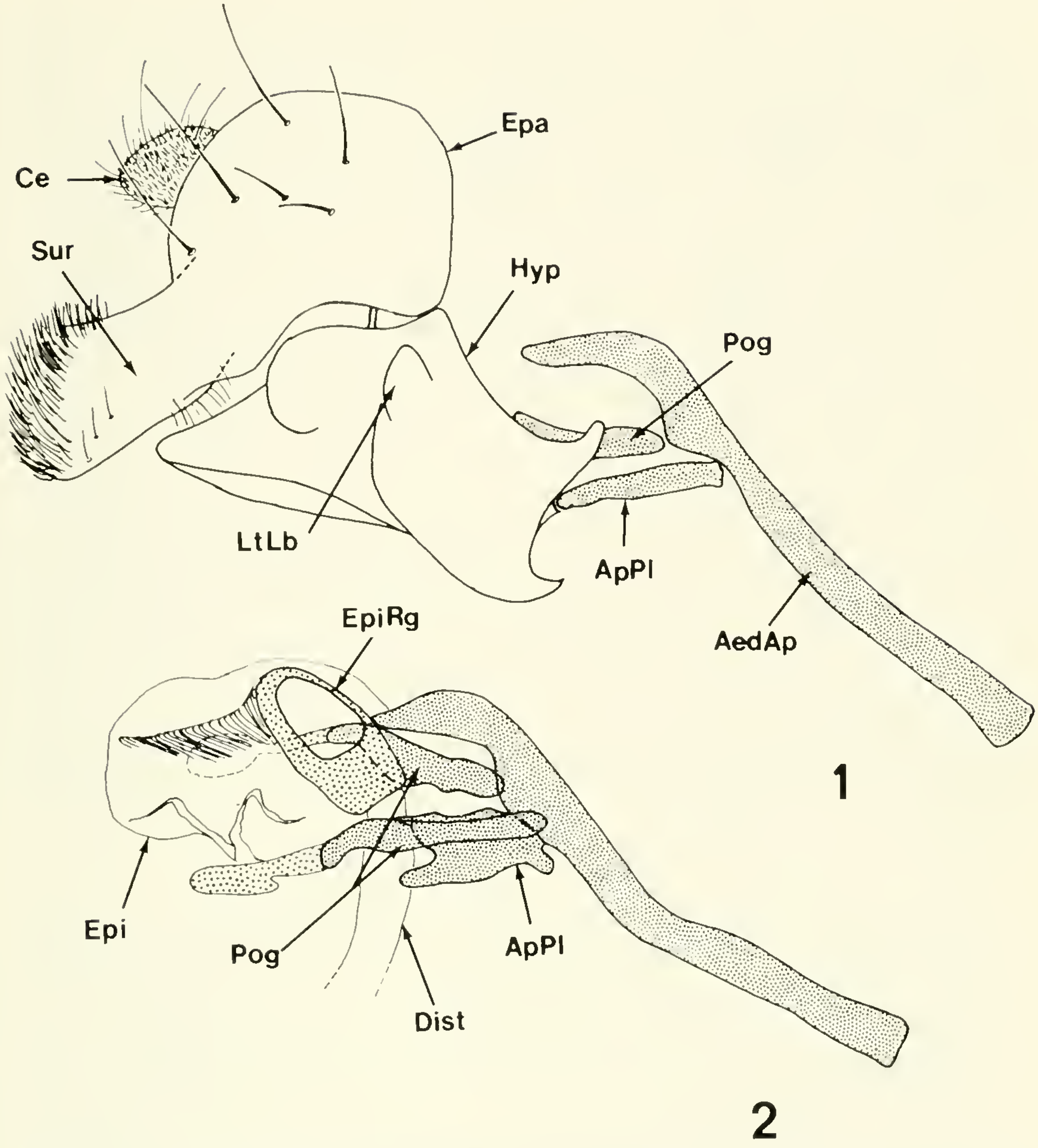


Fig. 1–2. Male genitalia of *Tethina milichioides*. 1, lateral view of entire structure. 2, dorsal oblique view of inner copulatory apparatus.

dorsally. They have many black hairs on the posterior edge, and on the mesal and lateral surfaces. The surstyli, while being fused with the epandrium, are also continuous mesally with the interparameral sclerite (Griffiths' term, 1972) which is located at about the same position dorsally as the cerci. The interparameral sclerite is an H-shaped sclerotized structure within the epandrium which articulates with the hypandrium.

Hypandrium (fig. 1, 6–8): The hypandrium consists basically of 2 arms fused at the posterior ends, a situation which is opposite of that in *Neopelomyia* Hendel, as discussed below. Between the 2 arms is an open space through which the distiphallus issues forth and is allowed to swing through a wide arc. Each arm has a lateral lobe which is variously developed in the 3 species of the *milichioides* group. These lobes originate at about the middle of the lateral wall of each arm.

Inner Copulatory Apparatus and Distiphallus (fig. 2): The inner copulatory apparatus is a complex structure composed of a long, rodlike, highly sclerotized aedeagal apodeme which is posteroventrally curved; a broad saclike epiphallus, the dorsal surface of which contains a partially sclerotized ring (which I am designating the *epiphallic ring*); a pair of postgonites located to each side of the aedeagal apodeme; and finally a broad, sclerotized plate anterior to the epiphallus.

The epiphallus is primarily a saclike membrane with 2 granular surfaced lobes on the anterolateral portions where the postgonites meet the epiphallus (the granular surface is not shown in the figure). In a ventral view of the hypandrium in an undissected specimen these granular lobes appear as 2 pubescent spheres connected to the posterior ends of the postgonites, but removal of the inner copulatory apparatus (effected by a gentle tug on the aedeagal apodeme) reveals the true situation.

The 2 postgonites articulate with the aedeagal apodeme and fuse with the epiphallus. At the point of fusion with the epiphallus they continue posteriorly as partially sclerotized spatulate structures. The sclerotized plate, which I will call the apodeme plate, is fused with the aedeagal apodeme at a point dorsal to the anterior edge of the hypandrium. The apodeme plate articulates with the anterior edges of each arm of the hypandrium. The aedeagal apodeme itself lies free in the abdominal cavity.

The distiphallus consists of a long, slender, flexible tube with long, dense hairs on the dorsal surface. The hairs extend about ⅔ of the length of the distiphallus which originates at the epiphallic ring.

Key to the Species of the Milichioides Group

1. Head prognathous in appearance as in fig. 9, 10; cheek white to yellowish; male genitalia: hypandrium in ventral view as in fig. 6, 7; lateral lobe of hypandrium not large and protruding 2

— Head not prognathous (fig. 11); cheek yellow to brownish; male genitalia: hypandrium in ventral view as in fig. 8; lateral lobe of hypandrium very conspicuous and protruding posteriorly; surstylus in lateral view somewhat curved posteriorly (fig. 5) ....*T. milichioides* (Melander)

2. Cheek yellowish to brownish; larger species–2.5 mm; male genitalia: hypandrium in ventral view as in fig. 6; surstylus in lateral view not curved posteriorly, spatulate (fig. 3) ....*T. woodi* new species

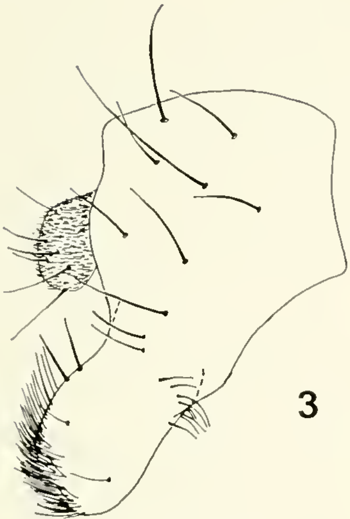
— Cheek distinctly white; smaller species–1.8 mm; male genitalia: hypandrium in ventral view as in fig. 7; surstylus in lateral view somewhat curved posteriorly (fig. 4) ....*T. steyskali* new species

Tethina woodi Foster, new species

fig. 3, 6, 9

Male: Length: Body 2.5 mm (2.4 mm–3 mm); wing: 2 mm.

As in *milichioides* group description except: Head: 1.12 longer than high; 3rd antennal segment black to gray except basal ⅓ dark orange; 2nd segment mostly orange, gray in area of bristles; 1st segment orange; face .52 times eye height; frons orange anteriorly, becoming brown to gray posteriorly; ocellars broken off



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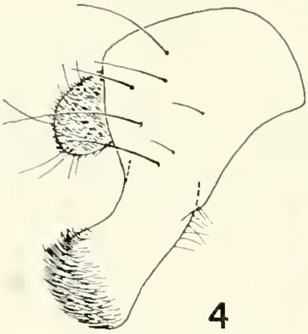

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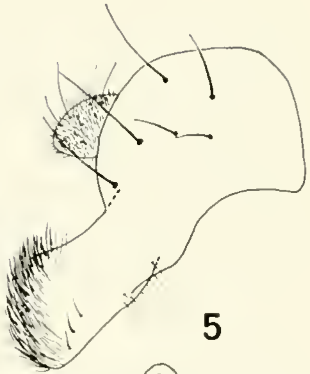

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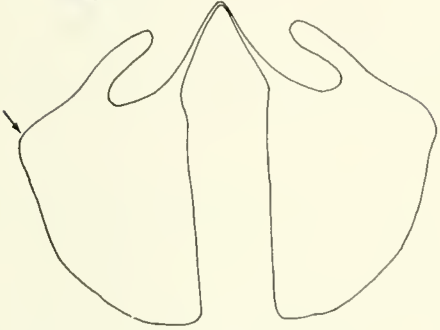

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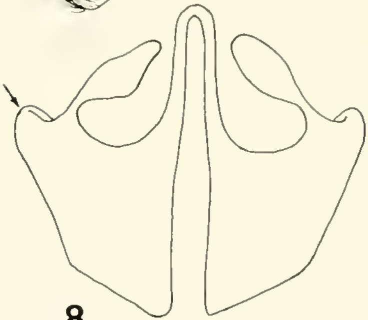

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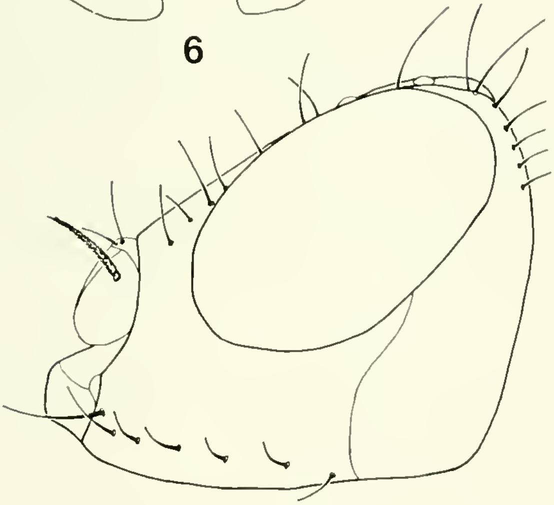

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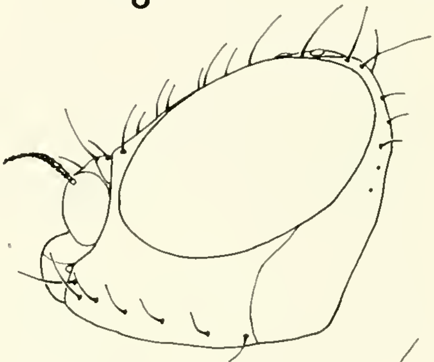

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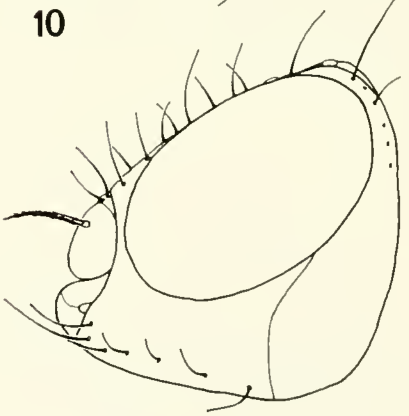

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Fig. 3–5. Epandria and surstyli, lateral view. 3, *Tethina woodi.* 4, *T. steyskali.* 5, *T. milichioides.* Fig. 6–8. Hypandria, ventral view (arrows indicate lateral lobe). 6, *T. woodi.* 7, *T. steyskali.* 8, *T. milichioides.* Fig. 9–11. Heads, lateral view. 9, *T. woodi.* 10, *T. steyskali.* 11, *T. milichioides.*

in holotype; cheek .52 times eye height, yellowish on anterior ⅔; holotype with 1 extra peristomal bristle between and slightly above 3rd and 4th bristles on left side; palpus yellow.

Thorax: Halter whitish. Legs: Mid-tarsus yellow through 2nd segment. Wing: Membrane white.

Abdomen: Male genitalia: Surstylus spatulate, not curved posteriorly; hypandrium with lateral lobes rounded, not projecting.

Female: Length: 2.4 mm–3 mm. Similar to male, except for postabdominal characteristics.

Holotype: ♂, Ilwaco, Washington, 12 July 1922, A.L. Melander, coll. No. 73640, USNM.

Paratypes: 19♂ 10♀, as follows: California: San Francisco, 22 June 1947, A.L. Melander, 5♂ 7♀; Seal Beach, 26 July 1942, A.L. Melander, 1♂ 1♀; Sharp Park, 22 June 1947, A.L. Melander, 2♂; Ventura, Rincon Beach, 28 August 1945, A.L. Melander, 1♂. Washington: Ilwaco, 12 July 1922, A.L. Melander, 7♂ 2♀; Ilwaco Beach, 17 July, year ?, A.L. Melander, 1♂; Ilwaco Beach, July 1917, A.L. Melander, 1♂; Seaview, 1 Sept. 1920, Miner, 1♂. Paratypes in USNM and CNC.

Variation: Some variation exists in the degree of prognathism and in the middle legs, in which the yellow color may extend to the 3rd tarsal segment but is usually limited to the 1st and 2nd segments.

Remarks: The larger size and greater prognathism of this species make it easy to separate from *milichioides* and *steyskali*. For positive identification, the male genitalia should be examined as little or no variation was found in these structures.

This species is named for Dr. F. Eugene Wood of the Department of Entomology, University of Maryland, in gratitude for his help in the past and present without which this study would not have been possible.

Tethina steyskali Foster, new species

fig. 4, 7, 10

Male: Length: Body 1.8 mm (1.4–2.2 mm); wing 1.5 mm.

As in *milichioides* group description except:

Head: 1.04 longer than high; antenna dark with gray pollin; 2nd segment with 3 bristles as long as segment; face .49 times eye height; frons gray with brownish tinge centrally; cheek .40 times eye height, anterior ⅔ white, pollinose; palpus light.

Thorax: Halter yellowish. Legs: Middle and hind tarsi yellow through 2nd segment. Wing: Membrane hyaline.

Abdomen: Male genitalia: Surstylus slightly curved posteriorly; hypandrium with lateral lobes rounded in ventral view, not strongly projecting.

Female: Similar to ♂ except for postabdominal characteristics.

Holotype: ♂, Pismo Beach, California, 29 August 1945, A.L. Melander, coll. No. 73639, USNM.

Paratypes: 33♂, 26♀, as follows: California: San Simeon, 31 Aug. 1945, Melander, 1♂ 2♀; Pismo Beach, 29 Aug. 1945, 2♂ 3♀, 26 July 1940, Melander, 1♂; Huntington Beach, 4 June 1945, Melander, 3♂; Morro Bay, 16 June 1947, Melander, 1♂, 26 Sept. 1946, Melander, 1♂, 7 Oct. 1946, Melander, 2♀; Morro Dunes, 17 June 1947, Melander, 5♂ 4♀; Seal Beach, 26 July 1942, Melander, 1♂ 1♀; Corona del Mar, 25 July 1942, Melander, 1♂; Carlesbad, 24 June 1954, Melander, 1♂ 1♀, 22 June 1950, Melander, 1♂; San Clemente, 23 May 1944, Melander, 1♂ 1♀, 5 June 1945, Melander, 1♂; Carpinteria, 28 Aug. 1945, Melander, 3♂ 2♀, 15 June 1947, Melander, ?; Asilomar, 2–3 Oct. 1946, Melander, 2♂ 1♀, 1–3 Sept. 1945, Melander, 1♂ 2♀, 1 Oct. 1946, Melander, 2♀, 28 Sept. 1946, Melander, 2♀; Pacific Grove, 28 July 1940, Melander, 1♂ 2♀; San Diego, 3 Aug. 1932, J.M. Aldrich, 3♂, 28 June 1917, Aldrich, 1♀. Mexico: Baja California, Ensenada, 24 June 1950, Melander, 3♂. Paratypes in USNM and CNC.

Variation: As in *woodi*, some variation exists in the extent of prognathism. Most specimens, however, are distinctly more prognathous than specimens of *milichioides*. In the middle legs, as is the case in *woodi*, the yellow color may extend to the 3rd tarsal segment. In the hind legs, some specimens have the 2nd segment also light, the last three being darker.

Remarks: This species can be separated from *milichioides* by its whiter cheek and greater prognathism, and from *woodi* by its smaller size. The male genitalia, however, must be examined before positive identification can be made.

Separation of the females of *steyskali* and *milichioides* is very uncertain. There seems to be no reliable genitalic characters and the variability of the head characters is always present. Female *woodi* are usually much larger than the other two species but overall size too can be variable.

This species is named for Mr. George C. Steyskal, Systematic Entomology Laboratory, USDA, in gratitude for his invaluable suggestions and commentary and his constant source of inspiration for me.

Tethina milichioides (Melander)

fig. 1, 2, 5, 8, 11

milichioides (Melander) 1913:299 (*Rhicnoessa*), type-locality, Washington. Lectotype, male, USNM. Subsequent references: Melander, 1952:198–199 (erects new genus *Phycomyza* for *milichioides*, distribution notes, descriptive notes). Hendel, 1934:48 (in key) (*Rhicnoessa*), 48 (citation). Sturtevant, 1923:6 (*Tethina*) (citation).

Male: Length: head + thorax: .96 mm (overall size range: 1.8 mm–2.4 mm); wing: 1.62 mm.

As in *milichioides* group description except:

Head: .86 as long as high; face .40 times eye height; frons yellow anteriorly, becoming slightly darker posteriorly; cheek .40 times eye height.

Thorax: Legs: Mid-tarsus with 1st and 2nd segments yellow, last 3 segments dark; hind tarsus with 1st segment yellow, others darker.

Abdomen: Male genitalia: Surstylus distinctly curved posteriorly; hypandrium with lateral process strong, pointed, projecting posteriorly.

Female: Similar to ♂ except for postabdominal characteristics.

Types: 3 syntypes: Alki Point, Seattle, Washington, August 1908, A.L. Melander, coll. I am designating a male of this series as lectotype. Deposited in USNM.

Material examined: (All collected by A.L. Melander unless otherwise indicated) 154♂, 165♀ as follows: California: Seal Beach: 17 May 1942, 2♀; 26 July 1942, 1♂ 6♀; Carpinteria: 15 June 1947, 1♂ 1♀; 12 June 1953, 3♂; 15 Oct. 1953, 3♂ 1♀; 24 Feb. 1950, 1♂ 1♀; 30 Nov. 1953, 1♀; 8–9 Oct. 1946, 3♂ 1♀; 3 Aug. 1954, 1♀; 28 Aug. 1945, 1♀; 11 Aug. 1950, 2♂; Pacific Grove: 28 July 1940, 3♂ 1♀; 4 July 1921, Sturtevant, 1♂ 2♀; 3 Sept. 1920, Sturtevant, 1♂; Palos Verdes: 15 Oct. 1944, 4♂ 1♀; 15 July 1945, 1♂; Morro Dunes: 6 Sept. 1945, 1♂ 1♀; Rincon: 6 June 1945, 1♂; Rincon Beach: 28 Aug. 1945, 1♀; 23 Feb. 1950, Sturtevant, 2♂; 17 June 1953, Sturtevant, 4♂ 1♀; no date, Sturtevant, 1♂; Carlesbad: 27 Mar. 1946, 1♀; San Clemente: 5 Feb. 1947, 1♀; 13 Oct. 1951, 2♂ 6♀; 5 Oct. 1950, 3♂ 3♀; 21 June 1950, 1♀; 5 June 1945, 9♂ 10♀; 23 May 1944, 9♂ 17♀; 26 Mar. 1946, 3♂ 2♀; 18 Oct. 1944, 10♂ 6♀; 15 Aug. 1949, 1♀; Corona del Mar: 29 June 1942, 3♀; 27 Aug. 1943, 1♂ 3♀; 11 June 1944, 3♂ 1♀; 4 Mar. 1950, Sturtevant, 1♀; 25 Mar. 1946, 3♂ 1♀; 25 July 1942, 4♂ 7♀; 28 Dec. 1944, 3♂ 1♀; 22 May 1944, 10♂ 4♀; 12 June 1948, 1♂ 2♀; 5 June 1945, 1♂ 4♀; 13 Aug. 1949, 3♂; Morro Bay: 9 Aug. 1950, 2♀; 16 June 1947, 2♀; 17-mile Drive: 1 Aug. 1954, 3♂; San Simeon: 31 Aug. 1945, 3♂ 1♀; Balboa: 13 July 1940, 7♂ 8♀; Laguna Beach: 18 July 1943, 3♂ 1♀; 22–23 May 1944, 2♂ 1♀; 5 June 1945, 3♂; 16 July 1945, 3♂ 2♀; 25 Mar. 1946, 1♀; 15 Aug. 1949, 1♂ 3♀; 3 May 1947, 1♀; 11 June 1944, 1♀; 25 Mar. 1953, Sturtevant, 1♂ 2♀; 22 May 1944, 1♀; 18 Aug. 1943, 1♂ 1♀; 15 May 1946, 1♂; Huntington Beach: 4 June 1945, 3♂ 3♀; Pismo Beach: 29 Aug. 1945, 1♂ 1♀; Pismo: 26 July 1940, 4♂ 2♀; Asilomar: 28 Sept. 1946, 1♂ 2♀; 1 Sept. 1945, 2♂ 2♀; 3 Sept. 1945, 1♂; 4 Aug. 1950, 1♀; San Diego: 3 Aug. 1932, J.M. Aldrich, 1♂ 13♀; 28 June 1917, Aldrich, 1♂; Long Beach: 4 Aug. 1911, 5♀; Pescadero: 16 Aug. 1951, 1♀; S. of Pescadero: 16 Aug. 1951, 1♂ 1♀; (Meadeno): 17 Aug. 1951, 1♀; Dana Pt.: 25 Mar. 1953, Sturtevant, 1♀; La Jolla: 28 Mar. 1946, 1♀. Washington: Orcas Isl., North Beach: 19 Aug. 1925, 5♂. Oregon: Waldport: 13 Sept. 1934, 3♂ 4♀; 3 mi. SE Pistol R.: 28 June 1972, Steyskal, 2♂; Neskowin: 31 Aug. year ?, 1♂ 1♀.

Variation: As in *woodi*.

Remarks: See under *steyskali*.

Genus *Neopelomyia* Hendel

Neopelomyia Hendel 1917:46, type-species, *Tethina rostrata* (Hendel) (original designation). Subsequent references: Melander, 1952:192 (in generic key). Hendel, 1934:38 (in key).

General appearance: small, gray-brown, entirely pollinose flies.

Head: Vibrissal angle projecting; arista dark, slightly longer than antenna, short pubescent; 3rd segment rounded, short pubescent; 2nd segment less than ½ length of 3rd; 1st segment shorter than 2nd, both segments with short dorsoapical bristle and short pubescence; face concave with weak median carina; epistomal knob indistinct; frons brown, slightly sunken, pollinose, sides convergent so that at vertex about twice width at base of antenna, center with indistinct pair of convergent hairs; ocellar triangle and occiput gray pollinose; orbits with outer row of 3 strong bristles, posterior longest, middle slightly shorter, anterior about ½ as long as middle bristle, inner orbital row composed of 4–5 short, indistinct hairs; ocellars strong, divergent-proclinate, with pair of short hairs between; inner verticals strong, convergent; outer verticals strong, divergent; postverticals short, convergent; cheek ⅓ eye height, pollinose, light brown on anterior ⅔, posterior ⅓ concolorous with occiput, with many scattered short, black hairs; oral vibrissa distinct; eye oval, oblique, anterior facets larger than others; palpus yellowish, remaining mouthparts dark brown.

Thorax: Gray pollinose. Bristles: Dorsocentrals 4 pairs, presutural 1, postsutural 3 pairs; acrostichals 2 rows, short; humeral 1 with several additional hairs; presutural 1; supraalar 1; postalar 2; intraalar field with 2 or 3 irregular rows of inconspicuous hairs; scutellar 2 pairs, posterior stronger than laterals; propleural 2, short, above anterior coxa; notopleural 2; mesopleural 1, with several finer hairs on posterior ⅓ of pleuron; sternopleural 1, strong, near posterodorsal corner, and several shorter hairs; pteropleural bristles absent; all other pleural surfaces bare. Halter light. Legs: Gray pollinose, except hind femur polished posteriorly, hairy, tarsi dark. Wing: Hyaline, faintly smoky; costa broken at end of subcosta.

Abdomen: Gray pollinose; terga with scattered hairs. Male genitalia: Epandrium an inverted U-shaped capsule with ventral process on each side; surstylus not fused with epandrium, base located near base of cercus, mesal surface bristly; ventral process with few stout bristles mesally; hypandrium 2-armed with distiphallus issuing from between; inner copulatory apparatus as in fig. 12, 13 and in discussion; distiphallus simple, long, pointed, dorsal surface hairy. (See further discussion of male genitalia below).

Discussion: *Neopelomyia* Hendel can be distinguished from other tethinids by the protruding vibrissal angle and the bristly cheek. The following characters of phylogenetic importance in the basic groundplan of the group should be noted: Vibrissal angle projecting (apomorphic); elongated labellum (apo-); strictly halophilic in habitat (apo-); 3 pairs of orbitals (plesiomorphic); wide face (plesio-); acrostichals normal (not reduced) (plesio-). The projecting vibrissal angle, elongated labellum, and halophilic habitat are the autapomorphic character states which demonstrate the monophyly of the group and separate it from its sister-group *Pelomyia* + *Pelomyiella*.

The two known species of *Neopelomyia* are restricted to the west coast beaches of North America. They can be collected on "newly stranded algae in association with *Phycomyza milichioides*" (Melander, 1952).

CHARACTERS OF THE MALE POSTABDOMEN OF *Neopelomyia*

The structure of the male postabdomen of *Neopelomyia*, as in other tethinid genera, is simple relative to many other acalyptrate groups. It basically consists of a simple epandrium with its surstyli and a 2-armed hypandrium with its associated structures.

Epandrium and Associated Structures (fig. 14, 15): The epandrium is an inverted U-shaped structure with several strong bristles on the lateral and dorsal surfaces. The cerci are connected posteriorly near the dorsum of this structure and these are simple, pubescent-hairy lobes which are separated from each other. The surstyli, as in the other Pelomyiinae are located just laterad to each cercus and articulate with the interparameral sclerite at their inner dorsal corner. They are not fused with the epandrium and are short decumbent structures with several short, stout, bristles on their mesal surface. The fact that there is no fusion between the surstyli and the epandrium can be demonstrated physically as well as visually. When the hypandrium and interparameral sclerite are pulled away from the epandrium, the surstyli accompany the interparameral sclerite leaving the epandrium undisturbed with no evidence of tearing.

The epandrium extends ventrally into 2 ventral processes, completing the arms of the U shape. The ventral processes are spatulate in shape, pubescent, and each has several short, stout, bristles on the mesal surface.

The interparameral sclerite is in the form of a stylized H connecting the surstyli with the hypandrium. The point of articulation of the interparameral sclerite with hypandrium is located slightly posterior to the point of articulation of the hypandrium and epandrium.

Hypandrium: The hypandrium seen in ventral view (fig. 16) is a simple structure formed by 2 arms fused anteriorly. The dorsal edge of this anterior fusion is fused with the aedeagal apodeme.

Aedeagus and Inner Copulatory Apparatus (fig. 12, 13): As seen in the figures, the inner copulatory apparatus is composed of a heart shaped "scaly"-surfaced epiphallus surrounded by a membranous sac. The dorsal surface of the epiphallus contains a partially sclerotized ring (the epipallic ring) which articulates with the posterior edge of the aedeagal apodeme. Also present are 2 postgonites articulating with the aedeagal apodeme anteriorly and fusing with the "scaly" portion of the epiphallus posteriorly. Both the postgonites and the aedeagal apodeme are heavily sclerotized. The postgonites in lateral view are quite parallel with the apodeme, unlike the *Tethina milichioides* group previously discussed.

The aedeagal apodeme itself is a long, rodlike structure which is free in the body cavity.

The distiphallus is simply a long, slender rodlike structure with long dense hairs on the dorsal surface extending about ½ of the distance from the base to the pointed tip. The distiphallus articulates with the epiphallic ring basally. At the posterior tip of the epiphallus are 2 non-sclerotized lobes which, I believe, are the "partially sclerotized spatulate structures" which were discusssed previously in the *milichioides* group.

KEY TO THE SPECIES OF NEOPELOMYIA HENDEL

1. Cercus of male longer than surstylus; ventral process of epandrium as in fig. 15 .... *N. longicerca* new species

— Cercus of male shorter than surstylus; ventral process of epandrium as in fig. 14 ....*N. rostrata* (Hendel)

Neopelomyia longicerca Foster, new species

Male: Length: body 1.5 mm (1.5 mm–2.2 mm); wing: 1.5 mm.

As in genus description except:

Head: face .72 length of frons; frons light brown except near base of antenna which is concolorous with face; cheek about ⅓ eye height.

Abdomen: Male genitalia as in fig. 15; cercus much longer than surstylus; ventral process of epandrium with anterior edge not strongly curved.

Female: Similar to ♂ except for postabdominal characteristics.

Holotype: ♂, California, Laguna Beach, 5 June 1945, A.L. Melander, coll. No. 73641, USNM.

Paratypes: 15♂ as follows: California: Laguna Beach: 25 Jan. 1935, Melander, 3; 22 May 1944, Melander, 1; 18 July 1943, Melander, 1; Corona del Mar: 22 May 1944, Melander, 2; 29 June 1942, Melander, 2; 25 Mar. 1946, Melander, 1; Carpinteria: 11 Aug. 1950, Melander, 1; Pt. Arguello: 23 Aug. 1962, R.R. Sanders, 1; Morro Bay: 24 Feb. 1950, Sturtevant, 2; La Jolla: 29 Dec. 1934, Melander, 1. Paratypes deposited in USNM and CNC.

Discussion: This species can easily be distinguished from *N. rostrata* by the longer cercus of the male and the shape of the ventral process of the epandrium. I have not found reliable diagnostic characters to separate the females of the two species.

Neopelomyia rostrata (Hendel)

fig. 12–14, 16

rostrata (Hendel) 1911:41, fig. 3 (head), type-locality, British Columbia. Subsequent references: Malloch, 1913:147, fig. 28 (*Tethina*). Melander, 1913: 297 (*Tethina*) (in key); 1952:190 (*Neopelomyia*) (biology), 198 (distrib. rec., compared to *Tethina milichioides.*) Saunders, 1928:545 (*Tethina*) (biology). Sturtevant, 1923:7 (list). Hennig, 1936:139 (systematic notes). Hendel, 1934:38 (in key), 53–54 (citation).

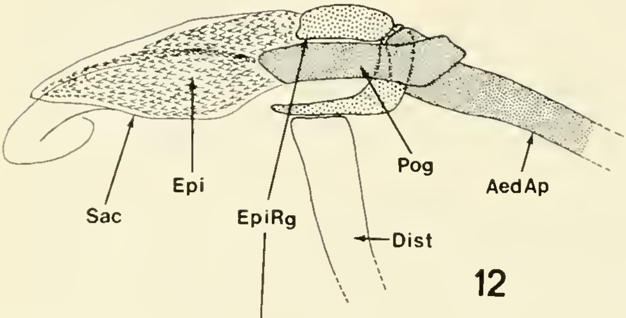
Male: Length: Body 2.0 mm (1.4mm–2.4mm); wing: 1.7 mm.

Similar to *N. longicerca* except:

Slightly darker coloration; male cercus shorter than surstylus; ventral process of epandrium with anterior edge strongly curved (fig. 14).

Types: 5 syntypes, Canada, British Columbia, Pender Island, 25 July 1905, J.R. Aldrich, coll.? I have seen 2 of the 5 syntypes and am designating a male as lectotype. Deposited in Naturhistorisches Museum, Vienna.

Material examined: 109♂, 90♀ as follows (all deposited in USNM unless otherwise indicated): California: Point Lobos: 7–8 Aug. 1969, B. Hocking, 2♀, CNC; Pacific Grove: 3 Aug. 1969, Hocking, 1♀, CNC; 28 July 1940, Melander, 6♂ 6♀; Monterey: 25 Sept. 1934, Melander, 10♂ 7♀; Pismo Beach:



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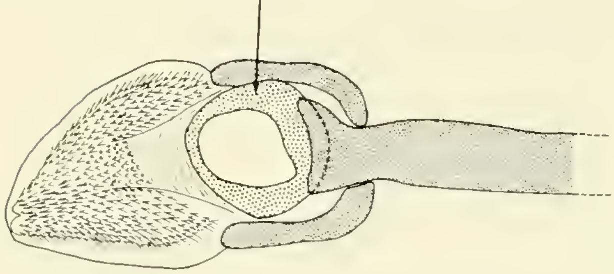

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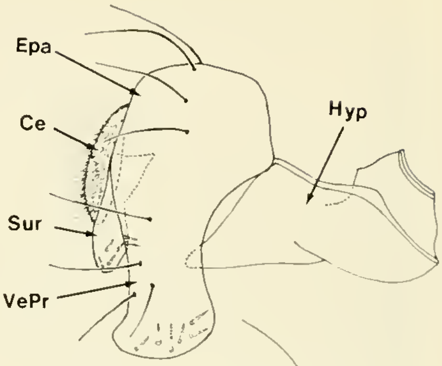

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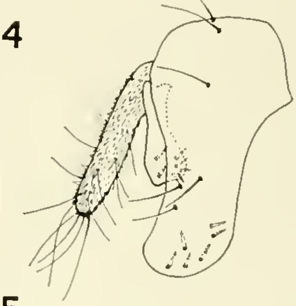

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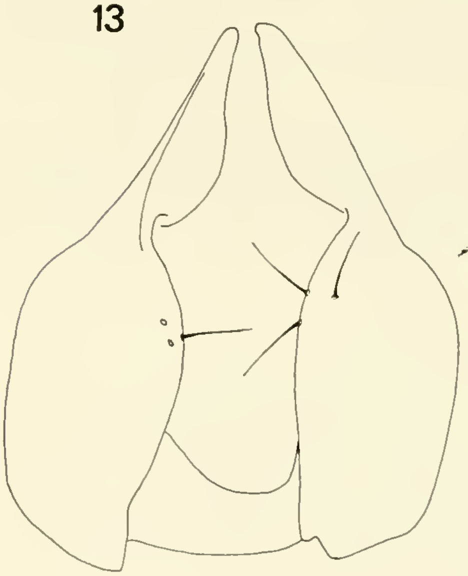

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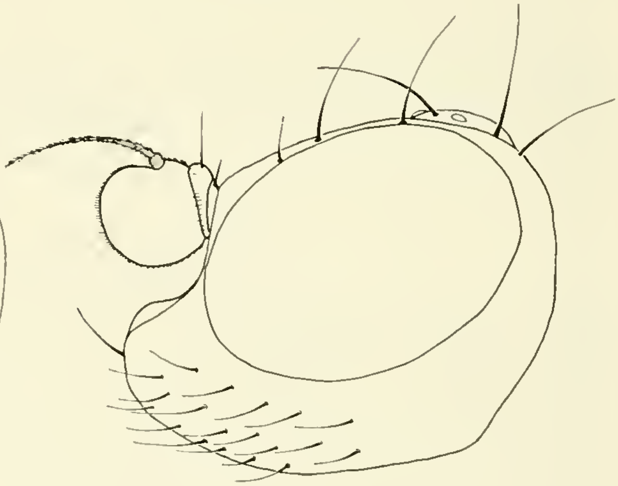

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Figs. 12–13. Male inner copulatory apparatus of *Neopelomyia rostrata.* 12, lateral view. 13, dorsal view. Fig. 14–15. Lateral view of external male genitalia. 14, *N. rostrata.* 15, *N. longicerca,* hypandrium not shown. Fig. 16. Ventral view of hypandrium of *N. rostrata.* Fig. 17. Lateral view of head of *N. longicerca* (head of *N. rostrata* is identical).

26 Sept. 1934, Melander, 1♂; Pismo: 26 July 1940, Melander, 2♂ 1♀; Laguna Beach: 25 Jan. 1935, Melander, 9♂; 24 Oct. 1951, Melander, 1♀; 25 Mar. 1953, Sturtevant, 1♀; Corona del Mar: 29 June 1942, Melander, 2♂ 1♀; 13 Aug. 1949, Melander, 1♂; 28 Dec. 1944, Melander, 1♀; 24 Feb. 1912, Sturtevant, 1♀; Palos Verdes: 15 Oct. 1944, Melander, 1♂; Morro Bay: 24 Feb. 1950, Sturtevant, 5♂ 1♀; 18.5 mi. N. Crescent City: 28 June 1972, Steyskal, 1♂; Moss

Beach: Intertidal rocks, 21 Mar. 1948, Wirth, 2♂; Golera: 28 Mar. 1955, Sturtevant, 1♂ 2♀; La Jolla: 29 Dec. 1934, Melander, 1♂; 22 June 1950, Melander, 1♀; Dry Lagoon Beach St. Pk.: 10 Aug. 1953, Arnaud, 4♂ 2♀, Cal. Acad. Sci.: Asilomar: 1–2 Sept. 1945, Melander, 2♀; Seal Beach: 26 July 1942, Melander, 1♀; Carpinteria: 8 Oct. 1946, Melander, 1♀. Washington: Ilwaco Beach: 17 July, year ?, Melander, 16♂ 12♀; 6 Sept. 1934, Melander, 1♂; 12 July 1922, Melander, 7♂ 13♀; Sequim: 25 Aug. 1951, Sturtevant, 1♂; Roche Harbor: 3 July 1909, collector?, 1♂; Shelton, Walkers Park: 21 July 1919, Melander, 3♀; Kanaka Bay: 8 July 1924, Melander, 1♀. Canada, British Columbia: Queen Charlotte City, Q.C.I., flowers of *Ranunculus* on foreshore: 9 July 1960, Shewell, 6♂ 5♀, CNC; Queen Charlotte City, on kelp on beach: 9 July 1960, Shewell, 15♂, CNC; Terrace (doubtful): 19 July 1960, C. H. Mann, 1♂, CNC; Departure Bay: 3 July 1927, collector, 1♂ 1♀, CNC; 30 June 1927, coll.?, 1♂ 1♀, CNC: Port Edward: 18 July 1960, Mann, 1♂, CNC; Port Grey, Vancouver: 9 July 1973, Vockeroth, 1♂ 2♀, CNC; Jct. Pr. Rupert-Port Edward Hwy: 18 July 1960, Mann, 4♀, CNC; Pender Id.: 25 July 1905, Aldrich, 1♀; Mill Bay: 12 July 1924, Melander, 4♂ 1♀; Butchart: 11 July 1924, Melander, 5♂ 6♀; B.C. Bio. Sta. Departure Bay: 14 July 1927, coll.?, 1♂ 2♀; Departure Bay: 30 June 1927, coll.?, 1♀.

Discussion: A substantial amount of variation exists in the degree of prognathism of the head, some specimens being much less prognathous than others. These differences do not, however, have corresponding differences in the male genitalia or any other major character complex so I do not consider them to be of specific importance.

Abbreviations used in figures: AedAp, aedeagal apodeme; ApPl, apodeme plate; Ce, cercus; Dist, distiphallus; Epa, epandrium; Epi, epiphallus; EpiRg, epiphallic ring; Hyp, hypandrium; LtLb, lateral lobe of hypandrium; Pog, postgonite; Sac, membranous sac around epiphallus; Sur, surstylus; VePr, ventral process of epandrium.

Dark, light, and no stippling indicate heavy, light, and no sclerotization, respectively.

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RHINAPHENA STRAND: A REDESCRIPTION OF THE TYPE-SPECIES AND TRANSFER TO THE PHYCITINAE (LEPIDOPTERA: PYRALIDAE)

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ABSTRACT—*Rhinaphena* (type-species: *R. discocellularis* Strand, 1920) is transferred from the Anerastiinae (*auctorum*) to the Phycitinae (Lepidoptera: Pyralidae). The species is redescribed and illustrations are provided for the adult moth, antenna, wing venation, and male genitalia.

While working on a revision of the Neotropical Peoriinae I recently had occasion to examine the holotype of *Rhinaphena discocellularis* Strand, type-species of the monobasic genus *Rhinaphena* Strand. The species was described on the basis of a single male from Misiones, Argentina, and, as the specimen lacked a proboscis, Strand placed his new genus in the Anerastiinae, a group separated from the Phycitinae solely on the basis of having the proboscis reduced or absent.

As stated in an earlier paper (Shaffer, 1968), I believe that the majority of these genera showing the reduced proboscis constitute a natural group (for which I have used Hulst's name 'Peoriinae') but that certain genera (*Anerastia* included) should be transferred to the Phycitinae. On the basis of wing pattern *Rhinaphena discocellularis* would appear to belong to the Phycitinae, a supposition borne out by an examination of the male genitalia, which are clearly phycitine—not peoriine—in structure. The genus was not covered in Heinrich's (1956) revision and a redescription is warranted.

Rhinaphena discocellularis Strand
Strand, 1920:118–120.

Antennae filiform, rather densely ciliate, cilia about ⅔ as long as shaft diameter near base. Eye diameter 1.1 mm. Ocelli well developed, black. Vertex, occiput, patagia brown. Forewing radius 13.5 mm; ground light brown anterior to and brown posterior to region of cubitus; prominent black discal spot, and poorly developed black irregular transverse anterior and transverse posterior lines; indistinct trace of dark-brown scales on M_1, M_2, M_3, and Cu_1; 11 veins (fig. 5); R_{3+5} stalked about ½ their length, from before upper outer angle of cell; M_1 from the angle; M_{2+3} stalked about ⅓ their length, from lower outer angle; Cu_1 from near the angle; Cu_2 from very near to Cu_1. Hindwing with 7 veins; Sc stalked for just over ½ its length with Rs; M_{2+3} fused, stalked with Cu_1 for just under ⅓ their length, from lower outer angle; Cu_2 from just before the angle.

Male genitalia (fig. 9) with uncus hoodlike, subtriangular, rounded apically. Gnathos (fig. 6) with apical process bifid, hooked; each lateral arm terminating

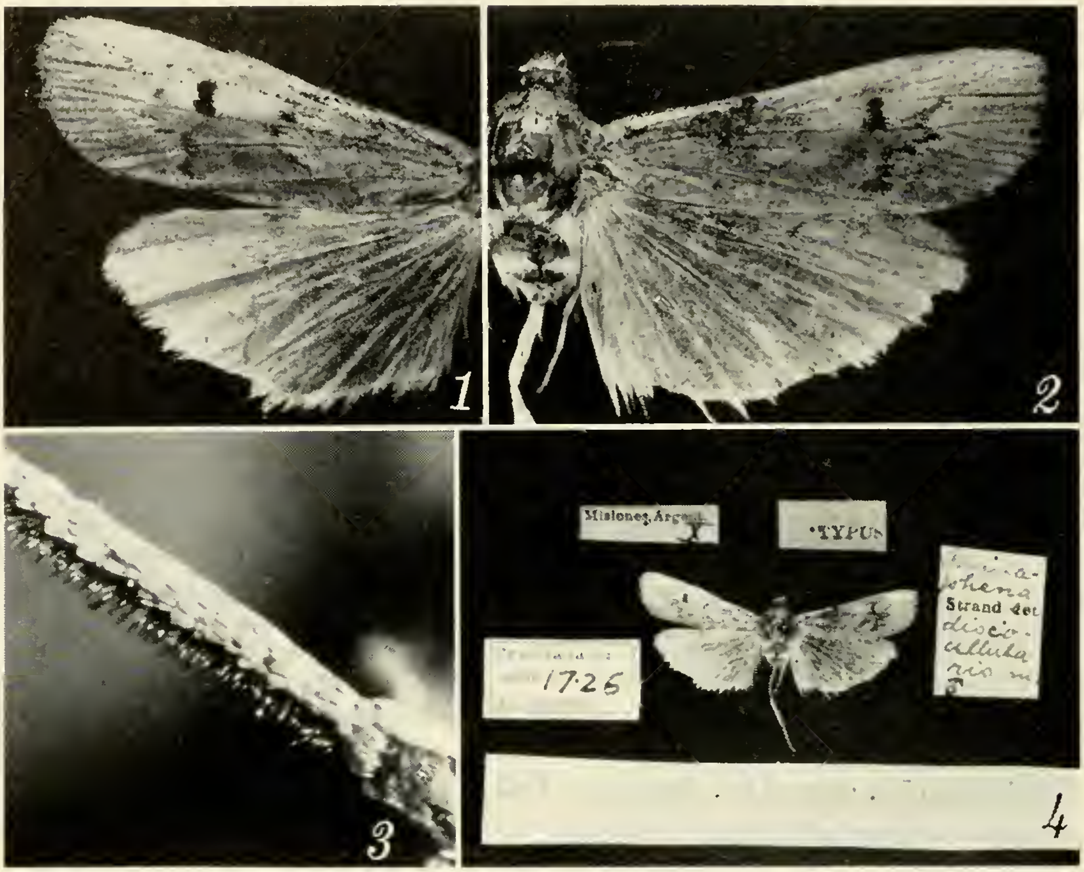

Fig. 1–4. *Rhinaphena discocellularis*, holotype. 1, left wings. 2, head, thorax, and right wings. 3, basal segments of antenna. 4, holotype with labels.

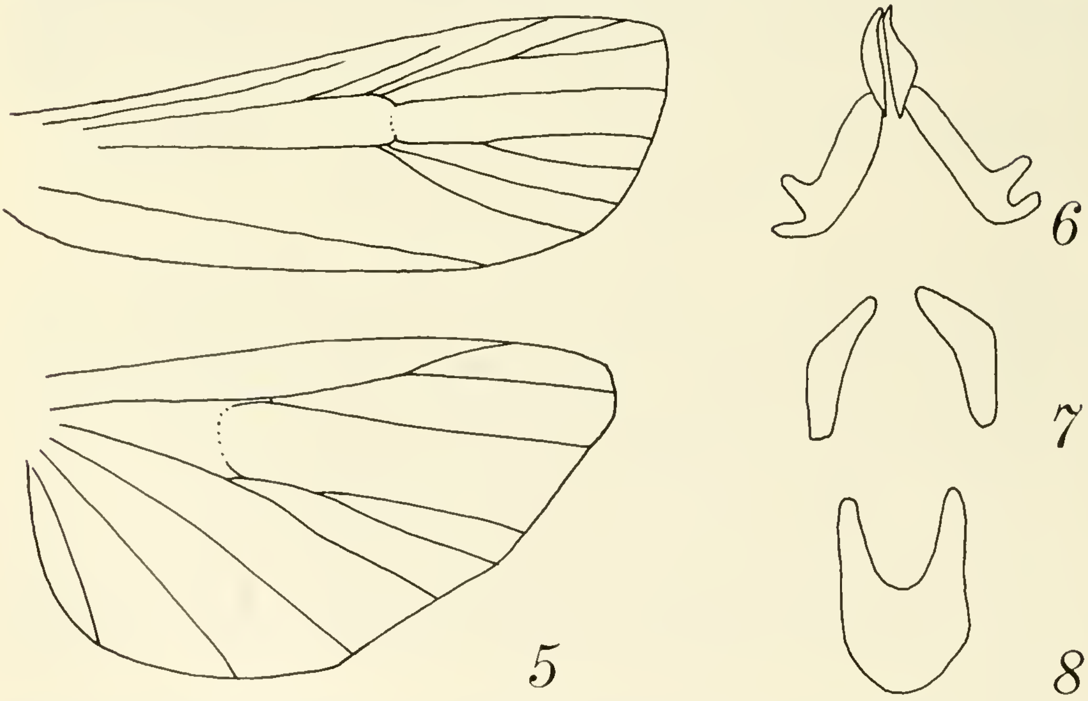

Fig. 5–8. *Rhinaphena discocellularis*. 5, wing venation. 6–8, details of male genitalia, all to same scale: 6, gnathos; 7, transtilla; 8, vinculum.

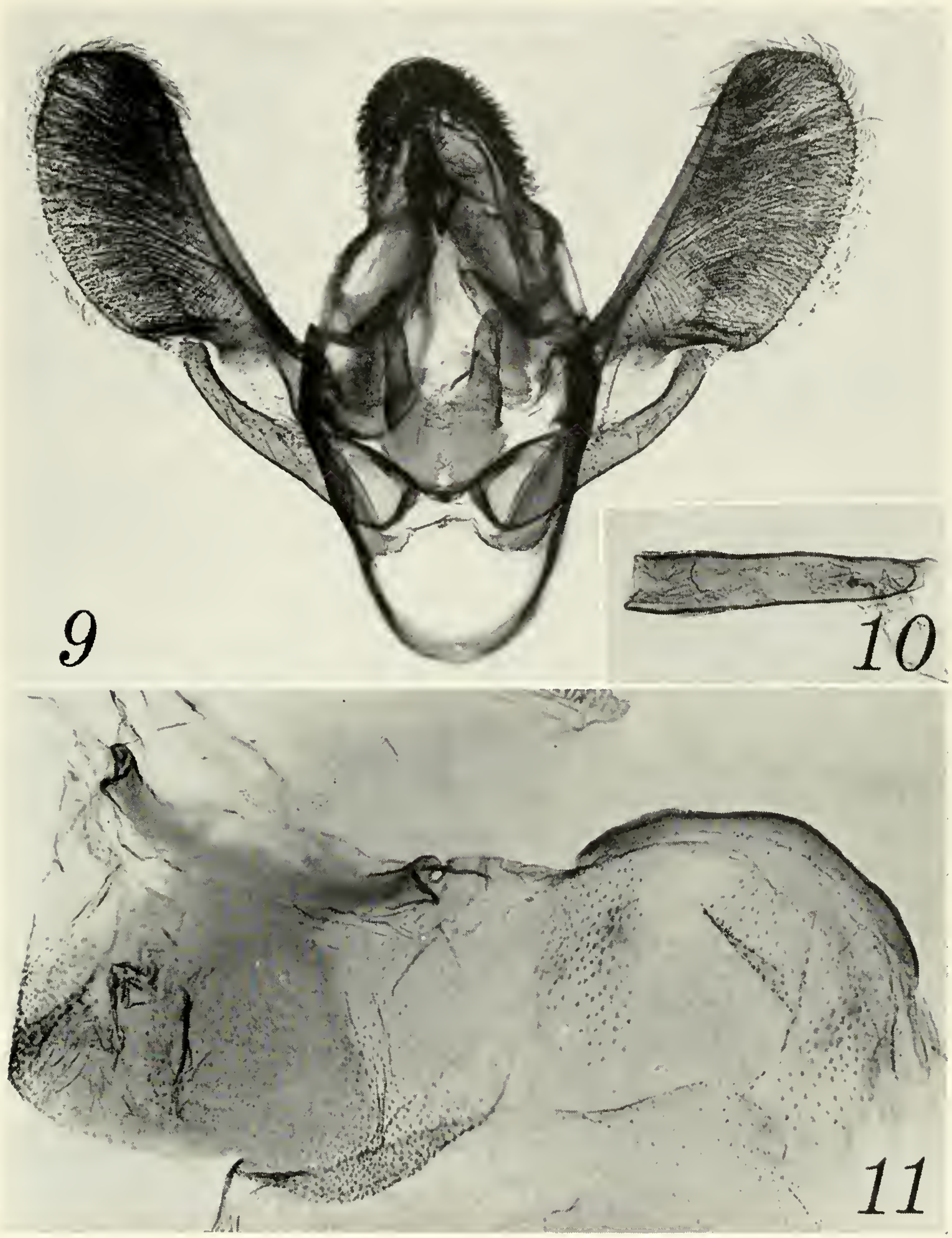

Fig. 9–11. *Rhinaphena discocellularis.* 9, male genitalia. 10, aedeagus, to same scale. 11, eighth segment of pelt.

in double flattened hook. Transtilla incomplete (fig. 7). Juxta U-shaped (fig. 8). Vinculum rounded. Aedeagus (fig. 10) subcylindrical; broadest distally, 4.5 times as long as maximum width; vesica unarmed.

The head is glued in place and somewhat damaged. Strand reported that the labial palpi were hanging and would normally likely be porrect, but now only the basal segments remain. Also, the maxillary palpi which I've found to be short and denuded of scales, were described as being very small and appearing subfiliform. The tongue is absent, but as there is a cavity in the head between the bases of the labial palpi, the tongue was probably broken off and its true development remains an open question. The tongue may or may not have been broken off before Strand described the specimen. He did report that the proboscis was absent, but also, some damage was done to this region at a later date as evidenced by the damaged palpi. There is a large lump of glue covering the ventral surface of the thorax, but I have no reason to believe the specimen was glued together anywhere but at the head, and clearly the abdomen was naturally connected, not glued, to the thorax.

The holotype is in the collection of the Institut für Pflanzenschutzforschung Kleinmachnow, Zweigstelle Eberswalde, DDR. I wish to thank the officials of the Institut for their kindness in permitting me to examine the type-specimen.

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A REMARKABLE STENOPODA FROM JAMAICA (HEMIPTERA: REDUVIIDAE)

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ABSTRACT—A new species *Stenopoda* **spinimarginata** is described from Jamaica. The genus is expanded in order to include this species and S. *spinulosa* Giacchi because contrary to the others in the genus they have the first antennal segment shorter than the length of the head. The former has 4 pairs of setigerous spines ventrally on the head before the eyes and the apical angle of the connexival segments produced laterad, characters not found in other species of the genus.

The genus *Stenopoda* was redescribed and redefined by Giacchi (1969). A specimen sent to me for identification by Dr. T. H. Farr, from the Institute of Jamaica, Kingston, Jamaica, proved to be a species that makes necessary the expansion of this genus. The first antennal segment is slightly shorter than the length of the head instead of being equal or longer and has a group of four pairs of setigerous spines ventrally before the eyes instead of not having such spines. These characters have been used to separate and key out *Stenopoda* from allied genera. Also contrary to all other species in the genus the connexival segments are produced laterally instead of having the margins subparallel. Although the structure of the connexival margin can be of generic importance in the Reduviidae, in cases like *Heza* and *Zelus* it varies from unspined to longspined. Therefore, in *Stenopoda* these lateral projections should be considered as of specific value and the length of the antennal segments can not be used to separate it from allied genera. These points are further discussed in the comparative notes that follow the description of the new species.

The drawings of the internal genitalia were made by Dr. Pedro Wygodzinsky, of the American Museum of Natural History, who also corroborated the generic position of the specimen. In the measurements that follow 12.5 micrometer units are equivalent to 1 mm.

Stenopoda spinimarginata Maldonado Capriles, new species

Male (fig. 8, 9): Overall color brown; forefemur with 3 light-brown inconspicuous annuli, 1 basal, 1 before and another after midlength; midfemur with a basal and a post-midlength light-brown inconspicuous annulus. Antenna brown, slightly lighter than head; with yellow-brown as follows: Basal ⅓ or 2nd segment, apical ½ of 3rd, and 4th. Forewing slightly lighter than pronotum; clavus dark brown; corium with yellowish as follows: Veins, area between Sc and R, and costal margin to about level of apex of scutellum, disk of cells of membrane,

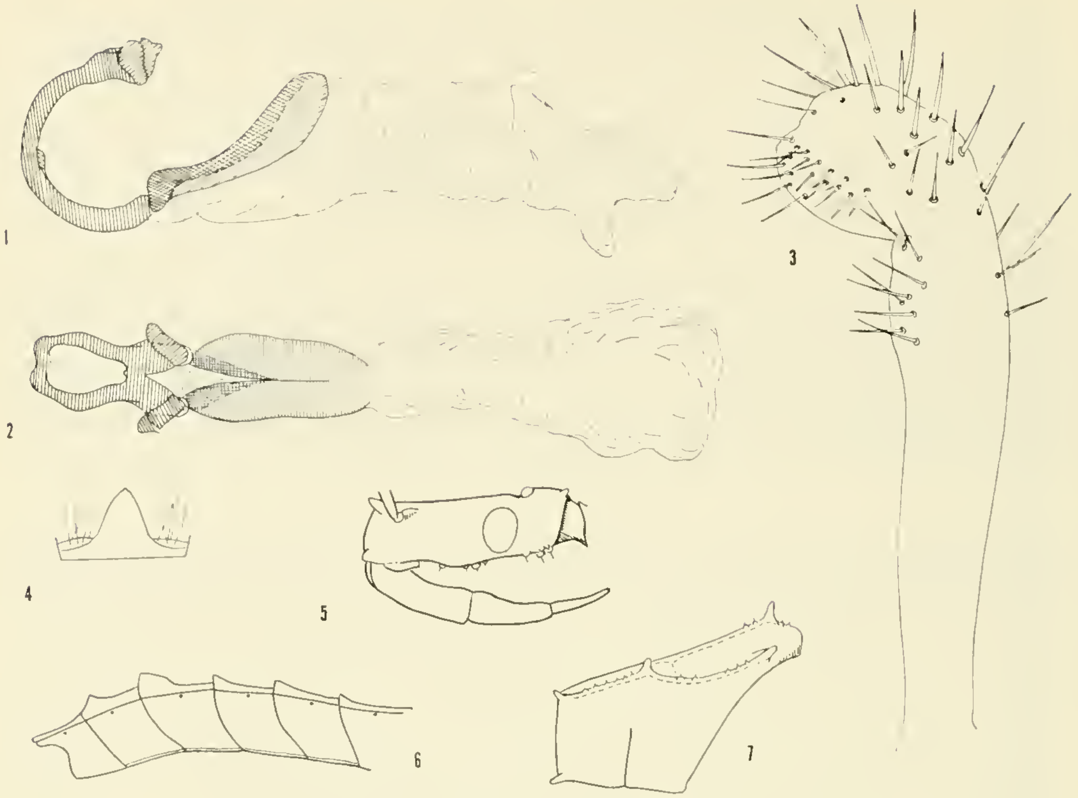

Fig. 1–7. *Stenopoda spinimarginata,* male holotype. 1, aedeagus, lateral. 2, aedeagus, dorsal. 3, clasper, dorsal. 4, spine of margin of hypopygium. 5, head, lateral. 6, abdomen, without genital capsule, lateral. 7, pronotum, lateral.

and most of membrane apically outside of cells. Abdominal sterna dark brown; sterna 2–4 yellowish on each side of median keel.

Head: Length 24, across eyes 15, interocular space 8, from antennal base to anterior margin of eye 9, from posterior margin of eye to base of head 4. Antennal segments: 21:34:10:9. Beak: 13:10:8, as in fig. 5. Head ventrally in front of eyes with 4 pairs of setigerous spines. Postocular margins of head nearly parallel sided, abruptly contracted before collum. Pronotum (fig. 7): Length 28, width to apex of humeral spines 38; lateral margin of anterior lobe with peglike elevation before constriction; humeral angle produced as sharp spine; disk of anterior lobe without pattern of carinae, posteriorly with slightly elevated carina each side of median line that extends as well defined carina into posterior lobe and ends as well elevated tubercle before posterior margin of pronotum; these carinae without setigerous spines except before spine; lateral margin of pronotum with globose setigerous spines. With simple setigerous spines ventrolaterally behind eyes and on legs. Shape of legs (fig. 8) and pilosity typical of genus; spongy fossa of protibia ¼ length of tibia; posterior femur slightly surpassing apex of abdomen. First 3 connexival segments with posterior angle angularly produced (fig. 6), 4th ampliate, 5th produced laterad as small triangle; posterior margin straight. Abdominal sterna keeled. Length 24 mm.

Genitalia as in fig. 1–4.

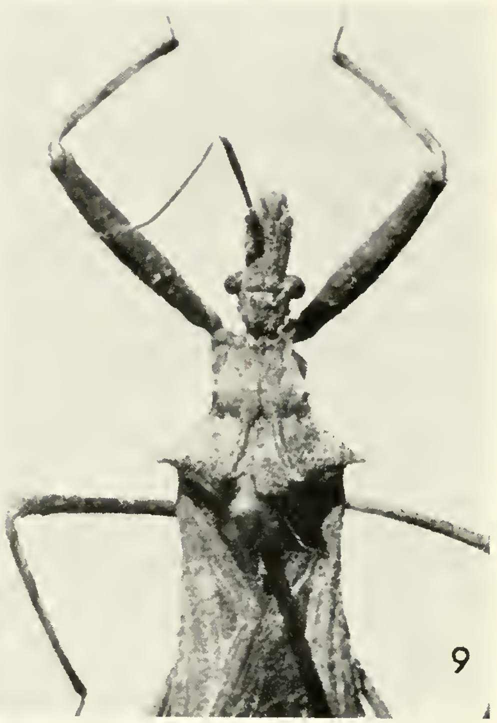

Fig. 8–9. *Stenopoda spinimarginata,* male holotype. 8, habitus. 9, head and thorax.

Holotype: ♂, from JAMAICA, Portland, Haward Gap, 31 Aug 1959, T. H. Farr collector; in the collection of the USNMNH, Cat. No. 73541.

According to Giacchi the species of *Stenopoda* can be separated into two groups, those having on the pronotum hemispherical spines with a short hair and those with conical spines with a long hair. *Stenopoda spinimarginata* falls in the first group. The relatively short first antennal segment, the shape of the connexival margin, the peglike tubercle on lateral margin of anterior lobe, the genitalia, the coloration, and the presence of 4 pairs of setigerous spines ventrally on the head before the eyes distinguish it from all other species. The produced connexival segments give this species somewhat the appearance of an *Ocrioessa.* Both *Ocrioessa* and *Apronius,* in the same couplet in Barber's (1929) key, have groups of setigerous spines ventrally on the head but before and after the eyes. Besides, these two genera have the anterior coxae spined while these are unspined in *Stenopoda*. *Stenopoda spinimarginata* and *S. spinulosa* Giacchi have the first antennal segment shorter than the length of the head. Therefore, the definition of the genus, as detailed by Barber (1929) and Giacchi (1969), has to be modified thus: First antennal segment usually as long or longer than length of head; abdominal margins converging to apex and segments usually not produced, seldom with apical angle of connexival segments produced laterad; sometimes with 2 pairs of setigerous spines ventrally on the head before eyes.

The two above mentioned species run to couplet 15 in Barber's (1929) key to the genera of *Stenopodainae*. However, because of the described antennal characters couplets 15 and 16 should be modified as follows:

15. Anterior femora strongly incrassate; 1st segment of rostrum somewhat shorter than 2nd and nearly equal to 3rd; expanded connexival margin entire .... *Podormus* Stål
— Anterior femora lightly incrassate; 1st segment of rostrum much longer than 3rd and somewhat longer than 2nd; connexival margin entire or produced 16
16. Segments of connexival margin expanded into dentiform acute lobes; head, pronotum, and legs with large conspicuous setigerous spines giving insect spiny appearance .... *Nitornus* Stål
— Segments of connexival margin straight or occasionally expanded only at apical angle; setigerous spines small 17
17. Anterior tibia with elongate spongy fossa at apex; postocular margins of head nearly parallel sided, abruptly contracted before collum; disk of anterior lobe and margins of pronotum not tuberculate ......*Stenopoda* Laporte
— Anterior tibia devoid of spongy fossa at apex; postocular margins not parallel sided, gently converging behind eyes to collum; disk of anterior lobe and lateral margins of pronotum tuberculate ....*Stenopodessa* Barber

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THREE NEW NEOTROPICAL PTEROMBRUS WITH DESCRIPTION OF THE DIAPAUSING LARVA (HYMENOPTERA: TIPHIIDAE)[1]

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ABSTRACT—Three new parasitoids of cicindelid larvae are described, *Pterombrus* **piceus** Krombein from Costa Rica, *P.* **ater** Krombein from Panama, and *P.* **petiolatus** Krombein from Venezuela. The diapausing larva of *P. piceus* is also described.

Williams (1929:145–150) reported two Brazilian species of the rare myzinine genus *Pterombrus* Smith as parasitoids of ground-dwelling tiger beetle larvae. He noted that the host of *P. cicindelicidus* Williams was an unidentified species of *Cicindela*, and he presumed that *Megacephala affinis* Dejean was the host of *P. iheringi* Ducke. Nothing further was observed on the host relationship and behavior of *Pterombrus* until 1975 when Palmer (1976) discovered a population parasitizing a large colony of the cicindelid *Pseudoxychila tarsalis* Bates in Costa Rica.

Examination of Palmer's specimens revealed at once that they represented an undescribed species of *Pterombrus* and differed from all described species in having the integument almost totally black, instead of the abdomen being bright red except for the first segment. Palmer's species is described herewith to provide a name for use in her account of the biology. This opportunity is taken also to describe two other black species which the first author has had in manuscript for many years.

Pterombrus piceus Krombein, new species
fig. 1, 4, 7–10

Male (holotype): Length 8 mm, forewing 5.5 mm. Black, glossy, apical ⅓ of mandible reddish, palpi and apices of tarsal segments dark brown. Vestiture glittering white. Wings hyaline except forewing with 2 relatively broad, trans-

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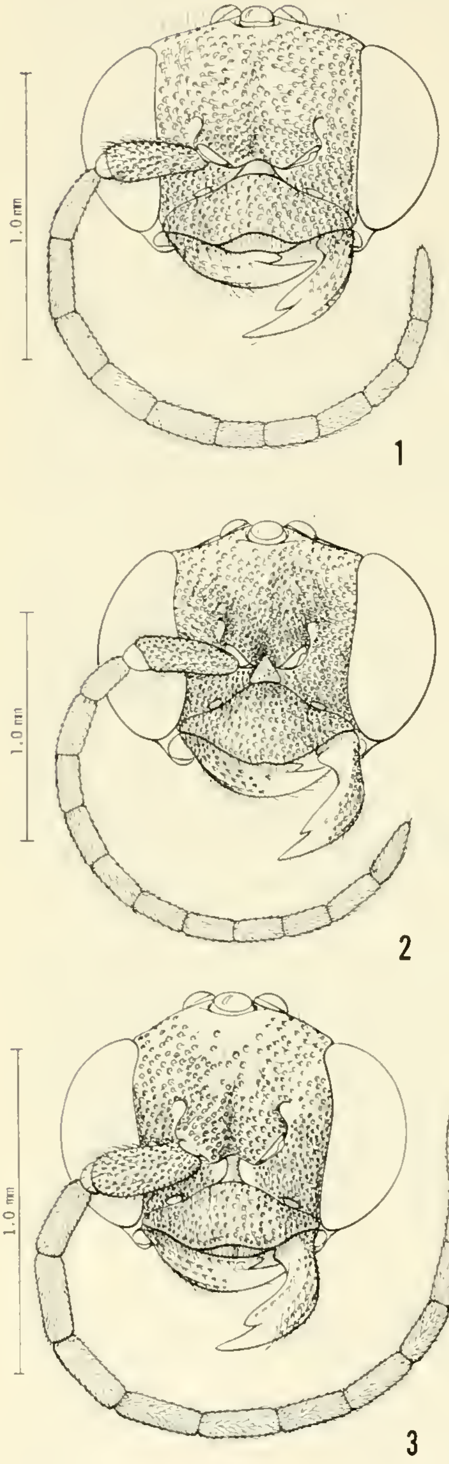
[1] Descriptions of the adults are by the first author, and of the diapausing larva by the second author. Illustrations of the adults (figures 1–6) are by G. L. Venable, Smithsonian Institution, and of the larva (figures 7–10) by the second author. The present contribution is Part XI of the first author's series, Studies in the Tiphiidae; Part X was published in Proc. U. S. Natl. Mus., vol. 124, no. 3644, pp. 1–22, 1 pl., 1968.



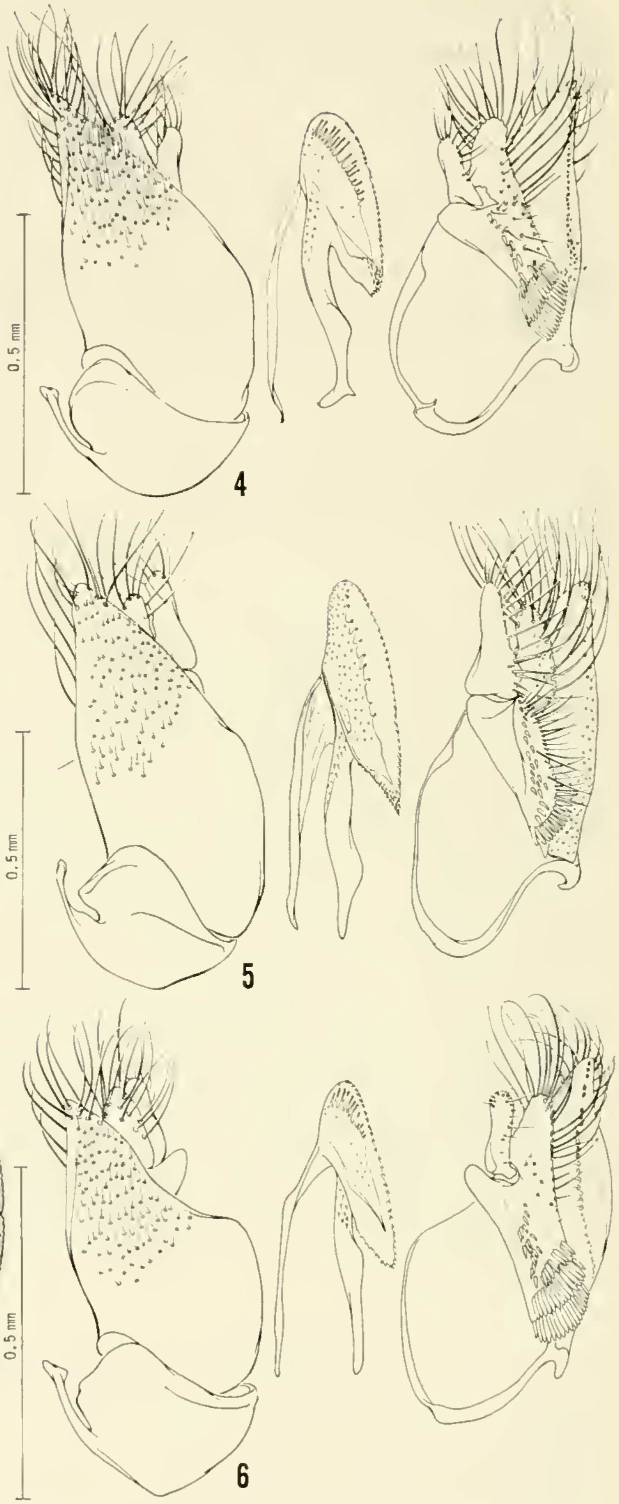


Fig. 1–3. *Pterombrus*, head in frontal view. 1, *P. piceus*. 2, *P. ater*. 3, *P. petiolatus*. Fig. 4–6. *Pterombrus*, lateral views of male genitalia; external aspect with cardo at left, aedeagus in center, internal aspect at right. 4, *P. piceus*. 5, *P. ater*. 6, *P. petiolatus*. (Illustrations by G. L. Venable.)

verse infumated bands across basal vein and marginal cell; infumated areas with coarser microtrichiae than rest of surface.

Head in frontal view (fig. 1) with height (apex of clypeus to ocelli) ⅔ width, punctation as figured; clypeal margin more broadly and deeply emarginate than in *ater;* supraclypeal area subtriangular, broader than in *ater*; ocelli in low triangle, postocellar distance ⅔ ocellocular distance and 1.5 times the lateral ocellar distance; deep groove behind posterior ocelli.

Pronotum shallowly depressed in middle behind anterior transverse carina, irregularly pitted anteriorly and with scattered punctures posteriorly; scutum with coarse, subcontiguous punctures; scutellum with smaller, scattered punctures; mesopleuron with anterior groove coarsely crenulate, discal surface with scattered small punctures; propodeum entirely irregularly and coarsely rugulosoreticulate.

Basal abdominal segment not petiolate, sides widening evenly toward apex, apical width 2.4 times basal width, length 2.4 times apical width; terga with only very scattered, fine punctures; 3rd and 4th terga without transverse discal groove; genitalia (fig. 4), volsella at base with 2 complete rows of flattened, contiguous setae forming ctenidia, digitus not exceeding volsellar apex.

Female (allotype): Length 7.5 mm, forewing 5.5 mm. Coloration and vestiture as in male except apices of antennal insertions, scape narrowly at base and apex, and last abdominal segment red, and 4th through 6th flagellar segment brown.

Head in frontal view with height (apex of clypeus to ocelli) subequal to width (12:13); antenna clavate toward apex; front and vertex with contiguous punctures; ocelli in equilateral triangle, no groove behind posterior ocelli, postocellar distance ⅔ ocellocular distance.

Pronotum shallowly depressed in middle beyond anterior transverse carina, anterior ½ of disc finely and contiguously pitted in close, transverse rows, posteriorly with larger, slightly more separated punctures; scutal sculpture mostly obscured by pin, but apparently mostly contiguously punctate except laterad of parapsides; mesopleuron with anterior furrow less strongly crenulate than in male, disc with small, subcontiguous punctures and fine oblique wrinkles anteriorly; propodeum relatively more delicately sculptured than in male, dorsal surface with strong median carina on each side of which is an elongate triangular area of irregular fine rugulae, anteriorly at sides smooth, posteriorly with coarse, irregular reticulations, laterally with close, oblique rugulae.

Basal abdominal segment not petiolate, sides widening gradually toward apex, apical width almost 3 times basal width and ½ the length; terga with only few, scattered, fine punctures; 3rd and 4th terga without transverse discal groove.

Host: *Pseudoxychila tarsalis* Bates; usually second, occasionally third, instar larva.

Holotype: ♂, Las Cruces Tropical Botanical Garden, 4 km south of San Vito de Java, Puntarenas Province, Costa Rica, egg laid 24 August 1975, wasp out 5 November 1975, M. Palmer No. 535 (USNM Type No. 73770).

Allotype: ♀, same locality data as holotype, egg laid 17 August 1975, wasp out 24 October 1975, M. Palmer No. 682. Paratypes: 2♂, same locality data as holotype; 1♂, egg laid 27 August 1975, wasp out 31 October 1975, M. Palmer No. 667; 1♂, 13 October 1975, reared by M. Palmer. The paratype males agree

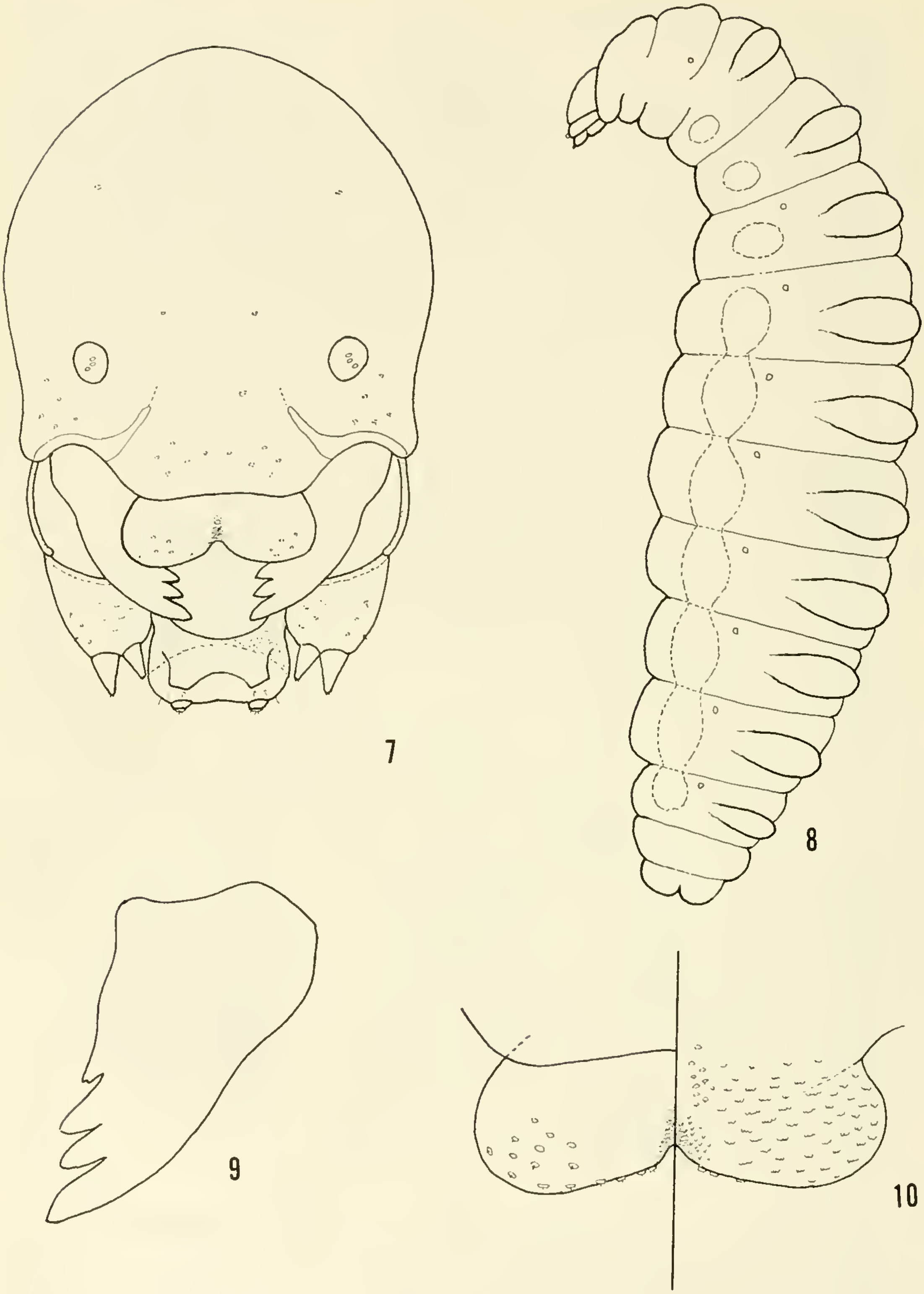


Fig. 7–10. Diapausing larva of *Pterombrus piceus*. 7, head, anterior view. 8, larva, lateral view. 9, mandible. 10, labrum (left) and epipharynx (right). (Illustrations by H. E. Evans.)

in all essential details with the holotype and vary from 7.0 to 7.5 mm in length; illustrations were made from No. 667.

The lack of transverse discal grooves on the third and fourth abdominal terga separate both sexes of *piceus* from most known species of *Pterombrus.* The male of *ater* also lacks these grooves, but it is distinguished from *piceus* by the arrangement of ocelli in an equilateral triangle, shape of the supraclypeal area, noncrenulate anterior groove on the mesopleuron, and the relatively coarse, scattered punctures on the abdominal terga. The genitalia of *piceus* are also diagnostic.

Larva of *Pterombrus piceus* Krombein

Material: The following description is based on a diapausing larva (prepupa) extracted from a cocoon from the Las Cruces Tropical Botanical Garden, San Vito de Java, Costa Rica, labeled "egg laid 15 Nov., killed 9 Dec.". Several other diapausing larvae were examined and found to agree in all details with this specimen, although none were in as good condition.

Description: Length 11 mm; maximum width (abdominal segment 4) 3.5 mm. Elongate-fusiform, with prominent pleural lobes except on 1st 2 and last 2 body segments, all but these same segments also with strong transverse dorsal welts (fig. 8). Anus a transverse slit at middle of terminal segment. Nine pairs of spiracles distinct and all about same size, 2nd thoracic spiracles present only as minute pores, without well developed atria; structure of 1st thoracic spiracles much as figured for *Methocha stygia* (Say) by Evans (1965, fig. 3), atrium lined with very weak, anastomosing ridges, opening into subatrium unarmed. Integument smooth except each dorsal welt bearing several minute setae in irregular transverse band (16 such setae can be counted on 1st abdominal segment).

Head very small, measuring 0.7 mm wide, approximately same height (measured exclusive of labrum and mouthparts) (fig. 7). Head largely unpigmented except the following light brown: pleurostomal thickenings, median streak on labrum, mandibles, basal supporting rods and most of apical ½ of maxillae, and basal part of labium. Parietal bands absent; antennal orbits large, each with the usual 3 sensilla. Head capsule and clypeus with a few pores, some bearing minute setae. Labrum measuring 0.25 mm wide, bilobed, pigmented at emargination; surface with 16 pores, some bearing minute setae not longer than pore diameter, apical margin with 16 minute sensilla (fig. 10). Epipharynx bearing rows of minute spinules, also with numerous sensory pores mediobasally. Mandibles robust, without setae or roughened areas, quadridentate but most basal tooth small, bifid or irregularly rounded (fig. 9). Maxillae each with laterobasal sclerotic rod, upper surface with rows of minute spinules like those on epipharynx, but mesal margin rather smooth; palpi large, conical, galeae also conical but slightly shorter and narrower than palpi. Labium broad, with several small setae apically, labial palpi much broader than long, with several apical sensory pegs; spinneret transverse, more prominent laterally than medially.

Discussion: The larva of *Pterombrus piceus* is very similar to that of *Methocha stygia*, as described by Evans (1965). The more robust body, with prominent pleural lobes and dorsal welts, may be a consequence of the fact that these larvae were taken from cocoons, while those of *Methocha* were preserved before spinning. *Methocha* has larger setae on the head, clypeus, labrum, and maxillae, and the labrum is less deeply emarginate; also, the sclerotic rods at the base of the maxillae are lacking, although such rods are present in *Tiphia* and *Myzinum*. In general the larva of *Pterombrus* agrees well with that of *Myzinum* (Evans, 1965) except for the very different spiracles.

Although much still remains to be learned about the larvae of Tiphiidae, one is left with the impression that all are very similar. Brothers (1975) has pointed out that Anthoboscinae also have only 9 pairs of well developed spiracles, rather than 10 as hypothesized by Evans (1965). Brothers (1972) has provided a detailed description of the larva of the mutillid *Pseudomethoca frigida* (Smith); this larva also has quadridentate mandibles, reduced second thoracic spiracles, and many other "tiphiid" features, although the palpi and galeae are mammiform and much shorter than in described Tiphiidae. The larva of *Sapyga*, however, differs in many ways from those of Tiphiidae (Torchio, 1972) and it seems unlikely that the Sapygidae tie in as closely to the Tiphiidae and Mutillidae as implied in Brothers' cladogram (1975, fig. 2).

Pterombrus ater Krombein, new species

fig. 2, 5

Male (holotype): Length 7.5 mm, forewing 4.5 mm. Black, glossy, mandible, palpi, fore and mid-tarsi reddish. Vestiture glittering white. Wings hyaline, not banded; microtrichiae uniformly fine.

Head in frontal view (fig. 2) with height (apex of clypeus to ocelli) 0.7 times width, punctation as figured; clypeal margin shallowly and narrowly emarginate in middle; supraclypeal area triangular; ocelli in an equilateral triangle, lateral ocellar and postocellar distances equal, the latter 0.6 times the ocellocular distance, deep groove behind posterior ocelli.

Pronotum not depressed in middle behind anterior transverse carina, with coarse punctures on anterior ⅔ which tend to be confluent in transverse rows; scutum with coarse, subcontiguous punctures; scutellum with smaller, more scattered punctures; mesopleuron with anterior groove not crenulate, surface with scattered punctures which are larger than in *piceus*; propodeum dorsally with transverse rugulae which are finer than in *piceus*, lateral surface with delicate, oblique rugulae, only posterior surface rugulosoreticulate but more delicately so than in *piceus*.

Basal abdominal segment not petiolate, sides widening evenly toward apex, apical width 2.3 times basal width, length twice apical width; terga with scattered, relatively coarse punctures; 3rd and 4th terga without transverse discal groove; genitalia (fig. 5), volsella at base with 1 complete row of flattened, contiguous setae forming a ctenidium, digitus exceeding volsellar apex.

Female: Unknown.
Host: Unknown.

Holotype: ♂, Pacora, Canal Zone, July 1953, F. S. Blanton (USNM Type No. 73771).

The scattered, relatively coarse punctures on the abdominal terga distinguish *ater* at once from the males of any other known *Pterombrus*; it is presumed that the female of *ater* will have similar abdominal punctation. From the other described black *Pterombrus*, *ater* may be distinguished by a combination of the ocelli in an equilateral triangle, triangular supraclypeal area, weakly emarginate clypeal margin, simple anterior groove on the mesopleuron, the presence of only a single ctenidium on the volsellar base, and the digitus extending beyond the volsellar apex.

Pterombrus petiolatus Krombein, new species

fig. 3, 6

Male (holotype): Length 6.5 mm, forewing 3.5 mm. Black, glossy, mandible, palpi, tegula, legs except coxae reddish, antennal flagellum brown. Vestiture glittering white. Wings hyaline, not banded; microtrichiae uniformly fine.

Head in frontal view (fig. 3) with height (apex of clypeus to ocelli) ¾ width, punctation as figured; clypeal margin more broadly and deeply emarginate than in *ater*; supraclypeal area narrow, higher than wide; ocelli in an equilateral triangle, lateral ocellar and postocellar distances equal, the latter 0.5 times the ocellocular distance, no groove behind posterior ocelli.

Pronotum shallowly depressed in middle behind transverse carina, with relatively coarse, subcontiguous punctures; scutum and scutellum with more scattered punctures of similar size; mesopleuron with anterior crenulate groove, surface with scattered, tiny punctures; propodeum with regular rugulose reticulations of finer and more delicate mesh than in *piceus*.

Basal abdominal segment quite slender and subpetiolate at base, apical width almost 3 times basal width, length 2.4 times apical width; 1st tergum with a few medium-sized punctures; 3rd and 4th terga with shallow transverse groove near middle; genitalia (fig. 6), volsellar base with 2 complete rows and partial 3rd row of flattened, contiguous setae forming ctenidia, digitus not exceeding volsellar apex.

Female: Unknown.
Host: Unknown.

Holotype: ♂, Caipe, east Barinas, Venezuela, January 1943, P. Anduze (USNM Type No. 73772; transferred from K. V. Krombein collection).

The relatively more slender, subpetiolate first abdominal segment distinguishes *petiolatus* from all known *Pterombrus*. The transverse grooves on the third and fourth abdominal terga are unique among the all black species, although they are found in some taxa with the abdomen mostly red.

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NOTES ON THE BIOLOGY OF PTEROMBRUS PICEUS KROMBEIN (HYMENOPTERA: TIPHIIDAE)

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ABSTRACT—Females of *Pterombrus piceus* Krombein enter burrows of larval *Pseudoxychila tarsalis* Bates, a tiger beetle (Cicindelidae), sting the larvae, position them ventral side up, lay a single egg on the venter of the abdomen, and close the burrow with bits of soil. Eggs hatch in 5 days and larvae grow an average of 1 mm/day. Larval development requires 8–13 days, and is followed by a prepupal stage lasting about 25 days. The pupal stage requires approximately 20 days, and adults emerge between 65 and 70 days after the egg is laid.

Members of the genus *Pterombrus* (Hymenoptera: Tiphiidae) have been recorded as parasitoids of the tiger beetle family (Coleoptera: Cicindelidae) in Brazil (Williams, 1928). *Pterombrus piceus* Krombein (Krombein and Evans, 1976) was found parasitizing the larvae of the tiger beetle *Pseudoxychila tarsalis* Bates in Costa Rica during the wet season of 1975. *Pseudoxychila tarsalis* is known to range from Colombia to Costa Rica (Horn, 1926). At 8.5° N, 83° W where this study was done, host larvae were never found below 1000 m elevation and were most abundant at about 1200 m. In this area, the three larval instars of *P. tarsalis* construct horizontal burrows in vertical clay banks along paths cut through second growth forest, coffee plantations, and along roadways. This paper describes the interaction of adult female wasps with their beetle prey, and provides information on the life history and growth rates of the wasp.

Materials and Methods

Observations were made from October to December of 1975 at the Las Cruces Tropical Botanical Garden, 4 km south of San Vito de Java, Costa Rica, in Central America. This area has a pronounced dry season from December to April, and receives about 3300 mm of rainfall during the remainder of the year (fig. 1). Over both seasons, nights are cool (mean 13.6°C) and days are warm (mean 29°C). The elevation of Las Cruces is 1250 m.

Adult female wasps were observed in nature locating and ovipositing in larval beetle burrows. One female wasp was observed with several host larvae in a glass terrarium in the laboratory. Eggs were gathered by excavating host larvae whose holes had been entered by wasps, and both host and wasp eggs were brought into the laboratory for examination of growth rates.

Host larval burrows were observed daily to discriminate between active and inactive (dead or parasitized) larvae. This was determined by inserting a straight pin into each hole with only the head of the pin remaining visible.

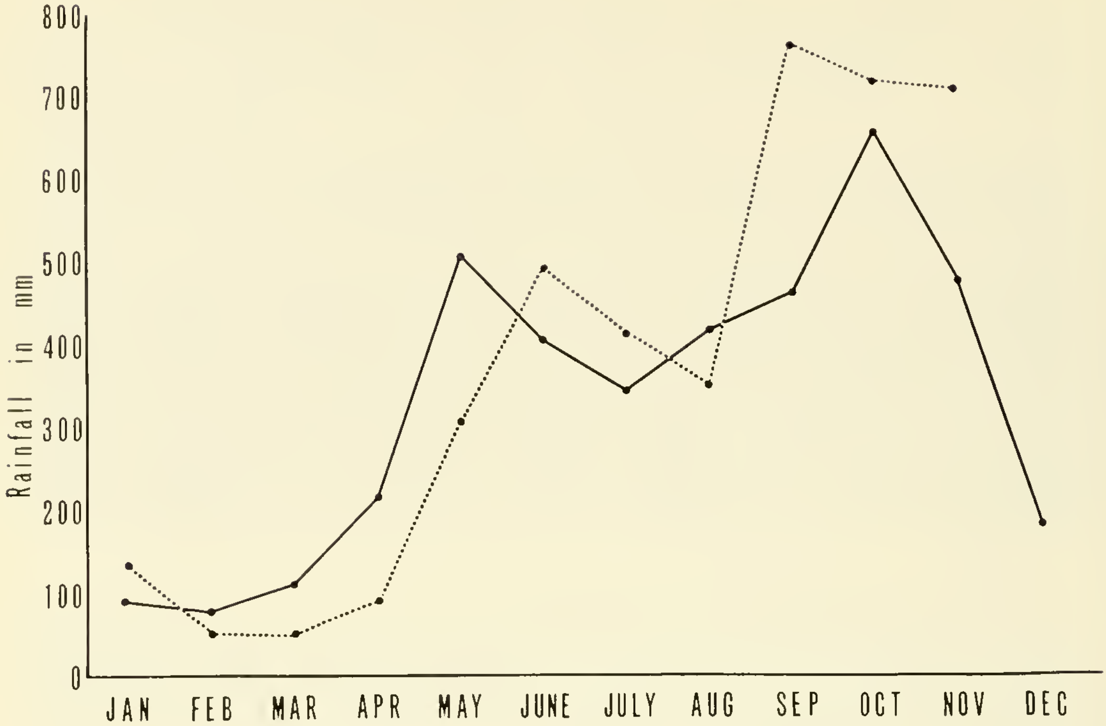

Fig. 1. Annual rainfall patterns for San Vito de Java, Costa Rica. Solid line represents 12 year averages, 1953–1964 (after Schnell, 1971). Dashed line is rainfall for 1975.

Active larvae push foreign objects out of their holes when they assume prey-capture posture at the entrances of the burrows. Presence of an unmoved pin is an indication that the beetle larva is either dead or parasitized. Thus, the exact date of morbidity can be determined. Holes of inactive beetle larvae were excavated at various time intervals after the date of morbidity, and all stages of *Pterombrus* were brought into the laboratory for further observation. Each wasp larva or cocoon was placed on a piece of moist filter paper in a covered petri dish and kept at room temperature (22–32°C) out of direct sun. During this period, larvae were measured daily until they constructed cocoons. The life history of the wasp as presented in this paper was generated from material collected from host larval burrows and from direct observations of growth rates in the laboratory.

RESULTS AND DISCUSSION

Behavior of Adult Females

In late October, adult female wasps were first observed walking on the banks where approximately 600 marked tiger beetle burrows were under observation. As is true for other members of this genus (Williams, 1928), *Pterombrus piceus* is a strong flier but does not fly when apparently searching for oviposition sites. Adult females walk slowly among the holes, stopping frequently and cleaning their antennae. One female wasp was seen to pass by several first and third instar burrows where beetle larvae were waiting at the entrances to catch passing prey. At one point, when she was within about 3 cm of a second instar hole, the beetle larva suddenly retreated into its hole, seemingly frightened by the approaching wasp. The wasp then entered the hole without hesitation and laid one egg on the larva.

On another occasion, a female again passed by all holes with beetle larvae at the entrances unless the larvae retreated as she approached. When she encountered a third instar which backed into its hole as she neared it, she entered the hole immediately. After 50 seconds, the beetle larva began backing out of its burrow with the wasp stinging it on the ventral portion of the thorax. The entire process lasted 10.5 minutes.

Another female was observed stopping only at holes with beetle larvae at the entrances. She partially entered a third instar hole that contained a larva at the back of the burrow. She circled the entrance of the hole, tapping with her abdomen and antennae; when the beetle came to the entrance of the hole, it appeared to grasp the wasp with its mandibles. Both insects then partially emerged from the hole with the wasp stinging the beetle larva repeatedly on the venter of the thorax. The larva then appeared to flip out of the hole or to fall out, and both insects fell a distance of about two feet. The wasp continued to sting the beetle after they fell. Once the beetle was immobilized, the wasp left and continued "searching" for holes as she had done previously.

It is interesting to note that this female did not attempt to drag the paralyzed larva or to dig a hole nearby in which to put the larva. *Methocha stygia* (Say) (Tiphiidae, subfamily Methochinae), which I have observed ovipositing on *Cicindela repanda* DeJean in Michigan, will often transport paralyzed larvae that it finds on the ground. I have seen these wasps struggle for up to two hours to drag paralyzed beetle larvae into suitable holes and then to oviposit on them and close off the burrows. Wilson and Farish (1973) describe this behavior in detail and discuss its significance in considering the ancestors of the Methochinae as possible ancestors of the Formicidae. To see what *Pterombrus piceus* would do with paralyzed larvae under laboratory conditions, I confined a single female (all I could find at that time) with a paralyzed larva and several active beetle larvae in a terrarium filled with soil to a depth of about 2 inches. She displayed no interest whatsoever in these larvae as long as they were lying on the surface of the soil. She readily entered burrows once the larvae dug them, however.

In general, the behavior of *Pterombrus piceus* females with their prey seems more cautious than that described by Williams for *P. cicindelicidus* Williams and *P. iheringi* Ducke. Females of *Pterombrus piceus* seem to prefer holes where beetle larvae can be seen waiting at the entrance and retreating when approached. One advantage for visual recognition is suggested by Williams, who notes that one female "quickly drew back" upon discovering a spider within a beetle hole (I saw one adult female fall prey to a spider outside a burrow during my observations). In addition, it seems that beetle larvae (especially third instars) may occasionally catch and eat wasps as they are entering burrows. Thus it may be safest for the wasp to enter while the beetle is retreating.

Life History

After stinging the beetle larva, the wasp positions her prey inside the burrow at a distance of about 3 cm from its entrance. All parasitized larvae dug out were lying ventral side up. As in other members of this genus for which the biology has been described (Williams, 1928), *Pterombrus piceus* closes the hole with a plug of loose soil varying in thickness from a few mm to 1 cm. *Pterombrus piceus* lays a single egg on the first and second abdominal sternites of the host, as shown by Williams for *P. iheringi.* Eggs are creamy, sausage-shaped and about 1 mm long, and are usually laid on second instar *P. tarsalis* larvae which are about 11 mm long. Of three eggs brought into the laboratory on the day they were laid, two hatched in 5 days, and one turned black (died) at 6 days (its host began to turn black at 8 days).

The young salmon-colored wasp larva feeds by inserting its head beneath the beetle's abdominal integument. Wasp larvae grow an average of 1 mm per day until they are between 7 and 10 mm long. At this time, they begin constructing a cocoon comprised of many layers of reddish-brown to whitish silk. Larvae detached from their hosts while in a petri dish are able to relocate the host.

For 28 second instar burrows excavated from August to December 1975, 31.4% contained beetles parasitized by wasps. Burrows containing parasitized beetle larvae which had shown no activity for 13 days or less contained either wasp eggs or wasp larvae in various stages of development. Holes with beetle larvae inactive for 18 days or more usually contained wasp cocoons (one at 20 days had a wasp larva). This suggests that larval development requires between 8 and 13 days after egg hatching. Further, five wasp larvae were observed under laboratory conditions from the date of egg-laying until construction of the cocoon was complete. Their growth rates indicate that larval development in the laboratory requires anywhere from 8 to 19 days ($\bar{x} = 12$, sd $= 17$). The longer period of development in the laboratory may be a function of the difficulty of constructing a cocoon without the attachment points provided by the burrow walls of the host. An additional five wasp larvae were unable to complete cocoons, but they virtually covered the bottoms of petri

Table I. Contents of larval tiger beetle burrows excavated at various time intervals after wasp eggs were laid.

Beetle instar	No. of days from wasp oviposition	Wasp condition
2	9	wasp larva, length unknown
2	11	wasp larva, 3.5 mm
2	11	wasp larva, 3 mm
2	13	wasp larva, 6 mm
3	16	no wasp (beetle paralyzed)
2	16	no wasp (beetle paralyzed)
2	18	wasp pupal case
2	19	wasp pupal case
2	20	large wasp larva
3	23	huge wasp pupal case
3	24	huge wasp pupal case
2	24	wasp pupal case
2	30	wasp pupal case
2	41	adult wasp in pupal case
2	45	wasp pupal case
2	45	wasp pupal case
2	49	wasp pupal case, wasp eaten?
2	49	wasp in cocoon, wasp dark and wings not fully expanded
2	50	wasp pupal case
2	51	wasp pupal case, wasp emerged or eaten
2	53	wasp in cocoon
2	56	wasp in cocoon
3	58	wasp pale and soft inside cocoon
2	58	wasp emerged
2	60	wasp inside pupal case
2	64	wasp moving inside cocoon
2	64	wasp moving inside cocoon, emerged at 65 days
2	65	wasp inside cocoon
2	66	wasp emerged
2	71	wasp emerged
2	74	wasp emerged
2	99	wasp emerged

dishes with silk. Normally, cocoons are formed immediately behind the host's head capsule and are attached to it (see Williams, 1928).

Cocoons opened at 22, 24, 39 and 46 days after the egg was laid contained prepupae, and two cocoons of 40 and 64 days contained pupae. This indicates that there is a prepupal stage of about 25 days which is followed by a short pupal stage of about 20 days. Adult wasps can be seen moving inside cocoons at about 60 days from the time the egg was laid. Unemerged wasps 62–63 days of age are soft, dark and with wings not yet fully expanded. Two adults eclosed in the laboratory at 65 days, and one did so at 71 days. Three wasps 64 and 65 days old found outside had not yet emerged, but all holes excavated after 66 days contained empty wasp cocoons (one adult emerged under field conditions before 58 days). Table I shows the contents of beetle burrows excavated at various time intervals after the wasp egg was laid.

It is clear from Table I that the vast majority of beetle larvae parasitized in the field were in the second instar. Virtually all of the third instar beetles parasitized (5 out of 7) were found in late November or early December, perhaps indicating a switch to larger hosts at the end of the rainy season when very few second instar beetle larvae remain in the population. It is interesting that of four third instar beetle burrows which had cocoons (the rest had either eggs or larvae), two contained very large wasp cocoons. These were about 3 cm long as compared to 1.5 to 2 cm for second instar hosts. These cocoons contained wasp larvae roughly equal in size to those found on second instar hosts. Most of the size difference was due to additional layers of silk in the cocoon. The hypothesized switch to a larger resource (that is, third instar hosts as opposed to second) may thus enable wasps to make larger, more desiccation-resistant cocoons and thus increase their probability of survival through the dry season.

As mentioned previously, no wasps were noticed until late October, at which time I could find no more than two adults per day. I suspect that I missed the time of peak abundance of wasps. During the period from August to December, 31.4% of second instar beetle deaths were due to parasitism by *Pterombrus piceus*, as determined by the excavation of holes. It was not always possible to ascertain causes of death for larvae dying prior to August, partly because of the deterioration of wasp cocoons in burrows. Let us assume, however, that sources of mortality are roughly constant throughout the wet season. Fig. 2 shows all second instar beetle deaths that occurred during the wet season in 1975, and displays a definite peak from mid-June to mid-August. From this we might conclude that October is not the optimal time of year to study *P. piceus* in this area, and that adult wasps may have been more abundant from mid-June to

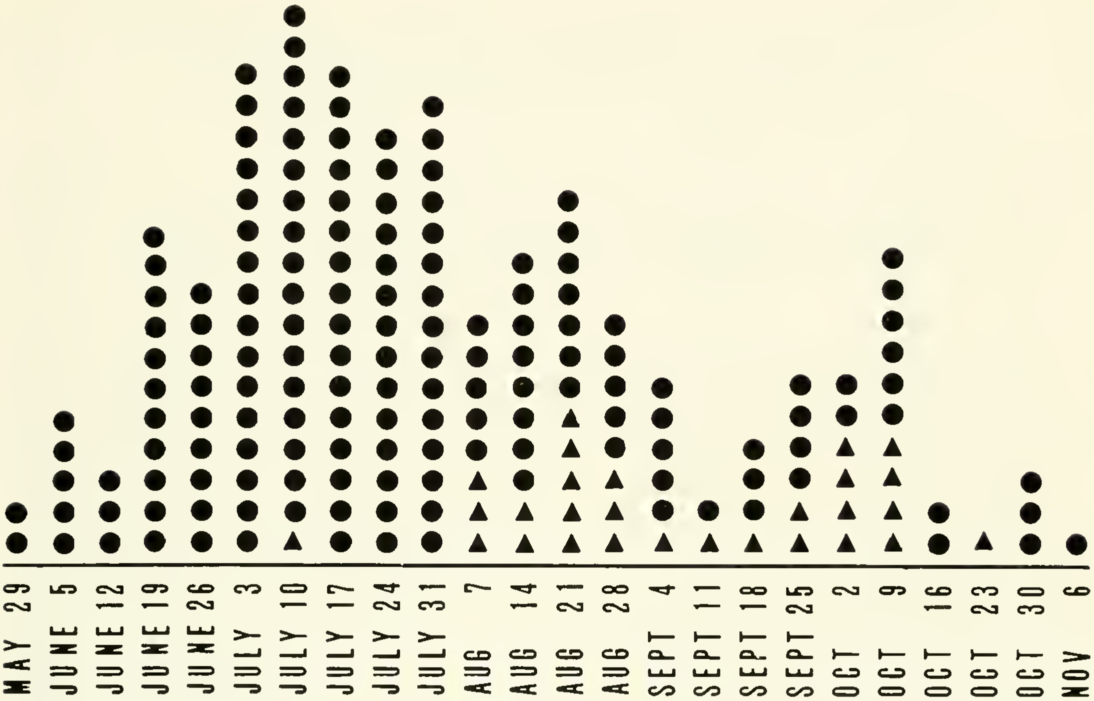

Fig. 2. All deaths of second instar tiger beetle larvae during wet season, 1975. Circles represent deaths due to unknown causes. Triangles are deaths due to *Pterombrus piceus*. Each symbol represents one larva. Records on sources of mortality not kept before about 1 August.

mid-August. No adults were seen after mid-November, although a few newly parasitized beetle larvae were found into December.

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TABANIDAE (DIPTERA) OF TEXAS. V. SECOND-YEAR COLLECTIONS FROM HUNTSVILLE STATE PARK AND THE NAVASOTA RIVER WATERSHED

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ABSTRACT—Collections of Tabanidae were made in a second consecutive year (1972) from Huntsville State Park and the Navasota River Bottoms, April through September. Based upon modified Manitoba Trap catches and overhead collections from sites common to both years, populations of most species at Huntsville Park were much less numerous in this second year, but the faunas were very similar qualitatively in both years. Seven species were found in only 1 of the 2 years at Huntsville and 8 species at Navasota; catches of most of these species were very small. Four species at the 2 study areas were the most abundant forms in both years—*Tabanus lineola* F., *Chrysops pikei* Whitney, *Tabanus petiolatus* Hine, and *Chrysops callidus* Osten Sacken at Huntsville; and *Tabanus fuscicostatus* Hine, *T. subsimilis* Bellardi, *T. proximus* Walker, and *T. trimaculatus* Palisot de Beauvois at Navasota. Eighteen of the 39 species taken in the 2-year study were found in both study areas which are 40 miles apart in adjacent physiographic regions (Pine Belt and Post Oak Belt). Huntsville produced a much richer fauna of deer flies (*Chrysops*) whereas Navasota was dominated by horse flies (*Tabanus* and *Hybomitra*), qualitatively and quantitatively. State and county records are reported.

Collections of Tabanidae in Huntsville State Park, Walker County, and in the Navasota River Watershed, Brazos and Grimes Counties, were reported in Thompson (1973) and Thompson (1974), respectively. Additional collections were made in a second year to describe the two faunas in more detail.

Methods

The physiography of the study areas, description of trap sites, and collecting methods were given previously. Catches were retrieved weekly in Huntsville State Park and 3 times weekly (Mon., Wed., Fri.) in the Navasota River location. Collections at Huntsville State Park (HSP) were continued in 3 of the 4 trap sites previously described (dam, opening, and creek) because of their productivity. Collections in the Navasota River Watershed were made in the Navasota River Bottoms (NRB) near Bryan-College Station, one of the locations previously described in Thompson (1974) and that producing the greatest numbers and species of flies. Traps were operated here in the sloughs and margins of the river near its intersection with FM 2038 (Grimes County).

Table 1.—Catches of Tabanidae (females) taken at Huntsville State Park, Walker County, Texas, Apr. 5–Sept. 28, 1972.[a]

Species	Total	Season
Chrysops brimleyi Hine[bc]	4	Apr 5–May 30
callidus Osten Sacken[de]	104	Apr 10–Jul 11
flavidus Wiedemann[e]	44	Apr 24–Jul 24
montanus Osten Sacken[e]	17	May 8–Jul 3
pikei Whitney[e]	141	Apr 5–Aug 1
reicherti Fairchild	18	May 30–Jul 24
separatus Hine[bc]	3	Apr 5–Jun 19
upsilon Philip	12	Jun 5–Sept 28
virgulatus Bellardi[c]	1	Jun 13
vittatus Wiedemann	4	May 8–Jun 26
Chlorotabanus crepuscularis (Bequaert)[c]	1	May 30
Leucotabanus annulatus (Say)[e]	22	Jun 13–Aug 28
Tabanus aranti Hays[c]	1	Jun 26
fuscicostatus Hine[e]	7	Apr 10–Jun 19
lineola F.[e]	316	Apr 5–Sept 28
longus Osten Sacken group[e]	25	Jun 5–Aug 7
molestus Say[e]	43	May 30–Jul 24
mularis Stone[c]	1	May 1
nigripes Wiedemann[e]	9	May 30–Aug 15
petiolatus Hine[ef]	116	May 30–Sept 6
proximus Walker[e]	67	Jul 3–Sept 6
pumilus Macquart	8	Apr 17–24
quaesitus Stone[e]	23	Apr 17–Jul 11
subsimilis Bellardi[e]	35	Apr 5–Jul 3
sulcifrons Macquart[ce]	3	Aug 1–21
trimaculatus Palisot de Beauvois[e]	38	May 1–Aug 1

[a] Catches by all methods at all sites; comparisons with 1971 catches are based upon portions of catch totals from both years.
[b] State record.
[c] County record.
[d] Represented by 1 male specimen.
[e] Species also recorded from Navasota River sites (including *T. sparus* var. *milleri* Whitney).
[f] *T. melanocerus petiolatus* Hine of previous papers in this series on Texas faunas.

RESULTS

Huntsville State Park

The Fauna: Collections in 1972 produced 1063 females (and 1 male) representing 26 species in 4 genera: 10 in *Chrysops*, 1 each in *Chlorotabanus* and *Leucotabanus*, and 14 in *Tabanus* (Table 1). The 1972 collections representing additional state and county records are noted in Table 1.

Comparisons in Annual Faunal Structure.—The same number of species in 4 genera were taken in both years. A fifth genus, *Hybomitra*, was not represented in 1972 (6 specimens of *H. trispila* (Wiedemann) in 1971). Approximately ⅓ to ¼ of the fauna were represented in one year but not in the other: 7 species only in 1971 (*Chrysops cincticornis* Walker, *C. fulvistigma* Hine, *C. hinei* Daecke, *Tabanus colon* Thunberg, *T. sparus* var. *milleri* Whitney, *T. stygius* Say, and *Hybomitra trispila*); and 6 species only in 1972 (*Chrysops brimleyi* Hine, *C. separatus* Hine, *C. virgulatus* Bellardi, *Tabanus aranti* Hays, *T. mularis* Stone, and *T. sulcifrons* Macquart). Of these 13 species collected in only one year, 12 were represented by only 1–8 specimens; one by 13 specimens (*T. sparus* var. *milleri*).

Comparisons in Annual Abundance: The 4 most abundant species in 1972 included 63.7% of all material taken: *Tabanus lineola* F., 29.7; *Chrysops pikei* Whitney, 13.3%; *Tabanus petiolatus* Hine, 10.9%; and *Chrysops callidus* Osten Sacken, 9.8%. In necessarily comparing the totals of these species taken by the same methods from sites common to both years, tabanid production was nearly cut in half the second year—1.2 to 4.1X greater in 1971. These 4 species were the most abundant forms collected in both years; only the relative positions of *Tabanus petiolatus* and *T. lineola* were reversed. Only 6 of the species collected in both years were more abundant in 1972 and 3 of these averaged less than 10 specimens per year (*Chrysops reicherti* Fairchild, *C. upsilon* Philip, and *Leucotabanus annulatus* (Say)).

Seasonal Periodicity: Peak numbers of the dominants appeared at about the same time in both years; late April and early May for *Chrysops callidus* and *C. pikei* and mid-June for *Tabanus lineola* and *T. petiolatus*. The earliest dates of collection for *Chrysops callidus* and *C. pikei* were 2–3 days apart in 1971 and 1972. *Tabanus petiolatus* was 18 days earlier in 1972; *T. lineola* was 4½ weeks earlier. At the other extreme, *Chrysops upsilon* was a month later in 1972. This species was found from June through September (16 weeks) although it was represented by only 12 specimens.

Navasota River Bottoms

The Fauna: Catches in 1972 produced 896 females (and 4 males) of 19 species in 5 genera: 3 in *Chrysops*; 1 each in *Whitneyomyia*, *Leucotabanus*, and *Hybomitra*; and 13 in *Tabanus* (Table 2).

Comparisons in Annual Faunal Structure: Similar numbers of species in the same genera were found in 1971 and 1972. Eight species were represented in one year: 5 species only in 1971 (*Chrysops montanus* Osten Sacken, *Chlorotabanus crepuscularis* (Bequaert), *Tabanus cymatophorus* Osten Sacken, *T. nigripes* Wiedemann, and *T. sparus* var. *milleri*); and 3 only in 1972 (*T. quaesitus* Stone, *T.*

Table 2.—Catches of Tabanidae (females) taken at the Navasota River Bottoms, Grimes County, Texas, Mar. 3–Sept. 28, 1972.[a]

Species	Total	Season
Chrysops callidus Osten Sacken	18	Mar 27–Aug 1
flavidus Wiedemann	2	Apr 17–May 1
pikei Whitney	11	Apr 5–Sept 6
Whitneyomyia beatifica var. *atricorpus* Philip	1	May 30
Leucotabanus annulatus (Say)	3	Jun 5–26
Tabanus americanus Forster	1	Jun 13
atratus F.[b]	2	Aug 1–28
fuscicostatus Hine	414	May 8–Sept 18
lineola F.	21	Apr 24–Sept 6
longus Osten Sacken group	1	Jun 5
molestus Say	43	May 8–Jun 19
petiolatus Hine	1	Jun 26
proximus Walker	60	Apr 10–Sept 18
quaesitus Stone	7	Apr 5–17
subsimilis Bellardi	158	Mar 20–Aug 28
sulcifrons Macquart	8	Apr 10–Aug 14
trimaculatus Palisot de Beauvois	56	Apr 10–Sept 6
venustus Osten Sacken	53	Apr 5–Sept 18
Hybomitra lasiophthalma (Macquart)[c]	36	Mar 20–Apr 17

[a] Catches by all methods at all sites; comparisons with 1971 catches are based upon portions of catch totals from both years.

[b] Represented by 1 male specimen.

[c] County record.

longus Osten Sacken group, and *Hybomitra lasiophthalma* (Macquart)). Of these 8 species, only 3 were represented by more than 4 specimens (*Tabanus nigripes*, *T. quaesitus*, and *Hybomitra lasiophthalma*).

Comparisons in Annual Abundance: Five dominants included 82.4% of the total catch in 1972: *Tabanus fuscicostatus* Hine, 46.1%; *T. subsimilis* Bellardi, 17.6%; *T. proximus* Walker 6.6%; *T. trimaculatus* Palisot de Beauvois, 6.2%; and *T. venustus* Osten Sacken, 5.9%. Based upon catches from sites common to both years, the first 4 of these were also the most abundant forms taken in 1971. The 2-year totals of these were similar, but for *Tabanus subsimilis*, which was nearly twice as numerous in 1972 catches. Of the remaining species represented by more than 2 specimens in each year, only *T. venustus* was more numerous in 1972.

Seasonal Periodicity: The dominant species were 3–9 weeks later in 1972 trap catches. *Tabanus fuscicostatus* appeared in early May, again reaching maximum numbers in traps in late May and early June. *Tabanus subsimilis* appeared in late May rather than early

April; *T. proximus* in early July rather than late June; and *T. trimaculatus* in late May and early June rather than late April and early May. *Tabanus venustus* was represented by only 4 males in one year (1971).

Trap Specificity

One Animal Trap operated at the opening site in HSP showed characteristic specificity for horse flies (10 of the 14 species collected), while taking only 2 of the 10 *Chrysops* spp. collected (*C. montanus* and *C. pikei*). It was especially productive for *Tabanus lineola*, the *T. longus* group, and *T. molestus* Say. The trap produced similar results at NRB the same year (1972), catching large percentages of the total catches of *T. fuscicostatus*, 54%; *T. lineola*, 47%; *T. molestus* and *T. venustus*, 81% each.

CONCLUSIONS

The faunas studied represent adjacent physiographic regions of the state, the Pine Belt (Huntsville) and the Post Oak Belt (Navasota). Of the 39 species collected, 18 were represented in both regions. Huntsville State Park produced a much richer fauna of deer flies than the Navasota bottoms, probably because of the greater variety of stream habitats found in the mixed pine-hardwood forests of the Park. The abundance of *Tabanus fuscicostatus* and *Hybomitra lasiophthalma* at NRB and their exclusion (*H. lasiophthalma*) or their rarity (*Tabanus fuscicostatus*) at HSP reflect the prevalence of these forms in lowland forests and swamps of major river floodplains throughout their ranges. Three dominant species, which were included among the 6 most abundant forms at both study areas, breed in a great variety of habitats throughout their eastern ranges: *Tabanus lineola* (sensu stricto) and *T. trimaculatus* in many lowland situations (in lit.); and *T. subsimilis*, in diverse lowland and upland habitats (Thompson, 1975).

This study produced results comparable to those found in successive 2-year studies of other Coastal Plain faunas—the Great Swamp of north-central New Jersey (Thompson, 1969) and Patuxent Wildlife Research Center of south-central Maryland (Thompson, 1972). Catches indicated richer faunas in those 2 eastern study areas; 2-year totals produced 43 species in each vs. 33 and 24 for Huntsville and Navasota, respectively. The greater faunal diversity of the NJ and MD faunas is expected because of the more extensive and more diverse habitats, especially lowland ones, available for tabanid breeding.

Differences in annual incidence of minor species were less marked in the eastern ecosystems than in the Texas ones. One-fourth or less of the NJ and MD faunas were represented in only one year whereas this was true for over ⅓ of the two Texas faunas. Again, populations of such species were probably less numerous at the Texas localities than those at the more productive eastern ones.

Only small year-to-year differences were found in the relative abundance of the dominant species in the 4 faunas studied.

Annual differences in dates of appearance were marked (10–90 days) for only 2 of the 43 species found at Great Swamp; only 1 specimen of each species was collected. Annual differences in phenology of the dominant species elsewhere were more marked; up to 4 weeks at Patuxent, 4½ weeks at HSP and 9 weeks at NRB.

Peak numbers of dominants at all study areas but Navasota showed annual variation of only several weeks. The seasonal catch highs of *Tabanus subsimilis* and *T. trimaculatus* varied by a month or more at Navasota. Some differences in seasonal periodicity, like those noted for faunal diversity and the incidence of minor species, can be attributed to the lesser productivity of the Texas ecosystems. Considerable variation can also be attributed to seasonal temperature changes, as those described for the phenology of Great Swamp species (Thompson, 1969).

I gratefully acknowledge the help of Mr. Edward J. Gregg for conscientiously collecting catches and maintaining traps. I would also like to thank Dr. L. L. Pechuman and Dr. Horace R. Burke for reviewing the manuscript.

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NOTE

ANAPTUS MAJOR ESTABLISHED IN EASTERN NORTH AMERICA (HEMIPTERA: NABIDAE)

Anaptus major (Costa) is a ground-dwelling nabid widely distributed in the Palearctic Region. This species was described in *Nabis* and has been placed in *Aptus* and *Stalia*. Recently, Kerzhner (1968, Entomol. Obozr. 47:848–63, transl. in Entomol. Rev. 47:517–25) described the new genus *Anaptus* with *major* as the only included species.

Barber (1932, Proc. Entomol. Soc. Wash. 34:65–66) first reported this nabid from North America, based on specimens from Oregon. Lattin (1966, Proc. Entomol. Soc. Wash. 68:314–318) gave records from British Columbia, California and Oregon. Collections from several ports and along the Willamette River suggested that the species had been introduced with ship ballast and further spread by river trade. *Anaptus major* has now been taken at Seattle, Washington (Lattin, pers. comm. 1975).

Lattin (1966) also reported *major* from the eastern United States, based on a single specimen collected at Ithaca, N. Y. in July, 1957. He stated (p. 317): "Only further collecting will determine whether it has become established."

Anaptus major has now been taken in alfalfa fields at Ithaca (Pimentel and Wheeler, 1973, Environ. Entomol. 2:659–668) and in a nursery in southcentral Pennsylvania. I recently identified specimens, including a fifth-instar nymph, collected during a survey of arthropods associated with grape vineyards along Lake Erie in Erie Co., Pa. These records might suggest a ballast means of introduction, but this appears unlikely. *Anaptus major* probably was introduced into eastern North America after the main ballast period, and ship traffic into Lake Erie was minimal before the St. Lawrence Seaway was opened in 1959.

The following records represent the known distribution of *A. major* in eastern North America: NEW YORK: Ithaca, Oct. 12, 1962, Simoni; Savage Farm (Ithaca), July 23, 1967, found dead on Alfalfa plant, A. G. Wheeler, Jr.; Savage Farm, Sept. 4, 1968, on ground under dead alfalfa stems, AGW; Warren Road (Ithaca), July 17, 1969, swept in alfalfa field, AGW (Cornell Univ. coll.). PENNSYLVANIA: Erie Co., North East, July 14–21, July 21–28, Aug. 4–11, 1971; June 23–30, July 28–Aug. 4, Aug. 18–25, 1972, taken in pitfall traps in commercial grape vineyards, Jubb and Masteller; North East, Sept. 8, 1971, sweeping weeds in vineyard, Jubb and Masteller; York Co., Manchester, Dauber's Nursery, July 15, 1971, beaten from *Pinus mugo*, AGW (Pa. Dept. Agric. coll.).

I am grateful to Drs. G. L. Jubb, Jr. and E. C. Masteller, Pennsylvania State University, for allowing me to refer to records from their survey of grape vineyards.

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BOOK REVIEW

Sterility Principle for Insect Control 1974. Proceedings of the symposium on the sterility principle for insect control jointly organized by the International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations and held in Innsbruck, 22–26 July 1974. Unipub, New York. 622 pages. Paperback, $36.00.

The proceedings of this symposium on the sterility principle for insect control reports the search by scientists around the world for alternate methods of insect control. The search came as a result of severe shortages of certain agricultural commodities including pesticides and the increasing costs of fuel. The sterility principle of insect control offers a potentially economical approach to controlling specific insect pests and under certain conditions, to eradicating them. As mentioned in the Foreword of the proceedings, the most difficult aspect of implementing insect control by this method is organizational. Individual growers and producers cannot use the method effectively since it must be applied over large areas where the total population must be controlled.

The organizers of the symposium did a good job in presenting speakers who gave salient facts in different disciplines relating to the sterility principle of insect control.

Due to the broad scope of this book, it is difficult to give a balanced review of all 53 papers presented in 8 different sessions. Following is a list of the 8 sessions and a brief indication of the emphasis of each:

Session 1: Sterile-Male Technique Field Programmes. General picture of the sterile-male technique in plant protection programmes; control technique of Mediterranean fruit fly, *Ceratitis capitata*; use of traps and fruit infestation in field evaluation of medfly and application of sterility techniques to the Caribbean fruit fly, *Anastrepha suspensa*.

Session 2: Economics of the Sterile-Male Technique. General considerations; economic factors to consider in choice of the sterile insect release method and the economic feasibility of setting up a pilot plant for control of the medfly.

Session 3: Computer Models and Application of the Sterile-Male Technique. Various mathematical models and computer simulation models of insect control are discussed.

Session 4: Control of Fruit Flies by the Sterile-Male Technique. Discussions of quality control and biology of the cherry fruit fly, *Rhagoletis cerasi*; population studies of the fruit fly, *Dacus zonatus*; increased egg production in rearing of olive fruit fly, *D. oleae*, with chemical stimuli; development of protein hydrolysate-free larval diets for rearing *D. oleae*; gamma radiation effects on eclosion, fertility, and competitiveness of the Mediterranean fruit fly, *Ceratitis capitata*; and development of inexpensive larval media for *C. capitata*.

Session 5: Effects of Sterilization by Radiation and Chemicals. Discussions of combined effects of radiation and chemical agents in altering the fecundity and fertility of the braconid wasp, *Bracon hebetor*. This allows opportunity to compare parthenogenetically produced offspring with biparental progeny. Laboratory studies were presented on irradiation of the male red palm weevil, *Rhynchophorus ferrugineus* and adult bean weevils, *Acanthoscelides obtectus*; thermal treatment effects on bean weevils, *A. obtectus*; mating competition of radiosterilized male armyworm, *Spodoptera exigua*, and of *Aedes aegypti*; effects of tepa, a chemical sterilant, on spermatogenesis and oogenesis of *Ceratitis capitata*, the Oriental fruit fly, *Dacus dorsalis*, and the melon fly, *Dacus cucurbitae*; effects of chemosterilants on red cotton bug, *Dysdercus koenigii*; and effects of juvenile hormone analogs on the house fly, *Musca domestica*, and on four species of *Dysdercus* that are pests of cotton and other malvaceous crops.

Session 6: Genetic Mechanisms of Insect Control. Discussions of conditional mutations; radiation induced chromosomal rearrangements of the onion fly, *Hylema antiqua*; cytological study of gamma-irradiated testes of the house fly, *Musca domestica*; differences in reproductive physiology and expression of dominant lethal mutations between dipteran and lepidopteran insects that occur after radiation treatments; phenomenon of incompatibility in mating studies between three varieties of the fig moth, *Cadra* (*Ephestia*) *cautella*; application of inherited sterility in *Gonocerus acuteangulatus*; and indication of structural chromosome mutations in progeny of *Tetranychus urticae* by irradiation of spermatids and oocytes.

Session 7: Control of Blood-Sucking Insects by the Sterile-Male Technique. Discussion of sterile-male techniques for control or eradication of the stable fly, *Stomoxys calcitrans*; *Glossina tachinoides*, *Anopheles pharoensis*; presentation of techniques for detecting abortions and for rearing *Glossina* spp.; and effect of bacteria and antibiotics on *Glossina* spp.

Session 8: Control of Lepidoptera by the Sterile-Male Technique. Presentations were given on the effects of irradiation on the biology and behavior of *Heliothis virescens*; response of pupae of the almond moth, *Cadra cautella* pupae to different dosages of gamma radiation; the habitat as a factor inducing diversity in populations of codling moths, *Laspeyresia pomonella*; ecological studies including influence of parasites and pathogens that are basic to the genetic control of *L. pomonella*; survey of synthetic diets for *L. pomonella* including sources, cost of ingredients, and list of publications on rearing; gamma-induced sterility of the greater wax moth, *Galleria mellonella*; and field evaluations of a synthetic sex pheromone of *Spodoptera littoralis*.

The presentations are all followed by a question and answer section, and an extensive list of up-to-date references. The only factor that may discourage anyone from purchasing it is the price—$36.00.

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THE NEARCTIC DORYCTINAE, X. THE GENUS RHACONOTUS RUTHE (HYMENOPTERA: BRACONIDAE)

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ABSTRACT—A key and descriptions for the 9 species of Nearctic *Rhaconotus* are presented; 6 species are described as new, **atratus**, **badius**, **barri**, **brevicaudus**, **canadensis**, and **phalarus**.

The genus *Rhaconotus* Ruthe is a very distinctive group of species with slender, strongly sclerotized and sculptured bodies. The most significant feature which distinguishes them from nearly all other braconids is the structure of the abdomen; the first five terga form a strongly sculptured and rigid carapacelike structure under which the last three terga are retracted.

The species of *Rhaconotus* also have a characteristic biology in that they appear to all be parasites of larvae of coleopterous and lepidopterous borers in stems of herbs, shrubs, and grasses. The most common groups of plants from which species have been reared are the Compositae, Gramineae, Solanaceae, and Euphorbiaceae. The Nearctic species do not seem to be of any great economic significance, but several species are important parasites of borers in rice, sugar cane, and cotton in areas of the World where these crops are grown.

The genus contains 150 described species of which most occur in the Oriental and Ethiopian Regions. These areas contain extensive cultivated areas of rice, sugar cane, and cotton which seem to be the major hosts for the hosts of *Rhaconotus* species. In the Palearctic and Nearctic Regions the species appear to be concentrated but not restricted to the southern areas. No species have been recorded from the Neotropical Region, but the National Collection contains a few specimens of unnamed species from Mexico and Central America. The Nearctic Region contains nine species of which six are described below as new.

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[1] Mail address: c/o U.S. National Museum, Washington, D.C. 20560.

Specimens for this study were received from the following institutions: University of Arizona, California Academy of Sciences, University of California at Riverside, Canadian National Collection (CNC), Florida State Collection of Arthropods, Iowa State University (ISU), University of Kansas, University of Michigan, Museum of Comparative Zoology (MCZ), Texas A & M University, and the U.S. National Museum (USNM). Scanning electron microscope time for this project was supported in part by the Electron Microscope Central Facility, Center of Materials Research, University of Maryland, College Park.

Genus *Rhaconotus* Ruthe

Rhaconotus Ruthe, 1854:349.

Type-species: *Rhaconotus aciculatus* Ruthe, monotypic; holotype deposited in British Museum (Natural History), London.

Hedysomus Foerster, 1862:238.

Type-species: *Hedysomus elegans* Foerster, monotypic and original designation; holotype deposited in Zoological Museum of Humboldt University, Berlin. Synonymy by Muesebeck and Walkley, 1951.

Hormiopterus Giraud, 1869:478.

Type-species: *Hormiopterus ollivieri* Giraud, monotypic; holotype deposited in National Museum of Natural History, Paris. Synonymy by Nixon, 1940.

Rhadinogaster Szépligeti, 1908:223.

Type-species: *Rhadinogaster testacea* Szépligeti, designated by Viereck, 1914; holotype deposited in Hungarian Natural History Museum, Budapest. Synonymy by Marsh, 1973.

Euryphrymnus Cameron, 1910:100.

Type-species: *Euryphrymnus testaceiceps* Cameron, monotypic; holotype deposited in Zoological Museum of Humboldt University, Berlin. Synonymy by Muesebeck and Walkley, 1951.

Diagnosis: Head cubical; notauli present but frequently weak; foretibia with row of 4–7 stout spines on anterior edge; all femora with a blisterlike swelling on upper surface just posterior to middle; hindcoxa with toothlike projection ventrally at base; forewings with 3 cubital cells, recurrent vein entering 2nd cubital cell at extreme base or rarely interstitial with 1st intercubitus, subdiscoideus interstitial with discoideus, medius sinuate; radiella and postnervellus of hindwing usually absent; forewings often marked with dark and light bands; 1st 5 abdominal terga strongly sclerotized and with sharp lateral margins, remainder of terga retracted beneath tergum 5 so that the abdomen appears carapacelike, all exposed terga with a predominating sculpture of deep striations or, in 1 species, punctations, transverse groove between terga 2 and 3 always crenulate; predominate sculpture of entire body coriaceous or reticulate with varying degrees of striation superimposed.

The closest relatives of *Rhaconotus* appear to be the genera *Spathius* Nees and *Platyspathius* Viereck by virtue of similar wing venations. But *Rhaconotus* can be readily recognized by its abdominal formation which separates it from all genera of the Doryctinae. Some authors have placed it in a separate tribe, but I think that this treatment only obscures its relationships with the other genera.

Several morphological characters are useful in recognizing species of *Rhaconotus*, the more important being the length of the ovipositor relative to the length of the forewing or the abdomen, the wing coloration, and the body sculpturing. The wing venation varies only slightly, but the wing pattern ranges from completely hyaline to banded with alternate dark and light transverse bands to dusky with irregular hyaline spots. The most important specific character is the sculpturing of the body. In defining the type of sculpturing I have used terms proposed by Eady (1968) in his paper on the microsculpture of Hymenoptera. In all species the body has a basic sculpture which is either coriaceous or reticulate. Coriaceous sculpturing gives the appearance of a cracked mud surface with the areas between cracks flat (fig. 7) or slightly convex (fig. 8); reticulate sculpturing is similar but the areas between cracks are concave (fig. 9). Occasionally there is a ground sculpture termed granulate which is similar to coriaceous except the raised areas are smaller and circular. Superimposed on these basic sculptures are various degrees of ridges, striae, or rugosities, such as striate-reticulate (fig. 10, 18), striate-coriaceous (fig. 8, 13), or strigose-reticulate (fig. 14, 16). Strigose sculpturing differs from striate in that the striae are irregular or wavy rather than straight and nearly parallel. Crenulate refers to a wide groove or furrow with transverse carinae at regular intervals, much like the prescutellar furrow (fig. 13).

The key that follows is to females only. Of the few males that I have seen, most are associated with a particular species with considerable difficulty. The males of *Rhaconotus*, as in most braconids, tend to be smaller and not as strongly or distincly sculptured as the females so that they become very similar and hard to distinguish. The best way to determine the male of a particular species is by association with reared females.

KEY TO FEMALES OF NORTH AMERICAN *Rhaconotus*

1. Forewing length (FWL) at least 3½× ovipositor length (OL), usually 4 or 5× 2
— FWL at most 3½× OL, usually about 2× 5
2. First abdominal tergum wider than long at apex; antenna less than 30-segmented; sternaulus weakly or not crenulate 3
— First abdominal tergum longer than wide at apex; antenna more than 30-segmented; sternaulus strongly crenulate 4

3. Body dark brown or black, legs brown; pronotum shorter than 1st flagellar segment and without distinct transverse carina .... *brevicaudus*, new species
— Head, prothorax, mesopleural disc, and abdominal terga 1 and 2 light brown, mesonotum, mesosternum, propodeum, and rest of abdominal terga dark brown, legs honey yellow; pronotum longer than 1st flagellar segment and with distinct transverse carina .... *canadensis*, new species
4. Body, including head, dark brown or black, hindfemur usually dark brown or black, darker than hindtrochanters; 3rd segment of radius of forewing usually about 1⅓× longer than 2nd segment .... *atratus*, new species
— Body brown, head light brown or honey yellow, hindfemur and hindtrochanters honey yellow; 3rd segment of radius usually 1⅔ to 1¾× longer than 2nd segment .... *badius*, new species
5. Wings with alternate dark and hyaline bands (fig. 4, 5), rarely weakly so; notauli shallow, often nearly absent, area where they meet usually with 3 or 4 longitudinal carinae (fig. 13); abdominal tergum 5 weekly coriaceous (fig. 11) 6
— Wings not noticeably banded, either hyaline (fig. 1) or dusky with irregular hyaline spots (fig. 2, 3); notauli deep, crenulate, strongly strigose where they meet (fig. 16); abdominal tergum 5 strongly sculptured, striae converging inwardly at apex (fig. 12), or at least granulations forming a circular swirl 7
6. FWL 3–3½× OL; propodeum and abdominal terga 1 and 2 usually reticulate; color generally light brown .... *graciliformus* (Viereck)
— FWL 2× OL or less; propodeum and abdominal terga 1 and 2 usually strigose-reticulate; color generally dark brown .... *fasciatus* (Ashmead)
7. Vertex strigose-reticulate (fig. 14) .... *cressoni* Muesebeck and Walkley
— Vertex reticulate 8
8. Mesopleuron strongly and deeply striate-coriaceous; wings dusky with hyaline spots (fig. 3) .... *phalarus*, new species
— Mesopleuron coriaceous; wings hyaline (fig. 1) .... *barri*, new species

Rhaconotus atratus Marsh, new species

Female Holotype: Length of body, 4 mm; ovipositor, 0.75 mm. *Color*: Body black; head with lighter face and spots around eyes; forelegs brown, foretibia dark brown with light basal ring, last tarsal segment black; mid- and hindlegs black except trochanters, basal ring on tibiae, and 1st 4 tarsal segments which are brown; basal antennal segments honey yellow, apical ones brown; wings banded, radial cell with hyaline spot at apex af stigma. *Head*: Entirely coriaceous to granulate; malar space ½ eye height; temples slightly less than eye width; ocellocular distance about 5× diameter of lateral ocellus; antenna 35-segmented. *Thorax*: Pronotum coriaceous, longer than 1st flagellar segment, transverse carina strong, propleuron coriaceous, striate medially; proepisternum coriaceous; mesonotal lobes shallowly reticulate, notauli weak, crenulate anteriorly, with weak longitudinal carinae where they meet posteriorly (as in fig. 13); scutellar disc coriaceous; mesopleural disc shallowly reticulate, subalar groove and sternaulus crenulate; mesosternum coriaceous; propodeum horizontal, not declivous posteriorly, weakly striate-reticulate with strong median basal carina. *Legs*: Foretarsus about 1½× longer than foretibia, mid- and hindtarsi equal to mid- and hindtibiae respectively. *Wings*: Second segment of radius 6× as long as 1st, 3rd segment 1⅓× as long as 2nd; longest hairs on apical border of forewing about equal to length of 1st segment of radius. *Abdomen*: First tergum longer than apical width, strongly striate-reticulate; 2nd tergum strongly striate-reticulate; terga 3–5 coriaceous except some strong striations at base of each terga; ovipositor slightly shorter than combined lengths of terga 1 and 2, forewing length 3⅔× ovipositor length.

Variation: Length of body, 3–4.5 mm; ovipositor, 0.5–1 mm; legs and head sometimes lighter brown; antenna 32- to 35-segmented; 3rd segment of radius 1¼ to 1½× as long as 2nd segment.

Male: Essentially as in female; antenna 25- to 28-segmented; radial cell sometimes without hyaline spot at apex of stigma; propodeum and abdomen less strongly striate.

Holotype Female: Hanover, New Hampshire, K. W. Cooper, 8–23–30? (label difficult to read). Deposited in USNM.

Paratypes: 4 ♀♀, 2 ♂♂, Patuxent, Maryland, 1 ♀, H. C. Owens, 1953 (USNM); Holliston, Massachusetts, 1 ♀, 1 ♂, 20-VII, 1-IX, N. Banks (MCZ); Douglas Lake, Cheboygan Co., Michigan, 1 ♀, Aug. 2, 1950, R. I. Sailer (USNM); 5 mi SE Pequot Lakes, Crow Wing Co., Minnesota, 1 ♀, July 4, 1957, J. L. Laffoon (ISU); Bear Mt., Palisades Pk., New York, 1 ♂, VI-8-41 (MCZ).

This species is similar to *brevicaudus* but is distinguishable by its longer first abdominal tergum, longer antenna, coriaceous face, wing coloration, and shorter hair on edge of forewing. It is also similar to *fasciatus* but is distinguished by its shorter ovipositor.

Rhaconotus badius Marsh, new species

Female Holotype: Length of body 3.5 mm; ovipositor, 0.75 mm. *Color*: Head light brown; basal antennal segments honey yellow, apical ones brown; thorax and abdomen dark brown, proepisternum, pronotum, and apical edges of terga 3–5 light brown; legs honey yellow, hindcoxa slightly darker, hindtibia slightly darker on apical ⅓, apical segment of all tarsi brown; wings banded, radial cell with small hyaline spot at apex of stigma. *Head*: Entirely coriaceous; malar space ½ eye height; temples less than eye width; ocellocular distance 5× diameter of lateral ocellus; antenna 32-segmented. *Thorax*: Pronotum coriaceous, about as long as 1st flagellar segment, transverse carina distinct, propleuron coriaceous, strongly striate medially; mesonotal lobes coriaceous, notauli weak, crenulate anteriorly with longitudinal striations where they meet posteriorly; scutellar disc coriaceous; mesopleural disc coriaceous, subalar groove weakly crenulate, sternaulus crenulate; propodeum horizontal, not declivous posteriorly, striate-reticulate with distinct median basal carina. *Legs*: Foretarsus 1⅓× as long as foretibia, mid- and hindtarsi equal to mid- and hindtibiae respectively. *Wings*: Second segment of radius 4½× as long as 1st segment, 3rd segment

1⅔× as long as 2nd segment. *Abdomen*: First tergum longer than apical width, strongly striate-reticulate; 2nd tergum strongly striate-reticulate; terga 3–5 coriaceous except some strong striations at base of each terga; ovipositor slightly longer than combined lengths of terga 1 and 2, forewing length 3⅔× as long as ovipositor.

Variation: Length of body, 3.5–4 mm; antenna 32- to 33-segmented; 3rd segment of radius 1½ to almost 2× as long as 2nd segment.

Male: Unknown.

Holotype Female: Richmond, Indiana, W. J. Philips colr. Deposited in USNM.

Paratypes: 12 ♀♀, same data as type, 4 ♀♀ (USNM); Lethbridge, Alberta, 2 ♀♀, VII-8-56, VI-24-56, O. Peck, (CNC); Scandia, Alberta, 3 ♀♀, VII-9 1956, VII-11-56, VI-26-56, O. Peck, swept from range grass (CNC); Lincoln, Nebraska, 2 ♀♀, F. M. Webster and G. I. Reeves colrs. (USNM); Lucern, Lake Chelan, Washington, 1 ♀, 29 July 19, A. L. Melander (MCZ).

This species is similar to *fasciatus* but is distinguished by its shorter ovipositor; also similar to *atratus* but is distinguished by its color and wing venation.

Rhaconotus barri Marsh, new species

fig. 1

Female Holotype: Length of body, 3.5 mm; ovipositor, 2 mm. *Color*: Head, basal antennal segments, and legs light brown; apical antennal segments, thorax and abdomen dark brown; wings nearly entirely hyaline (fig. 1). *Head*: Height equal to width, cheeks not strongly sloping inward; vertex and frons shallowly reticulate, face and temples coriaceous, cheeks smooth; malar space about ⅔ eye height; temples slightly narrower than eye width; ocellocular distance about 3½× diameter of lateral ocellus; antenna 23-segmented. *Thorax*: Pronotum and proepisternum coriaceous, propleuron strigose-reticulate, transverse pronotal carina weak; mesonotal lobes coriaceous, notauli deep, crenulate anteriorly, meeting posteriorly in narrow rugose area; scutellar disc coriaceous, not carinate laterally; mesopleural disc coriaceous, subalar groove wide and strongly crenulate, sternaulus rugose; mesosternum coriaceous; propodeum longitudinally striate-reticulate, not horizontal, gently curving from base to apex. *Legs*: Foretarsus 1½× as long as foretibia, midtarsus 1⅕× as long as midtibia, hindtarsus slightly shorter than hindtibia. *Wings* (fig. 1): More sparsely hairy than other species; 2nd segment of radius 3½× as long as 1st segment. *Abdomen*: Terga 1–5 striate-reticulate, striae on tergum 5 converging toward middle at apical edge (as in fig. 12); terga 3 and 4 coriaceous along apical border; 1st tergum as wide at apex as long; 5th tergum not notched apically; ovipositor as long as abdomen, forewing length about 1⅓× as long as ovipositor.

Variation: Length of body, 3–4 mm; ovipositor 1.5–2 mm; antenna 20- to 23-segmented.

Male: Essentially as in female, propodeum and abdomen not as strongly striate, occasionally only reticulate.

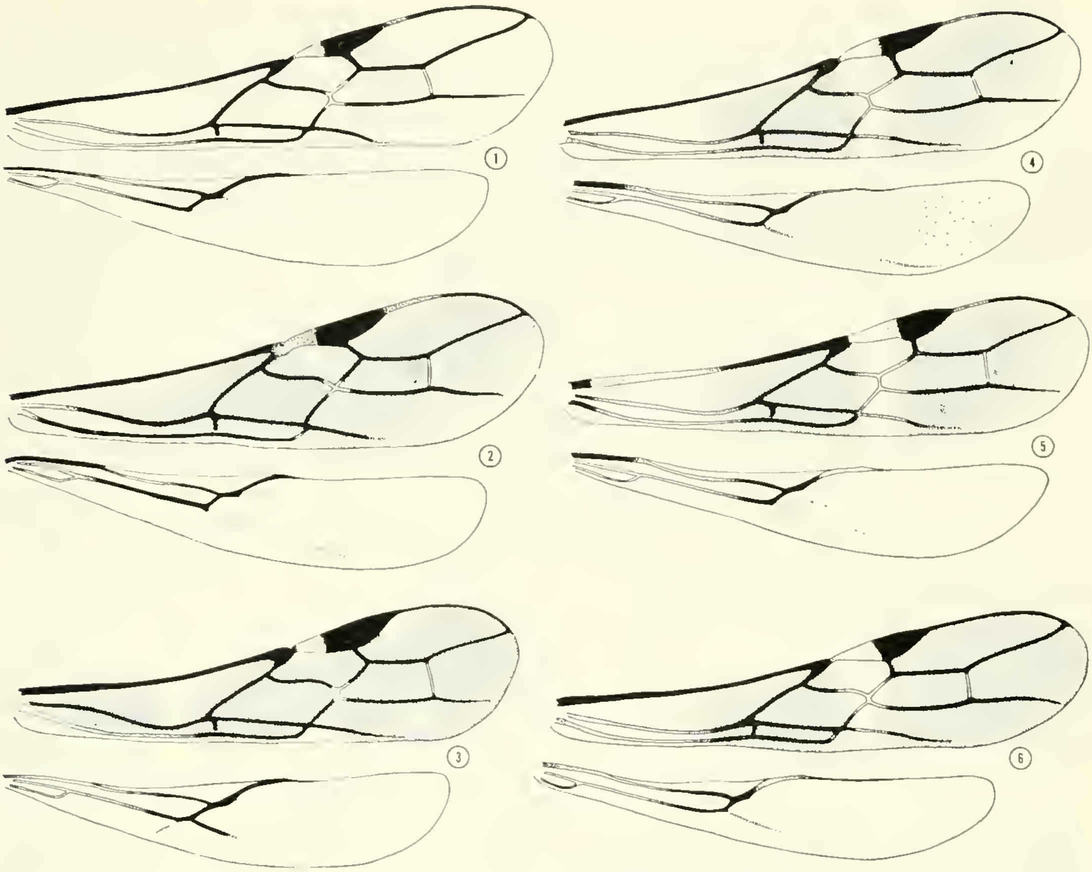

Fig. 1–6. Fore- and hindwings of *Rhaconotus* species. 1, *barri*. 2, *cressoni*. 3, *phalarus*. 4, *fasciatus*. 5, *graciliformus*. 6, *brevicaudus*. (Stippling represents wing coloration; wing hairs are not illustrated).

Holotype Female: 12 mi. W. Mt. Home, Elmore Co., Idaho, VI-1955, reared from *Eurotia lanata* infested with *Acmaeodera pulchella*, W. F. Barr. Deposited in USNM.

Paratypes: 2 ♀♀, 3 ♂♂ same data as type. (USNM).

This species is similar to *cressoni* but is distinguished by its shorter antennae, reticulate vertex, and longer ovipositor.

Biology: This species was reared from a sage brush, *Eurotia lanata* (Pursh) Moq. which was infested with the buprestid *Acmaeodera pulchella* Herbst. Judging from the host records of other North American *Rhaconotus* species, it is likely that *barri* is a parasite of this beetle.

Rhaconotus brevicaudus Marsh, new species

fig. 6

Female Holotype: Length of body, 2.5 mm; ovipositor, 0.5 mm. *Color*: Thorax and abdomen very dark brown, almost black, head dark brown, legs and antennae brown; wings banded, radial cell entirely infuscated (fig. 6). *Head*: Entirely finely coriaceous, face with raised smooth median area; malar space about ½ eye height, temples about ⅔ eye width; ocelli small, ocellocular distance about 5× diameter of lateral ocellus; antenna 25-segmented. *Thorax*: Pronotum coriaceous, shorter than 1st flagellar segment, transverse carina absent, propleuron coriaceous; mesonotal lobes and scutellar disc coriaceous, notauli very weak, hardly impressed posteriorly, weakly crenulate anteriorly; mesopleural disc coriaceous, subalar groove and sternaulus shallow, weakly crenulate; mesosternum coriaceous; propodeum declivous posteriorly, reticulate, median basal carina present. *Legs*: Foretarsus about 1⅓× longer than foretibia, midtarsus equal to midtibia, hindtarsus slightly longer than hindtibia. *Wings* (fig. 6): Second segment of radius 5× as long as 1st segment; longest hairs on apical border of forewing longer than 1st segment of radius. *Abdomen*: First tergum wider at apex than long, finely striate-reticulate; 2nd tergum striate-reticulate; terga 3–6 coriaceous with some striations at base and smooth at apex; ovipositor about as long as 1st tergum, forewing length about 5× as long as ovipositor.

Variation: Length of body, 2–3 mm; ovipositor, 0.5–0.75 mm; antenna 24- to 28-segmented; propleuron sometimes with a few striations medially; propodeum with some weak striations dorsally.

Male: Unknown.

Holotype Female: Holliston, Massachusetts, VIII-11, N. Banks. Deposited in USNM.

Paratypes: 3 ♀♀, same data as holotype, 2 ♀♀ (USNM, MCZ); Brighton, Ontario, 1 ♀, 17-VII-56, John C. Martin (CNC).

This species is similar to *atratus* but is easily distinguished by its shorter first abdominal tergum, shorter antenna, smooth median tubercle on face, wing coloration, and longer hair on edge of forewing.

Rhaconotus canadensis Marsh, new species

Female Holotype: Length of body, 3 mm; ovipositor, 0.5 mm. *Color*: Head, prothorax, mesopleural disc, and abdominal terga 1 and 2 brown, mesonotum, mesosternum, and remainder of abdomen dark brown, legs and basal antennal segments honey yellow, apical antennal segments brown; wings nearly hyaline, weakly banded, stigma with hyaline spot on apical ½. *Head*: Entirely coriaceous, face smooth medially; malar space about ⅔ eye height; temples slightly less than eye width; ocelli small, ocellocular distance about 5× diameter of lateral ocellus; antenna 27-segmented. *Thorax*: Pronotum coriaceous, longer than 1st flagellar segment, transverse carina present, propleuron coriaceous, weakly strigose medially; mesonotal lobes shallowly reticulate, notauli shallow, weakly crenulate anteriorly, meeting posteriorly in shallow striate area; mesopleural disc coriaceous, subalar groove and sternaulus shallow, narrow, weakly crenulate; propodeum reticulate with some striations dorsally on apical ⅔, median basal carina distinct. *Legs*: Foretarsus 1½× as long as foretibia, midtarsus equal to midtibia, hindtarsus equal to hindtibia. *Wings*: Second segment of radius 5× as long as 1st segment; longest hairs on apical border of forewing equal to length of 1st segment of radius. *Abdomen*: First tergum wider at apex than long, longitudinally striate-reticulate; 2nd tergum striate-reticulate; terga 3–5 coriaceous except for striations at base; ovipositor about as long as 1st abdominal tergum, forewing length 5½× as long as ovipositor.

Male: Essentially as in females; antenna 25- to 28-segmented; 1st abdominal tergum longer than wide at apex.

Holotype Female: St. Victor, Saskatchewan, 49 20′, 105 54′, 27-V-1955, J. R. Vockeroth, among grass roots on dry prairie. Deposited in CNC.

Paratypes: 2 ♂♂, same data as type (USNM).

This species is similar to *brevicaudus* but is distinguished by its color and structure of pronotum.

Rhaconotus cressoni Muesebeck and Walkley
fig. 2, 10, 12, 14, 16

Hormius? aciculatus Cresson, 1872:190. Preoccupied in *Rhaconotus* by *aciculatus* Ruthe, 1854. Holotype female in USNM.

Hormiopterus aciculatus (Cresson): Ashmead, 1893:44.

Rhaconotus cressoni Muesebeck and Walkley, 1951:281. New name for *aciculatus* Cresson.

Female: Length of body, 4–5 mm; ovipositor, 1.5–3 mm. *Color*: Head, thorax, and abdomen varying from reddish brown to dark brown or black, apical edges of abdominal terga 3–5 usually light brown; legs brown; basal antennal segments light brown or honey yellow, apical 10–15 segments black; wings infuscated (fig. 2), less so on basal ½, hyaline spots on costal margin of radial cell, base of stigma, middle of 1st cubital cell, base of 2nd discoidal cell, and along 2nd intercubitus. *Head* (fig. 14): Slightly wider than high, cheeks sloping strongly inward; face and temples coriaceous, vertex strigose-reticulate, frons rugose-reticulate, vertex and frons sometimes only weakly strigose or rugose; face medially with smooth raised area below antennae; malar space about ⅔ eye height; temples slightly less than eye width; antenna 32- to 36-segmented; ocelloculor distance 4–4½× diameter of lateral ocellus. *Thorax*: Pronotum and proepisternum coriaceous, propleuron striate-reticulate, transverse pronotal carina weak; mesonotal lobes reticulate, notauli deep, crenulate anteriorly, meeting posteriorly in strongly strigose-reticulate or rugose-reticulate area (fig. 16); scutellar disc coriaceous, occasionally rugose-coriaceous, carinate laterally; mesopleural disc reticulate, becoming strigose anteriorly and posteriorly and occasionally entirely striate-reticulate; subalar groove and sternaulus strongly crenulate; mesosternum coriaceous; propodeum strongly striate-reticulate. *Legs*: Foretarsus about 1½× as long as foretibia, midtarsus equal to midtibia, hindtarsus equal to hindtibia. Wings (fig. 2): Second segment of radius 3–3½× as long as 1st segment; recurrent vein interstitial with 1st intercubitus, or entering base of 2nd cubital cell at extreme base. *Abdomen* (fig. 10, 18): Terga 1–5 strongly longitudinally striate-reticulate (under high power, the reticulate areas between the striae sometimes appear like fish scales), striae on tergum 5 converging toward middle at apex (fig. 12), if these striae weak or absent, then reticulate

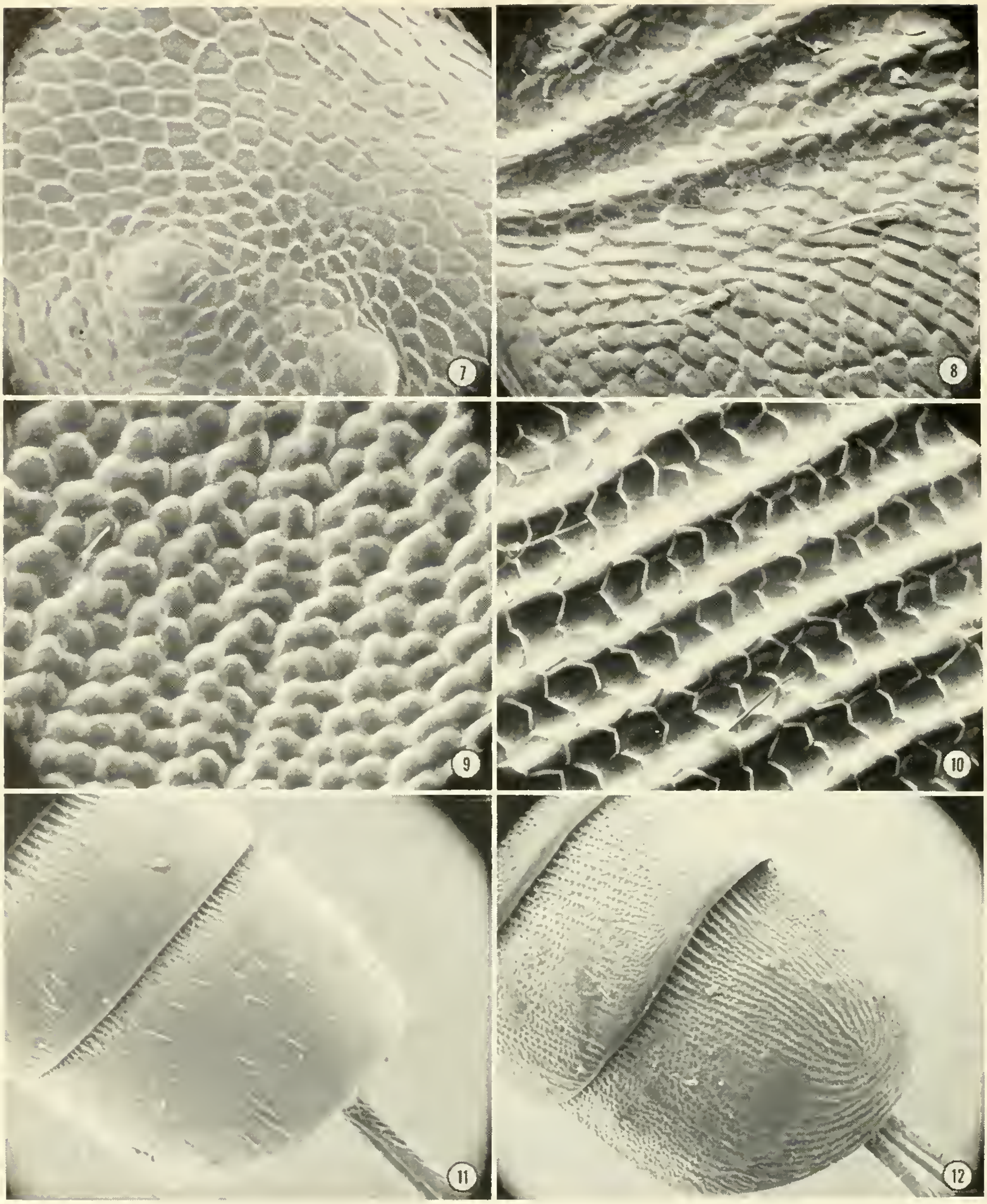

Fig. 7–12. Microsculpture of *Rhaconotus* species. 7, *gracilifornus*, vertex, ×640. 8, *fasciatus*, mesonotum, ×640. 9, *fasciatus*, abdominal tergum 2, ×600. 10, *cressoni*, abdominal tergum 1, ×650. 11, *fasciatus*, abdominal terga 4 and 5, ×64. 12, *cressoni*, abdominal terga 4 and 5, ×64.

sculpturing converging or swirling on apical part of tergum; 1st tergum slightly wider at apex than long; 5th tergum usually broadly notched medially; ovipositor about as long as abdomen beyond tergum 1, forewing length 2–3× as long as ovipositor, usually about 2½×.

Male: Essentially as in female.

Type-locality: Texas, probably Bosque Co.

Distribution: Maryland south to Florida, west to Kansas, Nevada, and California; Mexico.

This species is similar to *barri* but is recognized by its strigose vertex and shorter ovipositor. It is also similar to *phalarus* but is distinguished by its strigose vertex.

Biology: Several specimens were reared from *Cylindrocopturus adspersus* (Lec.) and *Lixus scrobicollis* Boh. Other specimens were reared from unknown hosts in various genera of Compositae such as *Artemisia*, *Ambrosia*, *Helianthus*, and *Vernonia*.

Rhaconotus fasciatus (Ashmead)
fig. 4, 8, 9, 11, 13, 17

Hormiopterus fasciatus Ashmead, 1893:43. Holotype female in USNM.
Rhaconotus fasciatus (Ashmead): Muesebeck and Walkley, 1951:181.

Female: Length of body, 3–4.5 mm; ovipositor, 1–1.5 mm. *Color*: Head brown; thorax usually dark brown or black, occassionally light brown; abdomen dark brown or black, basal segments occasionally light brown; legs brown, occasionally yellow, basal ring of tibiae and tarsal segments 1–4 light brown to yellow; basal antennal segments honey yellow, apical ones brown; wings banded (fig. 4). *Head*: Entirely shallowly reticulate; malar space ¾ eye height; temples slightly less than eye width; ocellocular distance about 4× diameter of lateral ocellus; antenna 33- to 40-segmented. *Thorax*: Prothorax coriaceous, propleuron weakly striate posteriorly, transverse carina on pronotum weak but distinct; mesonotal lobes and scutellar disc coriaceous, notauli shallow, slightly crenulate anteriorly, meeting posteriorly in shallow area with 3 or 4 short carinae (fig. 13); mesopleural disc coriaceous, subalar groove and sternaulus crenulate, the latter sometimes weakly; propodeum horizontal, reticulate, striate-reticulate dorsally near apex and laterally. *Legs*: Foretarsus about 1¾× as long as foretibia, midtarsus slightly longer than midtibia, hindtarsus slightly longer than hindtibia. *Wings* (fig. 4): Second segment of radius about 4× as long as 1st. *Abdomen* (fig. 17): First tergum longer than wide at apex, striate-reticulate; 2nd tergum striate-reticulate; tergum 3 striate-coriaceous on basal ⅔, coriaceous on apical ⅓; terga 4 and 5 coriaceous with some striations at base (fig. 11), tergum 5 broadly emarginate medially at apex; ovipositor longer than length of terga 1–3, forewing length about 1¾× as long as ovipositor.

Male: Essentially as in female.

Type-locality: Riley Co., Kansas (from label). Ashmead states that the type is from Manhattan, Kansas.

Distribution: Maryland south to Florida, west to Iowa and Texas.

This species is similar to *graciliformus* but is distinguished by its longer ovipositor and striate propodeum and abdomen.

Biology: I have seen specimens that were reared from *Conotrachelus* sp. in stems of *Euphorbia*, from *Lixus concavus* Say, and from unknown hosts in herbaceous plants of the genera *Solidago*, *Iva*, and *Solanum*.

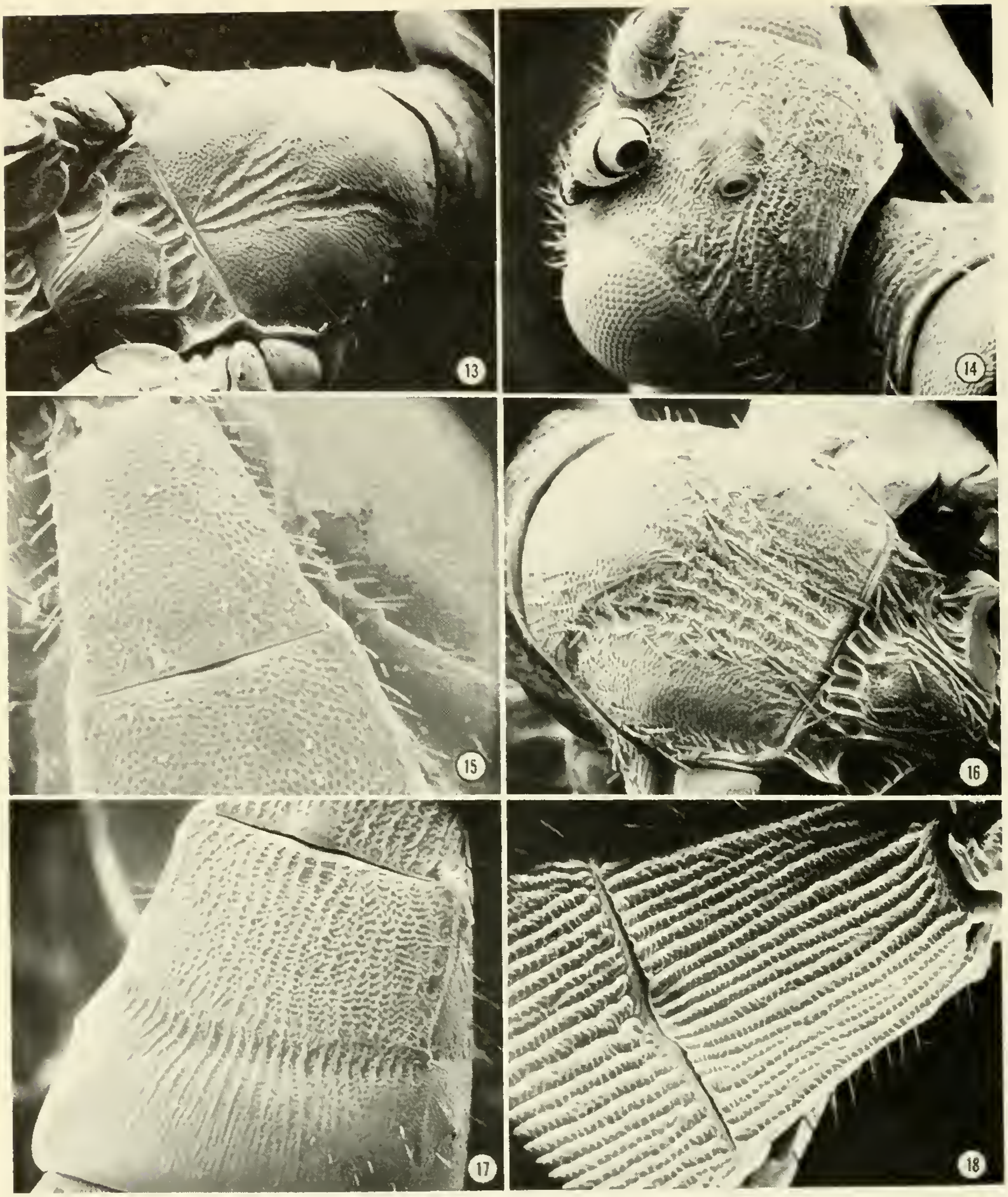

Fig. 13–18. Microsculpture of *Rhaconotus* species. 13, *fasciatus*, mesonotum, ×130. 14, *cressoni*, vertex, ×130. 15, *graciliformus*, abdominal terga 1 and 2, ×116. 16, *cressoni*, mesonotum, ×130. 17, *fasciatus*, abdominal terga 2 and 3, ×120. 18, *cressoni*, abdominal terga 1 and 2, ×130.

Rhaconotus graciliformus (Viereck)

fig. 5, 7, 15

Hormiopterus graciliformus Viereck, 1911:183. Lectotype female in USNM.
Rhaconotus graciliformus (Viereck): Muesebeck and Walkley, 1951:181.

Female: Length of body, 2.5–3.5 mm; ovipositor, 0.5–1 mm. *Color:* Head light brown, occasionally honey yellow; thorax and abdomen brown to dark brown; legs brown to honey yellow, last tarsal segment dark brown; basal antennal segments yellow, apical ones brown; wings banded (fig. 5). *Head*: Very finely coriaceous; malar space about ½ eye height; ocellocular distance about 4× diameter of lateral ocellus; antenna 25- to 32-segmented. *Thorax*: Prothorax finely coriaceous, propleuron weakly striate medially; mesonotal lobes and scutellar disc weakly coriaceous, notauli shallow, weakly crenulate anteriorly, meeting posteriorly in shallow area with 2 or 3 short carinae; mesopleural disc coriaceous, sternaulus and subalar groove weakly crenulate; mesosternum weakly coriaceous; propodeum horizontal, usually entirely punctate or reticulate, with a short stub of median carina at base, occasionally striate laterally. *Legs*: Foretarsus about 1¾× as long as foretibia; midtarsus equal in length to midtibia; hindtarsus slightly longer than hindtibia. *Wings* (fig. 5): Second segment of radius about 5× as long as 1st segment. *Abdomen* (fig. 15): First tergum longer than wide at apex, punctate or reticulate, occasionally with few striations; 2nd tergum punctate or reticulate; terga 3 and 4 striate reticulate; tergum 5 punctate or reticulate with striations basally; ovipositor as long as combined lengths of terga 1 and 2, forewing 3–3½× as long as ovipositor.

Male: Essentially as in female.

Lectotype Female: "Wellington, Kansas, T. H. Parker collector, Webster no. 5473, Cage no. 119, Type no. 13500 USNM, Hormiopterus graciliformus Vier. Type ♀." Apparently Viereck had six specimens before him when he described this species. Only four of these are in the USNM collection, and I have designated the female above as the lectotype.

Distribution: Maryland south to Florida, west to Iowa, Colorado, and Arizona; North Dakota, Alberta.

This species is similar to *fasciatus* but is distinguished by its shorter ovipositor and punctate propodeum and abdomen.

Biology: The original description states "reared from an eurytomid in *Agropyron*" but this reference to a chalcid host is certainly an error. Several other specimens were reared from unknown hosts in *Muhlenbergia* which indicates that this species might be restricted to borers in grass stems.

Rhaconotus phalarus Marsh, new species
fig. 3

Female Holotype: Length of body, 5 mm; ovipositor, 1.5 mm. *Color*: Head, thorax, and abdomen black except head behind eyes and apices of abdominal terga 3–5 which are brown and tegulae which are yellow; basal antennal segments yellow, apical ones dark brown; fore- and midlegs brown except their trochanters, tibiae at base, and tarsal segments 1–4 which are honey yellow, hindlegs black except trochanters, tibia on middle ½, and tarsal segments 1–4 which are brown, basal ring of tibiae yellow; forewings infuscated, with white hyaline spots (fig. 3). *Head*: Vertex and frons reticulate, temples and face coriaceous; malar space less than ½ eye height, temples ½ eye width; ocellocular distance 2⅔× as long as lateral ocellus; antenna at least 34-segmented (both broken in type). *Thorax*: Propleuron deeply striate-coriaceous, these striations extending over posterior ½ of pronotum, anterior ½ of pronotum and anterior edge of propleuron coriaceous, proepisternum coriaceous; mesonotal lobes finely reticulate, notauli deeply crenulate anteriorly, meeting posteriorly in a wide deeply striate area which covers posterior ½ of mesonotum, notauli with long gold hair along their course, middle mesonotal lobe with a shallow crenulate longitudinal groove along its midline, lateral lobes crenulate or striate laterally at beginnings of notauli; scutellar disc coriaceous, prescutellar furrow with 5 strong carinae separated by deep grooves; entire mesopleuron deeply striate-coriaceous, sternaulus not crenulate but represented by a deeper groove; mesosternum coriaceous; propodeum deeply striate-coriaceous, becoming rugose-coriaceous at apex. *Legs*: Foretarsus 1⅔× as long as foretibia, midtarsus equal to midtibia, hindtarsus slightly shorter than hindtibia. *Wings* (fig. 3): Second segment of radius 3× as long as 1st segment. *Abdomen*: All terga strongly striate-coriaceous, terga 3 and 4 smooth on apical edge, targa 4 and 5 coriaceous at base, striae on tergum 5 converging toward middle at apex, apical edge of tergum 5 very slightly emarginate medially; ovipositor about as long as length of terga 1–3, forewing length 2⅓× as long as ovipositor.

Male: Unknown.

Holotype Female: Cameron County, Texas, 8-3-28, R. H. Beamer. Deposited in USNM. Known only from the holotype.

This species is distinct from all other North American species and is similar to other species from Central and South America. The very strongly and deeply sculptured body and the maculated wings will easily separate it from all other species. The specific name is from the Greek *phalaros* which means white-spotted in reference to the spotted wings.

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A NEW COMBINATION IN BRUCHIDAE (COLEOPTERA)

Maurice Pic (1931. Bull. Soc. Linn. Lyon 10:139) described from "Bresil" *Bruchus subaenescens* which was later placed in *Acanthoscelides* by Blackwelder (1946. U.S. Natl. Mus. Bull. 185:761). Pic's collection, now at the Museum National d'Histoire Naturelle in Paris, contains 1 ♀ specimen bearing a handwritten label "*subaenescens* Pic" and his usual small, orange "type" label, but the locality label is partly illegible. I interpret the last as "Corumb" which probably indicates Corumba in Mato Grosso. Other specimens paced with it and conspecific with it are labeled "Bresil" and "*Bruchus subaenescens mihi*" in Pic's handwriting. Although there is some question as to the interpretation of the locality label, the specimen is marked in Pic's usual manner, therefore I regard it to be the holotype and have so labeled it. No mention of other specimens appears in his description.

The correct name for this species is *Sennius subaenescens* (Pic) NEW COMBINATION. Specimens from Cundinamarca Department, Colombia, have been deposited in the collection of the United States National Museum of Natural History, Washington, D.C., courtesy of Dr. Ingeborg Zenner de Polania. Known host plants are *Cassia tomentosa* Mutis ex L. and *Cassia viarum* Little (formerly *Cassia velutina* Britton & Killip), both grown as ornamental plants in Colombia. Studies are underway on the life-history of this bruchid.

Sennius subaenescens does not fit easily into any of the species groups outlined in a recent taxonomic study of the genus for North America (Johnson & Kingsolver. 1973. U.S. Dep. Agr. Tech. Bull. 1462.) and may represent a separate group.

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SURVEY OF THE OTITIDAE (DIPTERA: ACALYPTRATAE) IN THE REGION OF CINCINNATI, OHIO

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ABSTRACT—Fifteen species of Otitidae were found in southwestern Ohio. They were: *Callopistromyia annulipes* (Macquart), *C. strigula* (Loew), *Chaetopsis fulvifrons* (Macquart), *Delphinia picta* (Fabricus), *Eumetopiella rufipes* (Macquart), *Euxesta notata* (Wiedemann), *Idana marginata* (Say), *Myrmecothea myrmecoides* (Loew), *Physiphora demandata* (Fabricus), *Pseudotephritis approximata* Banks, *P. cribellum* (Loew), *P. vau* (Say), *Tritoxa flexa* (Wiedemann), *T. incurva* Loew, and *Tetanops luridipennis* Loew. Trap records indicate that *Idana marginata* is univoltine and *Pseudotephritis approximata* is multivoltine. *Tritoxa flexa* and *T. incurva* are sympatric at Cincinnati, Ohio. Trap records and field observations show that some Otitidae are not attracted to baits throughout their flight period. A modified sugar syrup and beer bait using Guinness Stout attracts species of several families of Diptera. A trap convenient for field collection using liquid bait is described.

In 1973, a bait attractive to several species of Diptera was discovered. During 1974, a concerted effort was made to obtain records of otitid flies in the Cincinnati region and record such biological and natural history data as could be obtained. This paper includes biological notes, earliest and latest occurrences of otitid species, and in some cases their abundances.

A similar study was done at Arendtsville, Pennsylvania in 1927 and 1928 (Frost, 1929). However, no field observations were included, and all traps were located in a single habitat, a peach orchard. Allen (1965) included data on some species of Otitidae occurring around Kent, a city in northwestern Ohio. Allen did not use traps in his work.

The Otitidae as a group apparently are not as restricted in their larval food requirements as are the Tephritidae, a closely related family. Many otitid larvae feed in decaying vegetable matter, but several phytophagous and faculative coprophagous species are known. In addition, larvae of a few species feed beneath the bark of dead and dying trees. The larvae of one species, *Eumetopiella rufipes* (Macquart) feeds in the stems of a grass (Valley *et al.*, 1969). The great variety of larval feeding habits in the Otitidae indicates that study of this family will provide data on evolution and adaptation in the Diptera. A literature review of Otitidae biology can be found in Allen and Foote (1967).

METHODS AND MATERIALS

Records of Otitidae were obtained from field observations and traps hung in in trees or bushes 2 to 6 feet above the ground. The trap localities were as follows. 1) Location A: Four traps in mixed deciduous woods. 2) Location B: One trap hanging in a bristly locust tree (*Robinia hispida* L.) in a residential area. 3) Location C: Observations on the limbs of the locust tree of location B. Some limbs of the tree were dying and were infested with beetle larvae. 4) Location D: A marsh area, with a cattail stand at one end. Other plants in the marsh were cutgrass (*Leersa* sp.), arrowhead (*Sagittaria* sp.), and species of *Polygonum*. 5) Location E: One trap in a small maple tree at the edge of the marsh described as location D. All locations are within 2 miles of each other in northcentral Hamilton County, Ohio.

The traps were constructed from jars used for canning foods. The dome lid was removed and replaced by a cone of wire screening pointing into the jar. Traps were hung in place by a piece of heavy string tied to the opposite sides of the ring top. A rain shield was made from the bottom ½ of a plastic milk jug. The rain sheild was held in place by threading the support string through holes punched in the rain shield. Knots in the string prevented the rain shield from sliding down and covering the trap opening.

The baited jar was screwed into the ring top to ready the trap for use. Collections were removed from the traps by pouring the contents into a 3″ kitchen strainer held over a small pan.

The bait used in the survey was a variation of the sugar water and beer bait commonly used for moths. Previously the author found that most beer baits attracted only a few species of Diptera. However, using Guinness Stout produced a more pungent bait and attracted species of several families of Diptera and Hymenoptera.

To prepare the bait, sugar and water of equal volumns were first boiled together and allowed to cool. For each quart of sugar water, 1 bottle of Guinness Stout and a few small pieces of canteloupe were added. The bait was best stored in a screw top jar with a loose lid. The bait was prepared at least 1 month before use. If the bait was too syrupy at the time of use it was diluted with water.

RESULTS AND DISCUSSION

The following 15 species of Otitidae were found in the Cincinnati region: *Callopistromyia annulipes* (Macquart), *C. strigula* (Loew), *Chaetopsis fulvifrons* (Macquart), *Delphinia picta* (Fabricus), *Eumetopiella rufipes* (Macquart), *Euxesta notata* (Wiedemann), *Idana marginata* (Say), *Myrmecothea myrmecoides* (Loew), *Physiphora demandata* (Fabricus), *Pseudotephritis approximata* Banks, *P. vau* (Say), *P. cribellum* (Loew), *Tritoxa flexa* (Wiedemann), *T. incurva* Loew, and *Tetanops luridipennis* Loew.

The results of the survey are tabulated in Table 1.

The most significant of the results is the large catch of *Idana marginata*. Frost (1929) caught only 4 specimens in his traps in 2 years. Although the bait used is probably important, trap location may be

Table I. Trap collections and field observations of Otitidae in the Cincinnati area. (Observations during 1974 unless otherwise noted).

Species	Earliest and latest dates of capture	Numbers caught in Location A traps	Location of observations
Callopistromyia annulipes	IV-13 to XI-16	29	A,B,C,E
C. strigula	IV-28 to V-14	0	B,C
Chaetopsis fulvifrons	V-25 to XI-2	0	E,D
Delphinia picta	V-11 to XI-9	28	A,B,C,E
Eumetopiella rufipes	VII-26 to VIII-18	0	D
Euxesta notata	V-13 to XI-1	0	B,C[a]
Idana marginata	V-30 to VIII-18	1792	A,E
Myrmecothea myrmecoides	VIII-10	0	On black locust.
Physiphora demandata	X-4 to XI-1	2	A,B
Pseudotephritis approximata	VI-9 to X-16	126	A,B,E
P. cribellum	VIII-13	0	E
P. vau	VI-6 to XI-4	16	A,B,E
Tritoxa flexa	VI-3 to IX-30	0	1973[b]
T. incurva	VI-27 to X-12	0	1973[b]
Tetanops luridipennis	VIII-10	0	1972[c]

[a] Also collected from discarded coffee grounds.
[b] *Tritoxa* observations in fields where wild garlic was present.
[c] On vegetation.

even more important since previous reports indicate that *I. marginata* inhabits wooded areas (Steyskal, 1951; Blanton, 1938). Blanton, in addition to reporting that *I. marginata* was common on the trunks of locust trees near Babylon, New York, reared 6 specimens from rotten narcissus bulbs. No further life history information on this species was found in the literature. Numbers of *I. marginata* taken in 20-day periods from Location A are as follows: 31 May to 20 June, 363, 21 June to 10 July, 1159; 11 July to 30 July, 144; 31 July to 20 August, 28. The single largest catch was taken during the 4-day period preceding July 5 when 752 specimens were collected in the Location A traps.

The fact that the catch of *I. marginata* built up to a single high peak early in the season and declined rapidly afterwards indicates that this is a univoltine species. As indicated in Table I, *I. marginata* was also caught in the Location D trap but was never caught or seen in residential areas approximately 1 mile distant.

A similar situation exists with *Pseudotephritis approximata* regarding the relative size of the collections. Frost (1929) caught 2 specimens, whereas a total of 126 were taken in this survey. There are no biological data in the literature concerning this fly. The flight period demonstrated by this survey, between the first week in June and the middle of October, indicates that the fly probably has more than 1 generation a year. Although this species was more common in wooded areas, it was taken in residential areas also.

Callopistromyia strigula is rarely collected. None was reported by Frost (1929) or Allen (1965). The only collections of this fly by the author were made on a bristly locust tree and 1 specimen from a trap hanging in the tree. When present, 3 or 4 individuals were observed. Adults were seen for only a few weeks and only on warm days. This tree supported an abundant population of *C. annulipes.* However, *C. annulipes* was present earlier and later in the season than was *C. strigula.*

Tritoxa flexa and *T. incurva* have been reported to occur together by Loew (1873) and Manis (1941) and are sympatric also in Cincinnati where they were found in fields containing wild garlic (*Allium vineale* L.), their local host.

Frost (1929) reported that the numbers of Otitdae caught in traps varied with precipitation and temperature. In addition, some data of the present survey illustrate that trap catches do not necessarily correlate with other means of measuring abundances of animals in the field. For instance, the only specimens of *Chaetopsis fulvifrons* caught in traps were two at Location D on July 20 although the trap was approximately 50 feet from a cattail stand where numerous adults of *C. fulvifrons* were seen from May 25 to November 2. The only *C. fulvifrons* specimens taken by Frost were also taken late in the summer. Another example of differing data from traps and field observations is that of *Physiphora demandata.* In the present survey trap catches of *P. demandata* were made only after October 4. However, from field observations, Allen and Foote (1967) reported a flight period extending from June 15 to September 2 for *P. demandata* at Kent, Ohio. For unknown reasons, *Chaetopsis fulvifrons* and *Physiphora demandata* are not attracted to traps throughout their flight period.

The author wishes to thank George C. Steyskal, Systematic Entomology Laboratory, IIBIII, Agr. Res. Serv., USDA, for determination of the species of *Euxesta, Eumetopiella, Idana, Myrencothea, Physiphora,* and *Pseudotephritis* taken in this survey. Thanks are due also to Andrew Butz of the University of Cincinnati for his encouragement of this work, and to B. A. Foote of Kent State University for critically reading the manuscript.

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BOOK REVIEW

Biogeography and Ecology in New Zealand. 1975. F. G. Kuschel (Ed.). 689 pp., illus. Dr. W. Junk b. v. The Hague. Price: 200 guilders (about $75 U.S.).

This substantial, well illustrated, and attractive book is Vol. 27 of the Junk series Monographiae Biologicae. The editor is a well-known specialist in Coleoptera, now in Auckland, who formerly lived for many years in Chile. There are 19 different authors, all in New Zealand, about two-thirds associated with government organizations, the others with universities or museums. The book, which took nearly 5 years to prepare, is aimed especially at overseas readers wishing a broad view. It complements a 1973 book, *The Natural History of New Zealand—an Ecological Survey* (G. R. Williams, Ed.).

Early chapters deal with geology, climate, soils, and other basic subjects. Two chapters concern the peculiar birds and the lizardlike reptile, the kiwi and the tuatara. Four chapters of special interest to entomologists, and their authors are: The spiders and harvestmen (R. R. Forster); The terrestrial insects (J. C. Watt); The freshwater insects (I. D. McLellan); The insects in relation to plants (J. S. Dugdale). The final chapter, The influence of man on the biota, is by a well-known New Zealand entomologist, John T. Salmon.

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NEW SPECIES OF ARIZONA NOCTUIDS, I. (LEPIDOPTERA: NOCTUIDAE: HADENINAE)

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ABSTRACT—**Synorthodes**, a new genus, with two new species, **auriginea** and **typhedana**, and *Orthodes* **adiastola**, a new species, are hadenine noctuids that have been taken in the mountain ranges of southeastern Arizona.

Nine extended periods of collecting in Arizona, one spring, one spring and summer, six summers, and one summer and fall, thirty-one months in all, have produced a large number of species of noctuid moths. Among them are a number of new species of which the following three hadenines are part.

Synorthodes n. gen.

Type-species: *Synorthodes auriginea* n. sp.

This genus is erected for a small number of moths that occur in the mountain ranges of southeastern Arizona and in the highlands of Mexico. In the past they would have been included in the heterogeneous assemblage of species that Hampson (1905) placed under the name *Eriopyga* Guenée. Dyar (1912, p. 60) described one species of this genus from Mexico as *Eriopyga melanops.* The genus is related to *Orthodes* Guenée, 1852, but it differs by the absence of specialized sex scaling and tufts in the males and by the general conformation of the male and female genitalia.

Description: Eyes hairy, the hairs longer toward rear of eye; palpi mostly smooth-scaled, only basal segment fringed with hairlike scales; proboscis well developed; antennae simple and pubescent. Thorax smooth, clothed with narrow scales; wing venation much as in *Orthodes*, forewing with R_5 connate with R_{3+4} and from apex of discal cell or slightly separated at origin, M_2 of hindwing absent and Rs and M_1 and M_3 and Cu_1 short stalked (M_2 evident in *Orthodes*;

Fig. 1. *Synorthodes typhedana* Franclemont. Type. Fig. 2. *Synorthodes auriginea* Franclemont. Type. Fig. 3. *Orthodes adiastola* Franclemont. Type.

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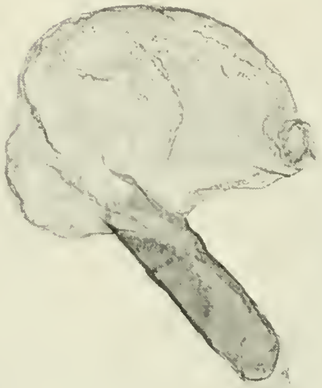

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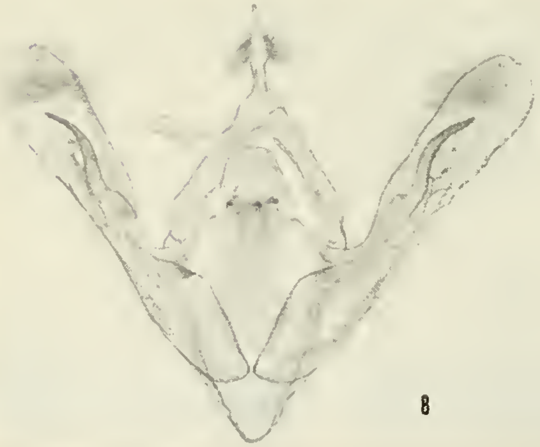

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Fig. 4–5. *Synorthodes typhedana.* 4, male genitalia, aedoeagus removed; genitalia slide JGF 4532. Madera Canyon 5600′, Santa Rita Mts., Santa Cruz Co., Arizona, 1 July 1960, J. G. Franclemont. 5, aedoeagus, genitalia slide JGF 4532. Fig. 6–7. *Synorthodes auriginea.* 6, male genitalia, aedoeagus removed; genitalia slide JGF 4535. Madera Canyon 5600′, Santa Rita Mts., Santa Cruz Co., Arizona, 27 June 1960, J. G. Franclemont. 7, aedoeagus; genitalia slide JGF 4535. Fig.

in *O. crenulata* (Butler) only M_3 and Cu_1 stalked in hindwing, in *O. cynica* Guenée only Rs and M_1 stalked in hindwing.)

Male genitalia with uncus well developed, narrow at base, enlarged toward apex, apex with a group of specialized setae; penicillus of tegumen weak or almost absent; valves membraneous on apical ½, more heavily sclerotized on basal ½, editum well developed, clasper heavily sclerotized, linear and long, ampulla, the linear structure dorsad of the clasper, lightly sclerotized; juxta various, with a raised circular bulla or fovea, an elongate ridge, or an apical projection; aedoeagus short and heavy, vesica somewhat balloonlike when inflated, covered with small spicules, in some species with a large cornutus or sclerotized plate.

Female genitalia as figured. Those of an undescribed Mexican species are intermediate between the 2 figured.

Synorthodes auriginea n. sp.

Figure 2 male moth, 6 and 7 male genitalia, 12 female genitalia, 19 and 20 venation of forewing and hindwing.

This species is similar to *melanops*, but it differs by the greater amount of yellow scaling on the forewings, the white scaling on the veins, and the irregular subterminal line. The male genitalia are similar to those of *melanops*, but they differ by the broader expanded area of the costa of the valve and the shorter "digital pieces."

Description: Head clothed with a mixture of black, gray and yellow scales; palpi with 2nd segment black on outer side with pale margins and pale apex, 3rd segment pale. Thorax with an admixture of black, grayish white, and yellow scales; patagia somewhat darker with upper margins grayish white; anterior tuft grayish white. Forewing shining blackish gray with considerable bright yellow and white scaling; basal line double, black with yellow between black lines; antemedial line double, inner line yellow, outer line irregular, black; postmedial line evenly curved, double, inner line black, outer line an inner series of black points on veins followed by an outer series of white points; subterminal line irregular, yellow, with a black shade on inner side; a series of terminal black dots in the interspaces; fringe concolorous with terminal area; orbicular and reniform black with yellow annuli, orbicular round. Hindwing fuscous black; fringe dark with a pale line at base and pale on outer part. Abdomen mostly black above with yellow anal tufts, below yellowish. Forewings and hindwings below yellowish gray with black discal dot on hindwing and vague indication of 1 on forewing; black postmedial line on forewing and hindwing, that on hindwing darker; area beyond postmedial line heavily infuscate; a series of terminal black dots in the interspaces. Legs with tibiae and tarsal segments with pale apical bands.

Length of forewing 12–13 mm; type 13 mm.

←

8–9. *Orthodes adiastola*. 8, male genitalia, aedoeagus removed; genitalia slide JGF 4281. Madera Canyon 4880′, Santa Rita Mts., Santa Cruz Co., Arizona, 30 July, 1959, J. G. Franclemont. 9, aedoeagus; genitalia slide JGF 4281.

Male genitalia as figured; vesica without a cornutus, membrane with numerous small spinules.

Female genitalia as figured.

Type: Male. Pinery Canyon 7000′, Chiricahua Mts., Cochise Co., Arizona, 14 July 1966, J. G. Franclemont. (Franclemont Collection).

Paratypes: Madera Canyon 5600′, Santa Rita Mts., Santa Cruz Co., Arizona, June, 1960, 1 ♂; East Turkey Creek 6400′, Chiricahua Mts., Cochise Co., Arizona, July, 1967, 1 ♂; Onion Saddle 7600′, Chiricahua Mts., Cochise Co., Arizona, July, 1966 and 1967, 3♂, 1♀; Pinery Canyon 7000′, Chiricahua Mts., Cochise Co., Arizona, July 1966, 1 ♂, J. G. Franclemont. (Franclemont Collection). Madera Canyon 5600′, Santa Rita Mts., Sta. Cruz Co., Arizona, June, 1955, 1 ♂, Lloyd M. Martin; Madera Canyon, Santa Rita Mts., Southern Arizona, July, 1956, 2♂, 1♀, Lloyd M. Martin, John A. Comstock, William A. Rees; Upper Camp, Pinery Canyon [7000′], Chiricahua Mts., Cochise Co., Arizona, July, 1956, 3♂, 1♀, Lloyd M. Martin, John A. Comstock, William A. Rees. (7 Collection Los Angeles County Museum of Natural History, 1 Franclemont Collection).

Synorthodes typhedana n. sp.

Figure 1 male moth, 4 and 5 male genitalia, 10 female genitalia.

A species with glossy grayish black forewings, very similar to *melanops*, but it differs from that species by the irregular subterminal line and the obsolescent annuli surrounding the black orbicular and reniform spots. The male genitalia differ from those of *melanops* by the much less prominent lobe on the costa of the valve, the wide "digital-costal piece", the expanded sacculus of the valve, and the more elongate juxta. It differs from *auriginea* by its larger size and darker coloration.

Description: Head dark grayish black; palpi black. Thorax and patagia black; tegulae black with a considerable admixture of grayish yellow scales; anterior and posterior tufts pale. Forewing grayish black with a grayish yellow sheen; basal line double, dentate, black; antemedial line poorly defined, double, black with some yellowish scales; median shade vague, black; postmedial line poorly defined, double, inner line a series of irregular, black dots, outer line represented by yellowish white points on the veins; subterminal line irregular, pale, yellow with an enlarged yellow spot below vein Cu_2, with a series of inwardly pointing, black, triangular spots on the inner side; a series of terminal, black spots in the interspaces; fringe darker at base and paler toward outer edge; orbicular rounded, subquadrate, black, without and evident pale annulus, reniform large, black, with a very indistinct pale annulus. Hindwing fuscous black, paler toward base; fringe dark with a pale line at base and pale on outer part. Abdomen blackish gray above, yellowish gray below. Forewings and hindwings below yellowish gray, heavily infuscate on outer ⅓, discal dots

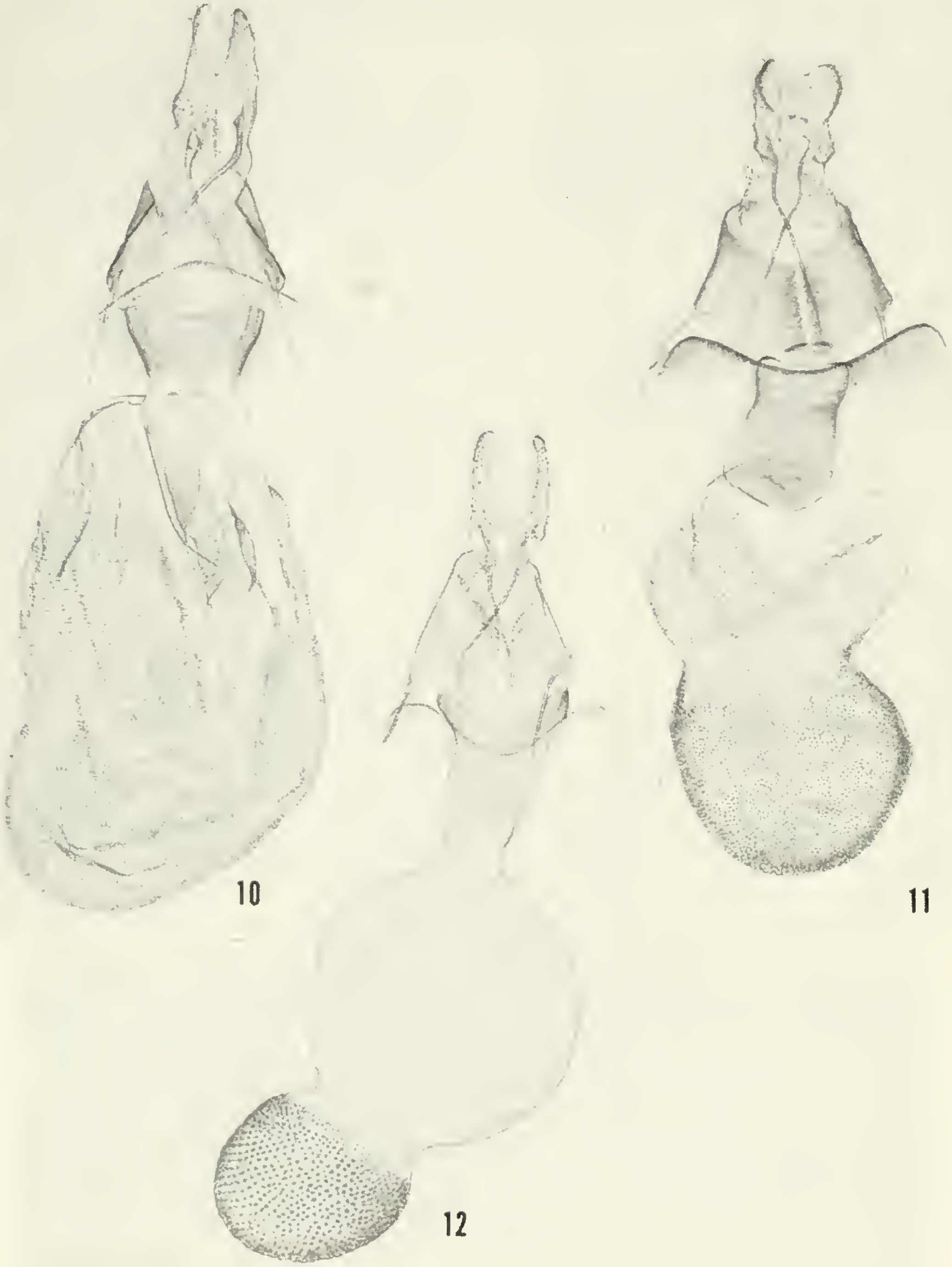

Fig. 10. *Synorthodes typhedana.* Female genitalia; genitalia slide JGF 4532. Madera Canyon 5600′, Santa Rita Mts., Santa Cruz Co., Arizona, 1 July 1960, J. G. Franclemont. Fig. 11. *Orthodes adiastola.* Female genitalia; genitalia slide JGF 4280. Madera Canyon 4880′, Santa Rita Mts., Santa Cruz Co., Arizona, 30 June 1959, J. G. Franclemont. Fig. 12. *Synorthodes auriginea.* Female genitalia; genitalia slide JGF 5278. Onion Saddle 7600′, Chiricahua Mts., Cochise Co., Arizona, 29 July 1966, J. G. Franclemont.

black, postmedial lines black, a series of black dots in the interspaces. Legs with tarsal segments with pale, apical annuli.

Length of forewing 15–16 mm; type 15 mm.

Male genitalia as figured; vesica with a short, stout cornutus, membrane with numerous small spinules.

Female genitalia as figured.

Type: Male. Madera Canyon 5600′, Santa Rita Mts., Santa Cruz Co., Arizona, 1 July 1960, J. G. Franclemont. (Franclemont Collection).

Paratypes: Madera Canyon 4880′ and 5600′, Santa Rita Mts., Santa Cruz Co., Arizona, June and July, 1959, 1960, and 1963, 76♂, 59♀, J. G. Franclemont. South Fork, Cave Creek Canyon 5280′, Chiricahua Mts., Cochise Co., Arizona, July, 1966, 1♂, 4♀; Cave Creek Canyon 5400′, Chiricahua Mts., Cochise Co., Arizona, June and July, 1966, 5♂; East Turkey Creek 6400′, Chiricahua Mts., Cochise Co., Arizona, June and July, 1966, 3♂, 2♀; Onion Saddle 7600′, Chiricahua Mts., Cochise Co., Arizona, July, 1966 and 1967, 3♂, 3♀; J. G. Franclemont. (Franclemont Collection). Upper Camp, Pinery Canyon [7000′], Chiricahua Mts., Cochise Co., Arizona, July, 1956, 9♂, 6♀, Lloyd M. Martin, John A. Comstock, William A. Rees; Sunnyside, West side Huachuca Mts., Cochise Co., Arizona, July, 1958, 8♂, 1♀, Lloyd M. Martin. (22 Collection Los Angeles County Museum of Natural History, 2 Franclemont Collection).

Orthodes adiastola n. sp.

Figure 3 male moth, 8 and 9 male genitalia, 11 female genitalia, 15 and 16 venation of forewing and hindwing.

A species that perhaps is confused in collections with *Pseudorthodes virgula* Grote, but it is larger and apparently allied to *Orthodes cynica* Guenée; the female genitalia are similar to those of the latter species.

Description: General color dull brown with some black scaling. Head and thorax dark brown; palpi black; posterior tuft of thorax black. Forewings dark brown, area between antemedial and postmedial lines lighter than basal ⅓ and terminal ⅓, these areas with black scaling; antemedial line somewhat irregular, crenulate, dentate inwardly; median shade vague; postmedial line outwardly curved from costa then almost straight to inner margin, black, crenulate, dentate outwardly with black points followed by pale points on the veins; subterminal line irregular, pale; area between postmedial and subterminal lines blackish; terminal series of short, black bars in interspaces; fringe concolorous with terminal area; orbicular and reniform somewhat paler than ground, vague, with vague annuli. Abdomen above fuscous, below whitish, heavily scaled with black and brown, anal tufts of male yellowish brown. Forewing below fuscous with vague, dark postmedial line and indistinct discal spot; hindwing below pale, dirty white, heavily infuscate along costal margin and beyond postmedial line, postmedial line evident, black, discal spot conspicuous, black. Tibiae and tarsal segments with narrow, pale, apical annuli.

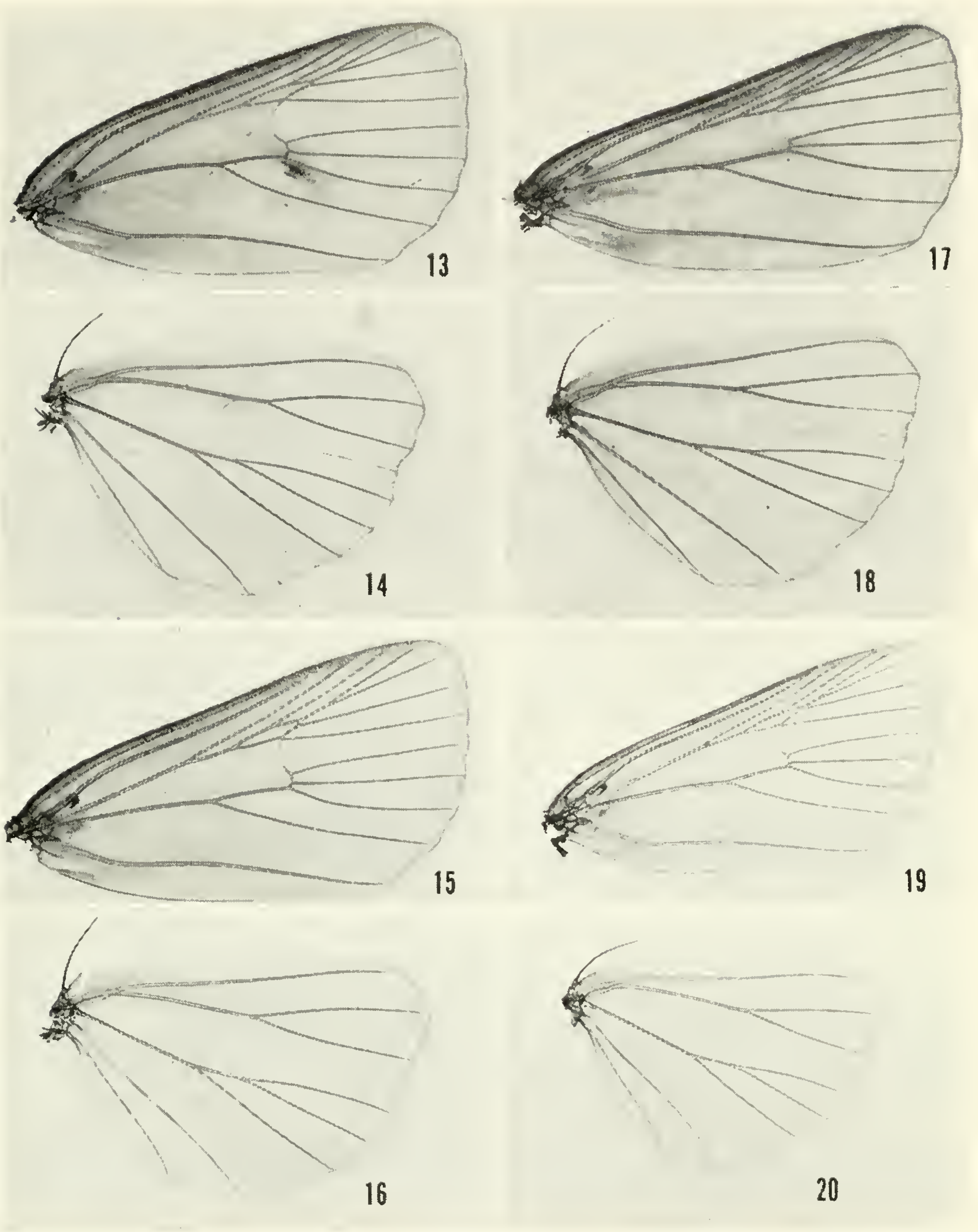

Fig. 13–14. *Orthodes cynica* Guenée. Venation of forewing and hindwing of male. Ithaca, New York. Fig. 15–16. *Orthodes adiastola.* Venation of forewing and hindwing of male. Madera Canyon, Santa Rita Mts., Santa Cruz Co., Arizona. Fig. 17–18. *Orthodes crenulata* (Butler). Venation of forewing and hindwing of male. Arlington, Virginia. Fig. 19–20. *Synorthodes auriginea.* Venation of forewing and hindwing of male. Onion Saddle 7600′, Chiricahua Mts., Cochise Co., Arizona.

Length of forewing 14–15 mm; type 15 mm.

Male genitalia as figured; vesica with well-defined areas of fine, hairlike spicules, no cornuti.

Female genitalia as figured.

Type: Male. Madera Canyon 4880′, Santa Rita Mts., Santa Cruz Co., Arizona, 14 July 1959, J. G. Franclemont. (Franclemont Collection).

Paratypes: Madera Canyon 4880′ and 5600′, Santa Rita Mts., Santa Cruz Co., Arizona, June, July, August, September, October, 1959 and 1960, 43 ♂, 16 ♀, J. G. Franclemont. Cave Creek Canyon 5400′, Chiricahua Mts., Cochise Co., Arizona, July, 1966, 2 ♂; East Turkey Creek 6400', Chiricahua Mts., Cochise Co., Arizona, June and July, 1966, 3 ♂; Onion Saddle 7600′, Chiricahua Mts., Cochise Co., Arizona, July, 1966 and 1967, 3 ♂, 3 ♀; Pinery Canyon 7000′, Chiricahua Mts., Cochise Co., Arizona, July, 1966 and 1967, 3 ♂, 1 ♀; J. G. Franclemont. (Franclemont Collection).

ACKNOWLEDGMENTS

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NOTES ABOUT THE SPECIES AND RELATIONSHIPS OF HARTONYMUS CASEY (COLEOPTERA: CARABIDAE: HARPALINI)

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ABSTRACT—This genus includes two allopatric species inhabiting sandy areas of mid- and southwestern United States: the more northern *Hartonymus hoodi* Casey, 1914, and the more southern *H. alternatus* LeConte 1863 (NEW COMBINATION). The two species are described and their pronota and male genitalia illustrated. Similarities in the armature of the internal sac suggest relationship of *Hartonymus* to the *desertus* and *fulgens* groups of *Harpalus*, not to the Selenophori, and not to other genera of Harpali whose members share with those of *Hartonymus* extra pronotal setae and serially punctate odd-numbered elytral intervals. Evolutionary considerations show that *H. hoodi* is more plesiotypic than *H. alternatus*.

During the past 15 years, understanding has been advanced significantly of taxa of the larger Nearctic harpalines, with Lindroth (1968) providing a synopsis of the Canadian-Alaskan species and a firm basis for classification of the species of *Harpalus*, and Noonan (1973) providing an extensive treatment of anisodactylines. But many problems remain, two of which are dealt with here.

First, the monotypic genus *Hartonymus* Casey, known from few specimens, seemed out of place among the Selenophori. Second, the species *Piosoma alternatum* LeConte, while easily separable from other harpalines by the combination of characters in Casey's key (1914:53–54), remained essentially unknown, because specimens certainly assignable to this species were not represented in the organized sections of the major collections best studied by carabid specialists, and the original description was inadequate.

Incidentally and unknowingly, I became involved in these problems when setting about the task of describing a remarkable species, seemingly new, assigned initially to *Harpalus*, specimens of which were collected in 1965 by David J. Larson, in western Texas. Comparison of the type-series of *Hartonymus hoodi* Casey with specimens of the Texas species suggested that both belonged in the same genus. Then, in 1973, on a visit to the Museum of Comparative Zoology, I found another specimen of the "new" species, determined by G. R. Noonan as *Piosoma alternatum.* But the type of this species was not in the LeConte collection, so the identification could not be verified. Where was the type? Some months later, after I had returned to Edmonton, I was browsing through a collection of reprints that P. J. Darlington, Jr. had given to me years before, and came across a publication on the LeConte species by Henshaw (1881), and learned that the type of *Piosoma alternatum* was in the Ulke Collection. Subsequently, Terry L. Erwin informed me that the collection was in the Carnegie Museum. In due course, the type-material was loaned at my request, providing confirmation of Noonan's determination of the specimen in the Museum of Comparative Zoology, and establishing the identity of the Texas specimens. Thus, initial interest in one seemingly aberrant, seemingly undescribed species of *Harpalus*, brought into juxtaposition two taxa hitherto thought to be unrelated. Details of this linkage are discussed below.

MATERIAL

This study is based on examination of 51 adults of *Hartonymus*, including the types of *H. hoodi* and *H. alternatus* LeConte, plus many additional specimens representing all Nearctic species groups of *Harpalus* and all genera of Nearctic Harpali.

The following acronyms identify in the text material loaned by the following institutions: CMNH—Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, 15213; ENMU—Department of Biological Sciences, Eastern New Mexico University, Portales, New Mexico, 88130; TTUL—Department of Entomology, Texas Technological University, Lubbock, Texas, 79409; UASM—Strickland Entomological Museum, Department of Entomology, University of Alberta, Edmonton, Alberta, T6G 2E3; USNM—Department of Entomology, Smithsonian Institution, United States National Museum, Washington, D.C., 20560.

No attempt was made to gather all material that may be available, and I relied primarily on collections of the USNM and UASM, plus specimens sent to me for determination.

METHODS

Standard methods were used for study and illustration of external structure and male genitalia (for details, see Ball, 1972:181–182).

Measurements are as follows: Length of head–linear distance from base of mandible to posterior margin of left compound eye; length of pronotum (P1)—linear distance along mid-line, from anterior to posterior margin; length of elytra (E1)—linear distance along suture, from basal transverse groove to apex of longer elytron.

Size is expressed as "standardized body length" (SBL) and is the sum of head length, P1, and E1. The quotient of the ratio P1/E1 expresses relative size of these structures.

The internal sac of the male genitalia was studied in the everted position. Designations of the armature are from a system that I am developing for *Harpalus* Latreille, but have not yet described fully, based on position of macrospines, spine patches, and macrotrichia.

THE GENERA OF HARPALI

The Harpali comprise a group of less than subtribal rank, defined polythetically (Ball, 1970:101) with members possessing a varying number of these character states: Lack of small setigerous punctures from elytral striae 2, 5 and 7; hind tarsomere 1 shorter than tarsomeres 2 plus 3; male front and middle tarsi biseriately squamulose ventrally; and males with median lobe asymmetric, apical orifice inclined to left, and internal sac everted to left.

In the Nearctic Region, the Harpali include the diverse genus *Harpalus*, with more than 100 species, and according to Ball (1960a), the monobasic *Cratacanthus* Dejean, *Eurytderus* LeConte, and *Harpalobrachys* Tschitschérine, and the dibasic *Piosoma* LeConte. Lindroth (1968) excluded *Cratacanthus* but described and included the monobasic *Harpalellus* (type-species *Harpalus basilaris* Kirby, included in *Harpalus* by Ball and earlier authors).

The genus *Hartonymus* shares with Harpali all of the above-listed character states. Therefore Casey (1914) and Ball (1960a) were wrong to place this genus in the Selenophori. Casey did so because he interpreted the serial punctures in intervals 3, 5, and 7 of *H. hoodi* specimens as the homologues of strial setae of Selenophori. Nonetheless, he noted the strong "harpaloid" (i.e. Harpali) affinities and observed that the character combination of *Hartonymus* might be used as a basis for combining *Selenophorus* and *Harpalus*. But he concluded that it was better for nomenclatorial purposes to consider these groups as genera rather than making one large genus with numerous subgenera. I paid insufficient attention to its "harpaloid affinities" and simply followed uncritically Casey's placement of *Hartonymus*.

Are these small groups of Harpali correctly ranked as genera? *Cratacanthus* is clearly defined by markedly distinct male genitalia and male mandibles and strikingly distinct mentum, so much so that Lindroth (1968:742) put it in a subtribe of its own. *Harpalellus* males are distinctive in form of the median lobe, although Habu (1973:66) is not inclined to give much weight to this particular feature in ranking taxa of Harpalina. The remaining genera are not that different from *Harpalus*: *Harpalobrachys* males lack modifications of the front and middle tarsi characteristic of Harpalina; and *Euryderus*, *Piosoma* and *Hartonymus* share among themselves extra pronotal and elytral setae. However, marked differences in male genitalia among these last three groups suggest that they are not closely related, but rather that each is related more closely to different species groups of *Harpalus*. In fact, all three of these "setose" groups should probably be included in *Harpalus* (as should *Harpalobrachys*). However, I prefer not to make this combination until relationships can be specified more precisely and until a reasonably convincing scheme can be proposed for the phylogeny of this complex. As *Harpalus* is now defined, the genus is paraphyletic rather than holophyletic, because it does not include all of the species that arose from the stem species. This arrangement is not satisfactory in terms of principles of cladistic classification, but groups of convenience are set apart, distinguished by easily recognized phenetic characteristics. This is good enough, for our present state of knowledge.

The probably apotypic similarities shared by *Eurycerus*, *Piosoma* and *Hartonymus* are considered as convergences, possibly associated with the tendency of animals of these groups to occupy sandy habitats.

Following is an abbreviated key, modified from Ball (1970:104, 111), to distinguish *Hartonymus* from other taxa of Harpalini of America north of Mexico.

1 Labial palpus with penultimate article bisetose or trisetose ...... Subtribes Cratocarina, Stenolophina, Pelmatellina

1′ Labial palpus with penultimate article plurisetose 2

2 (1′) Elytral striae 2 and 5, or 2, 5, and 7 each with row of setigerous punctures, small in most specimens ...... Group Selenophori, Subtribe Harpalina (in part)

2′ Elytral striae without setigerous punctures 3

3 (2′) Submentum and mentum fused ...... Subtribe Anisodatylina (in part)

3′ Submentum and mentum completely separated by transverse suture 4

4 (3′) Paraglossae glabrous 5

4′ Paraglossae setulose ...... Group Harpaïi, Subtribe Harpalina 6

5 (4′) Elytra with microsculpture lines close together, meshes transverse or absent, surface markedly to slightly iridescent ...... Group Selenophori, Subtribe Harpalina (in part)

5′ Elytra with meshes isodiametric, surface not iridescent ...... Subtribe Anisodactylina (in part)

6 (4′) Head with prominent frontal processes in front of eyes; mentum with tooth cylindrical, apex sharp, as long as lateral lobes; pronotum with sides sinuate in front of sharp hind angles ...... *Cratacanthus* Dejean

6′ Head without frontal processes in front of eyes; mental tooth, if evident, shorter than lateral lobes and flat; pronotum with sides various 7

7 (6′) Pronotum with 1 pair of lateral setae ...... *Harpalus* Latreille, *Harpalobrachys* Tschitschérine, *Harpalellus* Lindroth

7′ Pronotum with more than 1 pair of lateral setae; at least elytral intervals 3, 5, and 7 each with single row of setigerous punctures, setae as long or longer than antennal scape 8

8 (7′) Head between eyes with more than 1 pair of setae; each elytral interval with row of setigerous punctures ...... *Piosoma* LeConte

8′ Head between eyes with single pair of supraorbital setigerous punctures, only 9

9 (8′) Anterior tibia with outer apical angle prolonged as broad spine, subequal in length to apical spur; male front and middle tarsus not expanded, ventrally without vestiture ...... *Eurycerus* LeConte

9′ Anterior tibia with outer apical portion not prolonged as broad spine, male front and middle tarsus expanded, with ventral vestiture ...... *Hartonymus* Casey

Hartonymus Casey

Hartonymus Casey, 1914:166. Type-species, *Hartonymus hoodi* Casey, 1914:167. By original designation and monotypy; Hood, 1952:173 (figure of paratype, p. 175); Ball, 1960a:138, 142.

Comparisons: External character states indicated in the above key distinguish members of this genus from other Nearctic harpalines. Males resemble those of the *Harpalus desertus* and *fulgens* group (Lindroth, 1968:809–811) in that the internal sac bears a single spine patch, more or less ventral in position. Further, specimens of the *H. desertus* group have setigerous punctures in intervals 3, 5, and 7, but these are confined to the apical 0.33 of the elytron.

Description: Body form slightly more robust than average for Harpali, size average for Harpali (see Table 1 for data on variation in standardized body length). Color of body rufous to piceous, appendages generally rufous, but apices of palpi flavous.

Microsculpture: Head, dorsally, with lines fine, almost effaced in males, meshes small, flat, isodiametric; ventrally, lines more distinct, meshes transverse. Pronotum of males, meshes isodiametric in lateral grooves, transverse on lateral convex areas of disc, lines effaced on central portion of disc; females, surface uniformly with small isodiametric meshes. Proepisterna and mesepisterna, meshes longitudinal; prosternum, pterosterna and mesepimera, meshes transverse; metepisterna, meshes transverse to oblique; metepimera, meshes isodiametric to transverse. Abdominal sterna II–VI, meshes longitudinal laterally, transverse medially, sternum VII (anal sternum), meshes transverse anteriorly, isodiametric posteriorly. Elytra, dorsally, meshes isodiametric, epipleura with meshes narrow, longitudinal.

Luster: Body slightly shining, males more so than females; no indication of iridescence.

Setae and pubescence: Dorsal surface of head with single pair of supraorbital setae; pronotum laterally with 5 to 7 pairs of setigerous punctures, on inner edges of lateral grooves (fig. 1–3); thoracic sterna sparsely setose, metepisternum setose or glabrous. Elytron with setigerous punctures extended from apex nearly to base, in odd-numbered intervals including interval 1 or not (see Table 3 for data on variation in number of punctures). Coxae and femora with long setae. Abdominal sterna generally sparsely setose, III–V each with long accessory setae posterolaterally. Anal sternum with 4 long setae posteriorly.

Head: Frontal impressions small, punctiform. Eyes small but prominent. Antennae and mouthparts average for Harpali, mentum edentate.

Prothorax: Pronotum as in fig. 1–3, anterior margin slightly concave, lateral margins rounded, narrowly beaded, sinuate or not, posterior margin truncate, beaded; disc generally convex, narrowly flattened medially; median longitudinal impression shallow; posterior lateral impressions small, more or less linear; lateral grooves narrow. Prosternum with intercoxal process not beaded apically.

Pterothorax: Metepisternum either elongate, with lateral margin ca. 1.25× longer than anterior margin; or subquadrate, with anterior and lateral margins subequal.

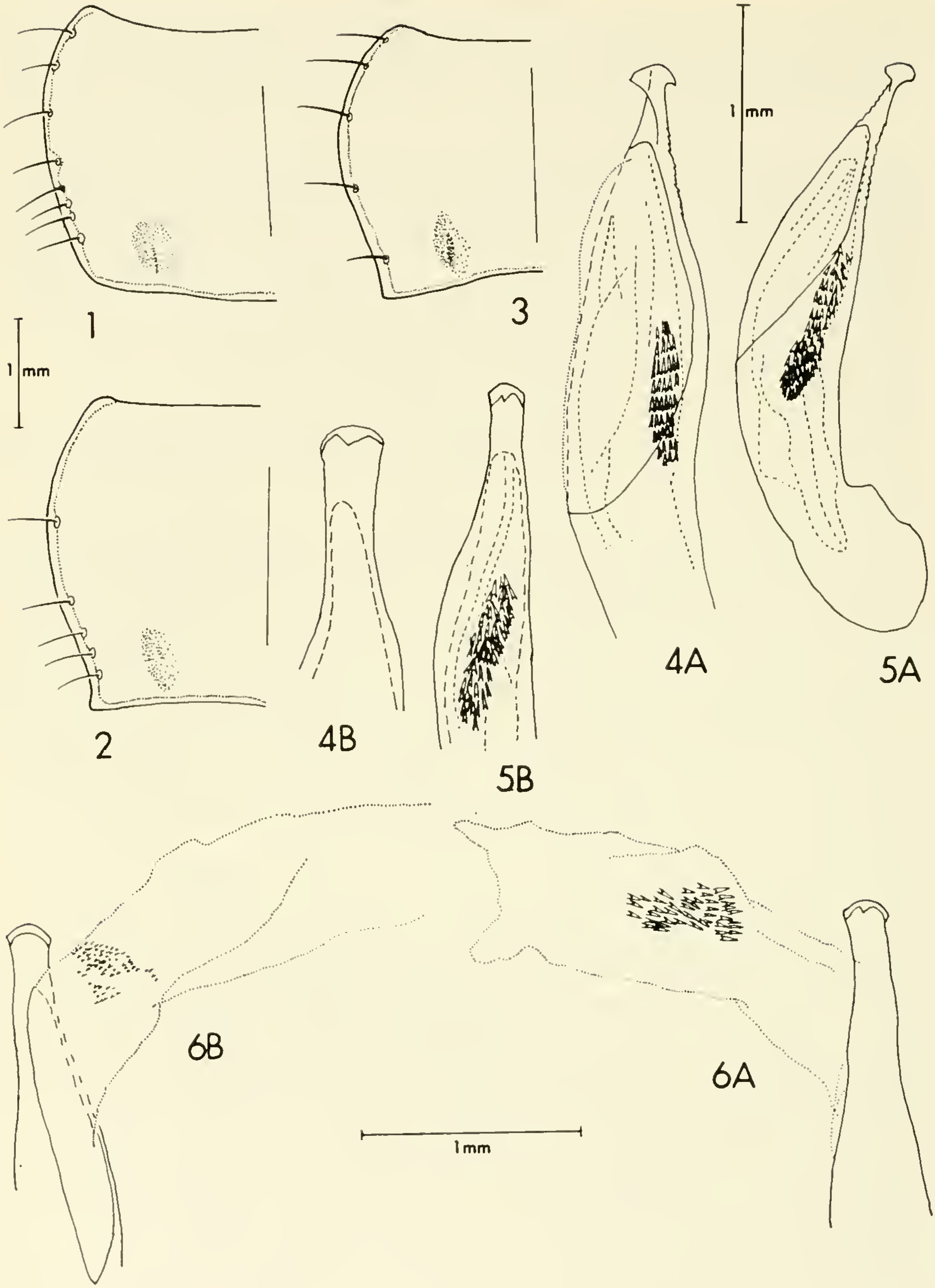

Fig. 1–3. Pronota, dorsal aspect, left half. 1, *Hartonymus hoodi.* 2, *H. alternatus* (paralectotype—"Ark"). 3, *H. alternatus* (Monahans, Texas). Fig. 4–6. Male genitalia. 4, *H. hoodi,* A, median lobe, left lateral aspect, with internal sac inverted; B, median lobe, ventral aspect, apical portion. 5, *H. alternatus*, median lobe and inverted internal sac, A, left lateral aspect; B, ventral aspect, apical portion. 6, *H. alternatus*, median lobe, apical portion, and everted internal sac (microtrichia omitted), A, left lateral aspect of internal sac, ventral aspect of median lobe; B, right lateral aspect of internal sac, dorsal aspect of median lobe.

Elytra: Narrow; proportions various with species. Humeri various, more or less toothed or not. Preapical margins slightly sinuate.

Hind wings: Normally developed, or short stubs.

Legs: Average for Harpali, apical spurs of front and hind tibiae broad. Hind basal tarsomere in length less than length of tarsomeres 2 and 3 combined. Male with articles 1–4 of front and middle tarsus biseriately squamulose ventrally.

Male genitalia: Median lobe with apical portion moderate to short, ventrally spinulose, apex with dorsally directed flanges and ventral median projection (fig. 4–6). Internal sac with single more or less ventral spines patch ("1", fig. 6A).

Ovipositor: Average for Harpali.

Geographical distribution: The two included species are allopatric and their range includes the central portion of the Mississippi Basin and western Texas and eastern New Mexico (fig. 7).

Key to Species

1 Pronotum with posterolateral angles rounded, sides rounded, not sinuate (fig. 1); elytron with interval 1 impunctate; metepisternum elongate, lateral margin distinctly longer than anterior margin .... *Hartonymus hoodi* Casey

1′ Pronotum with sides sinuate posteriorly, posterolateral angles acute (fig. 2–3); elytron interval 1 with 2–10 setigerous punctures; metepisternum approximately quadrate .... *Hartonymus alternatus* LeConte

Hartonymus hoodi Casey

Hartonymus hoodi Casey, 1914:166–167. LECTOTYPE female (here selected), labelled: Topeka, Ill. Oct 29 07; Coll'ct'n J.D. Hood; Casey bequest 1925; TYPE USNM 47906 [red paper]. [Casey coll, USNM]. Paralectotypes (here selected), 3 ♂, 3 ♀, locality labels same as type; Hood, 1952:173–177; Ball, 1960a:142.

Note on Casey material: Included with the type-series is a male labelled: "Havana, Ill. Oct 30 '07, Coll'ct'n J.D. Hood; Casey bequest 1925; hoodi-6, determ. Casey." This is here excluded from the paralectotype series.

Comparisons: In addition to characters presented in the key, specimens of *H. hoodi* are distinquished from those of *H. alternatus* by longer elytra (values for ratio Pl/El less than 0.40), fewer setigerous punctures (Table 3) and larger apical dorsal flanges of the median lobe (fig. 4A; cf. fig. 5A).

Description: Date on variation in standardized body length and in values for ratio Pl/El are presented in Tables 1 and 2. Color of body generally rufous. Pronotum in form as in fig. 1, lateral margins rounded, not sinuate; posterolateral impressions each small shallow linear basin, space between impression and adjacent lateral groove not markedly convex. Metepisternum sparsely setose, distinctly elongate, lateral margin ca. 1.25× longer than anterior

Table 1. Data on variation in standardized body length (SBL) among population samples of *Hartonymus hoodi* Casey and *H. alternatus* LeConte.

Species and locality	Males			Females		
	N	Range	Mean	N	Range	Mean
H. hoodi Casey						
Ia. City, Ia.	2	9.21–9.72	9.46	2	9.88–10.96	10.42
H. alternatus LeConte						
"Ark"	2	8.96–9.13	9.04			
Monahans, Tex.	2	7.30–7.72	7.51	7	7.14– 8.72	8.00
Lubbock Co., Tex.				1	8.13	
Portales N.M.	3	8.05–8.63	8.35	6	7.88– 8.96	8.50

margin. Elytron with humerus almost rectangular, lateral margin not projected as small tooth. Intervals 3, 5, and 7 each with row of setigerous punctures (for data on total number of punctures on left elytron, see Table 3). Hind wings normally developed. Male genitalia with median lobe in lateral aspect as in fig. 4A, ventral surface bowed, apical portion shorter than in *H. alternatus* (cf. fig. 5A), ventrally spinulose, dorsally with prominent apical flanges, and ventrally with well developed apical hook; in ventral aspect (Fig. 4B), apical portion flared, apex broadly rounded. Internal sac ventrad with single patch ("I") of moderate-sized spines.

Natural history notes: Hood (1952) records that specimens were collected along the Illinois River on sandy soil, under boards and other debris. He also cites a note from Wickham that the adult is probably the overwintering stage, and Hood states that maturity is reached in October.

Geographical distribution:—This species is known only from the more or less central part of the Mississippi Basin (fig. 7).

Table 2. Data on variation in values for the ratio PI/E1 among population samples of *Hartonymus hoodi* Casey and *H. alternatus* LeConte.

Species and locality	Males			Females		
	N	Range	Mean	N	Range	Mean
H. hoodi Casey						
Ia. City, Ia.	2	0.34–0.38	0.36	2	0.35–0.36	0.355
H. alternatus LeConte						
"Ark"	2	0.42	0.42			
Monahans, Tex.	2	0.40–0.43	0.41	7	0.40–0.43	0.41
Lubbock Co., Tex.				1	0.45	
Portales, N.M.	3	0.40–0.44	0.42	6	0.40–0.45	0.42

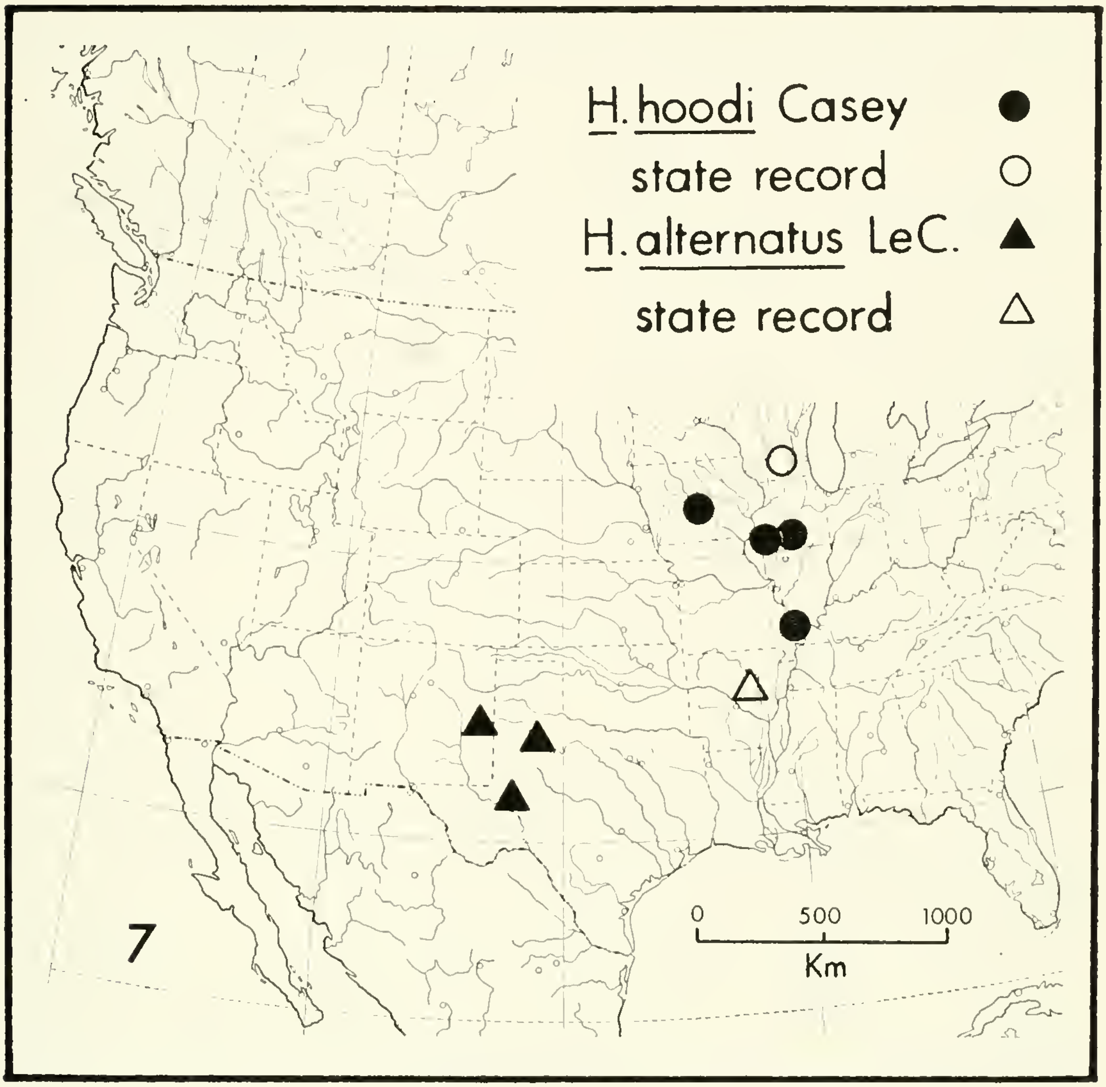

Fig. 7. Map, showing distribution of the species of *Hartonymus* Casey.

Material examined: Total of 29 adults, from the following localities. ILLINOIS: Mason County: Havana (USNM); Topeka (USNM). IOWA: Johnson County: Iowa City (USNM, UASM). MISSOURI: Scott County: Sikeston (USNM). "WISCONSIN."

Hartonymus alternatus LeConte, NEW COMBINATION

Cratognathus alternatus LeConte, 1863:13. LECTOTYPE male (here selected), labelled: Ark; Piosoma alternatum LeC. Paralectotype male (here selected), labelled: Ark. [Both specimens in Ulke Collection, Carnegie Museum of Natural History].

Piosoma alternatum Henshaw, 1881:212; Casey, 1914:54.

Note on type-material: From the original description, it is not clear if LeConte saw both specimens from the Ulke collection. He gave a measurement for a single specimen, only. As the two specimens

Table 3. Data on variation in total number of setigerous punctures in intervals 1–8 of the left elytron among population samples of *Hartonymus hoodi* Casey and *H. alternatus* LeConte.

Species and locality	Males			Females		
	N	Range	Mean	N	Range	Mean
H. hoodi Casey						
Topeka, Ill.	3	11–20	15.4	4	14–21	16.3
Havana, Ill.	3	17–23	20.0			
Sikeston, Mo.	1	12				
Ia. City, Ia.	10	9–17	12.5	8	13–18	15.8
H. alternatus LeConte						
"Ark"	2	43–45	44			
Monahans, Tex.	2	27–30	28.6	7	23–36	28.4
Lubbock Co., Tex.				1	33	
Portales, N. M.	3	27–30	28.2	6	27–33	30.4

are similar in size, perhaps he measured only one. Under the circumstances, it seems best to assume that LeConte saw both specimens, and thus to choose one as lectotype, rather than assuming that he saw only one and then having to guess which of the two Ulke specimens is holotype.

The paralectotype was apparently damaged, for it lacks genitalia.

Systematic note: Although Horn (1881:177–178) and LeConte and Horn (1883:55) did not specify that *Cratognathus alternatus* belonged in *Piosoma*, it is clear that this was their opinion from their characterization of *Piosoma* and exclusion of *Cratognathus* from the North American fauna. Casey (1914:54), who had not seen material of this species, expressed doubt that it really belonged in *Piosoma*. His misgiving was well founded, for structural features, especially of the male genitalia, establish the close relationships of *Cratognathus alternatus* and *Hartonymus hoodi*, and hence their congeneric status.

For diagnostic features, see the key and "Comparisons," under *H. hoodi*.

Description: Data on variation in standardized body length and in values for the ratio Pl/El are presented in Tables 1 and 2. Color of dorsum of mature specimens piceous, venter rufo-piceous to rufous. Pronotum in outline as in fig. 2 and 3, lateral margins incurved posteriorly, posterolateral angles acute; posterolateral impressions deep, separated from narrow lateral grooves each side by pronounced convexity. Metepisternum glabrous, with anterior and lateral sides subequal in length. Elytra shorter than in *H. hoodi*, with humeri more constricted, and basal ridge elevated laterally and more or less projected as humeral tooth. Intervals 1, 3, 5, and 7 each with row of setigerous punctures, generally more numerous than in *H. hoodi* (see Table 3 for details). Male genitalia with median lobe in lateral aspect as in fig. 5A, ventral surface not bowed as in *H. hoodi*; apical portion longer, dorso-apical flanges smaller, and apex more sloped; in ventral aspect, sides of apical portion more parallel than in *H. hoodi* (fig. 5B). Internal sac with spine patch I ventrad (fig. 6A); patch of macrotrichia on dorsal surface, near apical orifice (fig. 5B).

Natural history notes: Specimens of this species were collected in the vicinity of Monahans, Texas, on sandy soil with sparse vegetation of mainly *Opuntia* cactus, acacias and grasses.

Geographical variation: The material available is not sufficient to warrant detailed consideration. However, it is evident that the eastern (Arkansas) and western (Texas-New Mexico) groups differ, as follows: Eastern group with elytral interval 1 with 9–10 setigerous punctures and sides of pronotum more distinctly sinuate (fig. 2); Western group with elytral interval 1 with 1–5 setigerous punctures and lateral margins of pronotum less sinuate (fig. 3).

Material examined: Total of 22 adults, from the following localities. "ARKANSAS" (CMNH). TEXAS: Lubbock County (TTUL). Ward County: 4 mi. n.e. Monahans (UASM, USNM). NEW MEXICO: Roosevelt County: 8 mi. n.e. Portales (ENMU).

EVOLUTIONARY CONSIDERATIONS

In general terms, this genus is probably most closely related to the complex of *Harpalus* including the *desertus* and *fulgens* species groups. The well-developed array of dorsal setae characteristic of its members is certainly an apotypic feature, and probably so is the tendency to live in sandy soil. Within *Hartonymus*, the members of *H. hoodi* are more plesiotypic with respect to pronotal form (rounded sides and posterolateral angles of the pronotum), fully developed metathorax and hind wings, and fewer elytral setae, but more apotypic in form of the median lobe (dorso-apical flanges larger). Expressed in a different way, evolutionary trends in the genus are probably these: Wing reduction with directly associated reduction of metathorax and length of elytra, and probably indirectly associated change in form of pronotum; increase in number of elytral setae; and increase in size of the dorsoapical flanges of the median lobe.

Reasons for these suppositions are as follows. First, absence of functional wings is judged apotypic on the basis of group trends and that special expression of the principle of parsimony, Dollo's Law. In Carabidae generally, absence of functional wings (i.e., brachyptery) is a common phenomenon and can be interpreted as the result of life in ecologically stable habitats (Darlington, 1971:171) and as having evolved from long-winged ancestors that lived in unstable habitats. Further, because carabids are pterygote insects, their ancestors were winged, and in accordance with Dollo's law complex structures (such as wings and associated sclerites), once lost, are not regained in their original form. In the case of *Hartonymus*, it would be contrary to this law to propose that the winged condition of *H. hoodi* had arisen from the short-winged condition of *H. alternatus*. Of course, the reduced metathorax of *H. alternatus* is a reflection and extension of loss of ability to fly as are the reduced elytral humeri (Erwin, 1970:20).

The subcordate pronotum of *H. alternatus* is interpreted as apotypic because in Harpali generally, this form is associated with brachyptery (but there are exceptions—*Piosoma*, for instance). Conversely, rounded pronotal sides and hind angles are generally associated with macroptery, and this is the commonest condition in the Harpali. Also, the prothorax of *H. alternatus* is larger than that of *H. hoodi*, and this seems to be a general correlate of brachyptery, too. Perhaps members of soil-bound species tend to be more fossorial, with a large prothorax housing enlarged muscles used in digging. Certainly, the association of prothoracic size and form with wing development should be investigated by a functional morphologist. Interestingly, the series of differences between *H. hoodi* adults and those of *H. alternatus* are paralleled almost exactly by differences between the macropterous *H. erraticus* and brachypterous *H. retractus* of subgenus *Plectralidus*.

Variation in number of setae is interpreted as a morphocline, with the lower number approaching the probable remote ancestral condition of no or few dorsal setae. This is an in-group comparison based on the fact that adults of most species of Harpali either lack dorsal setae from the elytra, or have few. Interestingly, in *Hartonymus*, the lower number of setae is associated with the species judged plesiotypic on other external structural characteristics.

The large dorso-apical flanges of the median lobe, characteristic of males of *H. hoodi*, are interpreted as the terminus of another morphocline, based on in-group comparison: In Harpali generally, these flanges are absent or small. Thus one could imagine a short series of steps leading from the relatively smaller flanges of the ancestral stock and *H. alternatus*, to the relatively larger ones of *H. hoodi*.

How closely related to one another are the species of *Hartonymus*? Although adults of the two are readily distinguished from one another, several of the diagnostic features seem to be simply correlates of wing reduction, so they can be thought of as a single character complex. This leaves the relatively minor differences in number of elytral setae and in male genitalic characteristics. Thus, the differences are not many, or complex, and could be evolved in a relatively short time and the species are allopatric. On the other hand, the two species occupy different habitats: *H. hoodi*, in (damp?) riparian sand and *H. alternatus* in (drier?) aolian sand. This might suggest a longer period of differentiation than if the two occurred in the same habitat, but in different geographical areas. Nonetheless, one could imagine colonization of aolian sand by a stock very much like *H. hoodi*, followed by marked differentiation to produce *H. alternatus*, and slight differentiation to produce *H. hoodi*, without development of a species intermediate between the extant ones. In fact, I think this probably happened, and that *H. hoodi* and *H. alternatus* are recently evolved sister species, probably no more than a few million years old. I do not anticipate discovery of additional species of *Hartonymus* in sandy areas not yet investigated, nor do I believe that living populations will be found with characters intermediate between those of *H. hoodi* and *H. alternatus*. (I do think, however, that the minor differences between the eastern and western forms of *H. alternatus* will be bridged by character combinations of geographically intermediate populations).

The climatological-geographical-historical correlates of this scenario cannot be specified. It may be possible to do so, after the ranges of the two species have been defined and when much more information is available about their bionomics than the pittance that we have now.

The North American Harpali are probably rich in situations such as the one described here (see, for instance, El Moursy, 1958; Ball, 1972). But so little is known about this complex of taxa, whose species in aggregate make the Harpali ubiquitous and an important element in the temperate portions of the Nearctic Region. Study of its many complexes should repay richly the efforts of zoogeographers and other evolutionists in their attempts to understand the history of life in North America. And, as knowledge of relationships of the Harpali increases, so will our ability to construct a phylogenetic classification of this group.

The following entomologists loaned material, or otherwise made it possible for me to study specimens of *Hartonymus*: T. L. Erwin, Department of Entomology, Smithsonian Institution; N. Jorgensen and J. H. Broadus, Department of Entomology, Eastern New Mexico University; C. W. and L. O'Brien, Department of Entomology, Florida Agricultural and Mechanical University; and G. Wallace, Carnegie Museum of Natural History.

J. S. Scott and T. E. Gibson, Department of Entomology, University of Alberta, respectively prepared the plates and typed the final copy of the manuscript. A preliminary draft was reviewed by G. R. Noonan.

I appreciate the cooperation and assistance of these associates and colleagues, and I'm also grateful to D. J. Larson, Saskatoon, Saskatchewan, who collected the specimens that first stimulated my interest in this genus.

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TWO NEW SPECIES OF PEORIINAE (LEPIDOPTERA: PYRALIDAE) FROM TEXAS

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ABSTRACT—Two new species of peoriine moths (Lepidoptera: Pyralidae), *Homosassa* **blanchardi** and *Peoria* **punctata**, are described from Texas, U.S.A. Adult moths, heads, and male genitalia are illustrated.

I have recently had the pleasure of examining a series of 27 specimens of Peoriinae taken by Mr. André Blanchard in Texas. Though small, the collection is in superb condition, and with a good variety of species represented. Included are *Arivaca artella*, a new species of *Homosassa*, and seven species of *Peoria*, one of which is new.

There are two new records of interest. The two specimens of *A. artella* were taken at Canadian (Hemphill Co.) and in Big Bend National Park and constitute a new record for Texas, the species previously being known only from Arizona and New Mexico. *Peoria gemmatella* is represented by three specimens (Jackson and Hemphill Counties), and is a more significant new record as this species was previously known in the West only by three specimens (all types) from Colorado. The range of this species extends eastward through Iowa and Illinois to New Jersey, north to Maine and Ontario.

Homosassa blanchardi Shaffer, new species
fig. 1, 2, 5–9

Diagnosis: The species is very similar to *H. ella*, but differs in details of the uncus and gnathos.

Description: Frons conical, dark brown; labial palpi obliquely ascending (fig. 2), 3rd segment porrect, 2.3 to 2.6× as long as eye diameter, basal segments white, 2nd and 3rd white ventrally (distally mixed with dark brown) and on inner sides, dark brown dorsally and on outer sides; maxillary palpi small, often hidden by labials; male antennae sublaminate and ciliate, scape dark brown anteriorly, white posteriorly, shaft light brown; eye diameter 0.57 to 0.67 mm; ocelli well developed, black; vertex light brown to brown; occiput, patagia, and tegulae dark brown; pro- and mesothorax dark brown dorsally, metathorax golden brown dorsally; abdomen dorsally golden brown on anterior 2 segments, grading to brown posteriorly.

Forewing radius 6 to 7 mm; with prominent white costal band, proximal ½ margined anteriorly with dark brown line, broadest at base; band sharply delimited posteriorly by radius; ground uniformly dark brown elsewhere; 10 veins; R_2 from same point as or short stalked with R_{3+5}; M_{2+3} fused, from lower outer angle of cell. Hindwing with 7 veins; Sc stalked with Rs for about

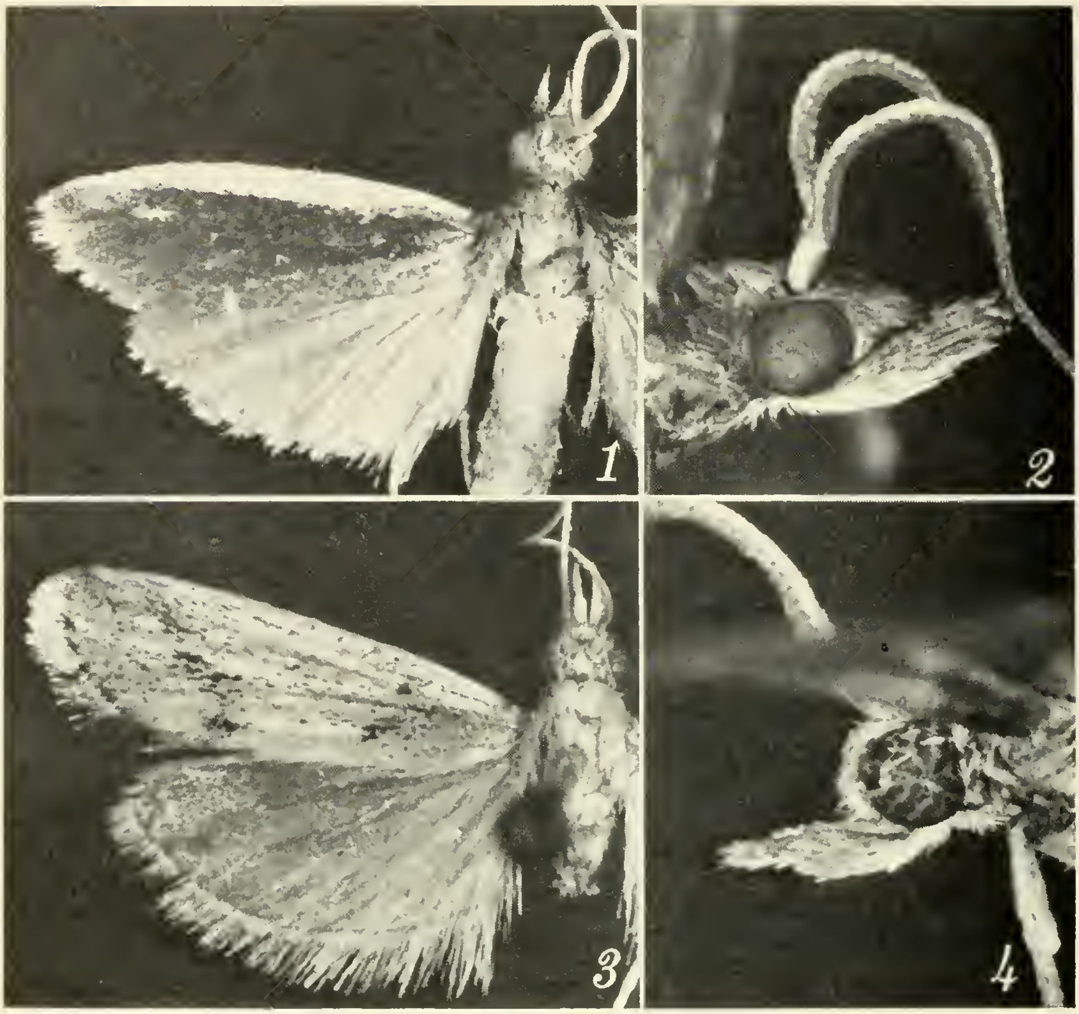

Fig. 1–2. *Homosassa blanchardi.* 1, paratype, dated 31-V-67. 2, head profile of paratype, dated 2-VI-67. Fig. 3–4. *Peoria punctata,* holotype. 3, head, thorax, and left wings. 4, head profile.

½ its length; M_{2+3} fused, stalked with Cu_1 for about ½ its length, from lower outer angle of cell.

Male genitalia (fig. 5) with uncus bearing well-sclerotized ring, opening anteriorly and bearing ventro-laterally directed spine on anterior end of each arm. Gnathos U-shaped (fig. 6), opening anteriorly, posteriorly bearing pair of heavily-sclerotized triangular plates, each terminating in short sharp spine laterally, and serrate on antero-medial margin. Juxta shield-shaped, V-shaped cut on posterior margin. Vinculum subtruncate. Valvae as described for the genus (Shaffer, 1968). Aedeagus (fig. 7) about 4.2× as long as maximum width; vesica with a single small serrate cornutus (fig. 9), and a small patch of minute triangular cusps (fig. 8).

Female unknown.

Holotype: ♂, No. USNM 73826, labelled: "Houston Harris Co., Texas 5. VI. 67 A. & M. E. Blanchard; ♂ genitalia on slide 971 A. B. 1967."


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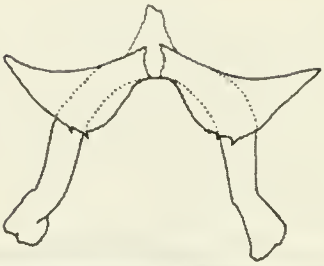
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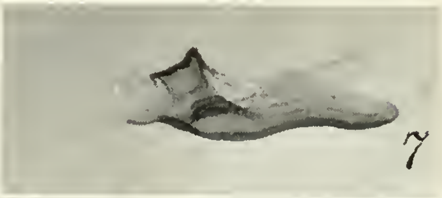
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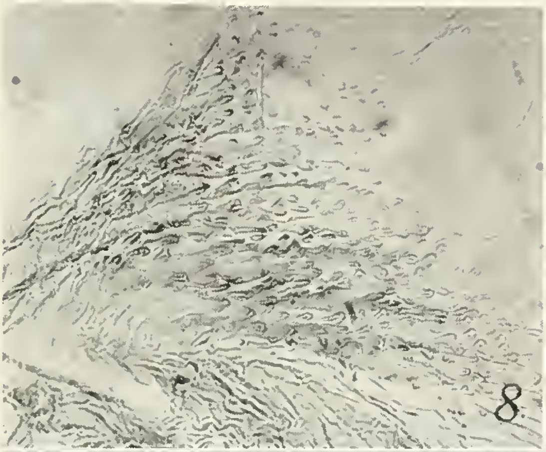
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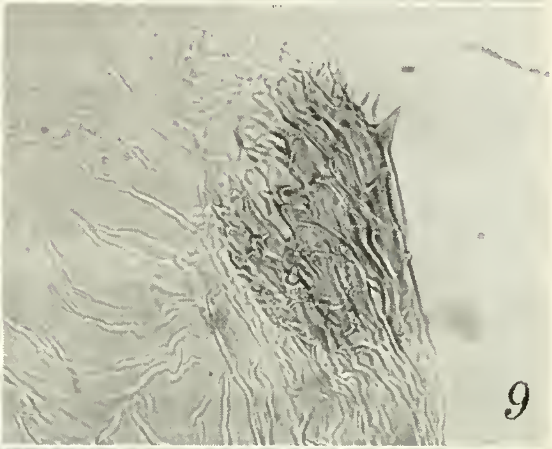
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Fig. 5–9. *Homosassa blanchardi*, holotype. 5, male genitalia. 6, gnathos (slightly enlarged). 7, aedeagus, vesica removed (same scale as fig. 5). 8, cusp patch on vesica (greatly enlarged). 9. cornutus (same scale as fig. 8). Fig. 10–11. *Peoria punctata*, holotype. 10, male genitalia. 11, aedeagus (same scale as fig. 10).

Paratypes: 5 ♂, same data as holotype except dates are: 21. VI. 66, 19. VIII. 66, 20. VIII. 66, 31. V. 67, and 2. VI. 67. The specimen of 21 June 1966 is also labelled: "♂ genitalia on slide 1436 A. B. 1969."

The holotype and two paratypes are deposited in the collection of the U.S. National Museum of Natural History, Washington, D.C.

Three paratypes are in the collection of Mr. André Blanchard, Houston, Texas.

The venation of *H. ella* is identical to that of *H. blanchardi*, and is illustrated (fig. 58) in Shaffer, 1968.

I am pleased to name this species after Mr. Blanchard who first called my attention to it.

Peoria punctata Shaffer, new species
fig. 3, 4, 10, 11

Diagnosis: This is the only known North American species of *Peoria* bearing setaceous tubercles on the juxta.

Description: Labial palpi porrect (fig. 4), 2.2× as long as eye diameter; basal segments white; 2nd and 3rd segments white on inner sides; on outer sides 2nd white proximally, brown distally, 3rd brown. Maxillary palpi well developed, cylindrical, white. Antennae sublaminate in male, light brown. Eye diameter 0.67 mm; ocelli minute, light colored. Occiput reddish brown dorsally, similar laterally but with 4 horizontal bars of dark red scales; patagia and tegulae reddish brown. Forewing radius 7 mm. Ground reddish brown, sprinkled with dark brown scales; broadly and irregularly marked with white on costa, subcosta, radius, cubitus, and mid region of A_2. Dark brown spot on A_2 at ⅓ from wing base; dark brown transverse posterior line, especially well developed on upper and lower outer angles of cell, and on A_2; terminal line of dark brown spots between veins. 10 veins. R_2 well stalked with R_{3+5}; M_{2+3} fused, stalked with Cu_1 for about ⅓ its length, from lower outer angles of cell. Hindwing with 6 veins, Sc stalked with Rs for about ½ its length; M_3 fused with Cu_1, from lower outer angle of cell; Cu_2 from very near the angle.

Male genitalia (fig. 10) with uncus having posterior margin of medial band irregular. Gnathos broad, lacking medial process. Juxta scoop-like, with pair of lateral tubercles, each bearing about 8 setae. Vinculum deeply notched medially. Valvae rounded apically. Aedeagus (fig. 11) subcylindrical, about 3.7× as long as wide; vesica lacking cornuti, but with minute transverse lamination.

Holotype: ♂, No. USNM 73827, labelled: "Conroe, Texas Montgomery Co. 13. V 70 A. & M. E. Blanchard; ♂ genitalia on slide 2579 A. B. 1970". Type deposited in the U.S. National Museum of Natural History.

Table 1 (Shaffer, 1968, p. 12) compares 12 sets of characters for the known North American species of *Peoria*. For *P. punctata* the symbols o, *, o, o, o, x, x, p, x, l, o, 0 may be added in columns 1 through 12 of that table. The venation is essentially identical to that of *P. roseotinctella* (see Shaffer, 1968, fig. 61).

REFERENCE

Shaffer, J. C. 1968. A Revision of the Peoriinae and Anerastiinae (Auctorum) of America North of Mexico (Lepidoptera: Pyralidae). Bull. U.S. Natl. Mus. 280:1–124.

THREE NEW SPECIES OF CASTOLUS AND A KEY TO THE SPECIES (HEMIPTERA: REDUVIIDAE)

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ABSTRACT—*Castolus* **bicolor** n. sp., *C.* **lineatus** n. sp., and *C.* **pallidus** n. sp. are described and included in a key to the known species of this neotropical genus. *Castolus nigriventris* Breddin, whose type may be lost, is not considered in the key.

An undescribed species of *Castolus* was found among specimens of Reduviidae from Coco Solo, Panamá, sent to me by Dr. Dodge Engleman. More specimens of the same species were found among undetermined material in the U.S. National Museum (USNM), Washington, D.C. and at the American Museum of Natural History (AMNH). Dr. P. Wygodzinsky, from AMNH, loaned me other specimens that included two more new species also described below. The genus now includes 13 species.

Thanks to Dr. Per Inge Persson, from the Swedish Museum of Natural History, I had the opportunity to study Stål's types of *Castolus multicinctus* and *C. fuscoapicatus*. Both species are redescribed below. The type of *C. nigriventris* Breddin seems to be lost according to Dr. Gunter Morge who has devoted several years to study Breddin's types. At least the type is not in the collection of the German Entomological Institute at Berlin. The key given below does not include this mostly black species as Breddin's description is insufficient. Dr. R. C. Froeschner, of the USNM, kindly loaned me specimens of *C. spissicornis*.

The types of the new species are deposited in the USNM, AMNH or in my collection (JMC). In the measurements that follow 12.5 micrometer units are equivalent to 1 mm. The length of the specimens is given to the tip of wings. This paper is in part possible thanks to NSF Grant GB-7382.

Castolus Stål, 1858

Head: Slightly shorter than pronotum. All antennal segments linear, 3rd segment thickened in *spissicornis*, 1st shorter than head and pronotum together; jugum inconspicuous, not produced; ocelli slightly or well elevated above level of head, sometimes whole ocellar area elevated; 1st segment of beak longer than 2nd, reaching beyond anterior margin of eye, 3rd the shortest; subantennal spine very short, seldom absent; postocular region nearly 2× as long as anteocular. Pronotum with anterior lobe somewhat inflated, posterior lobe not inflated and not produced over scutellum; unarmed on disc of both lobes; posterior lobe with humeral angle sometimes spined, with slight or no discal elevation; posterior margin straight and horizontal over scutellum, not even slightly produced each side of scutellum; mesopleuron without plica, in some species with an anterior batch of scalelike pilosity; scutellum triangular, with a Y-shaped carina. Postscutellum shortly produced beyond scutellum. Legs: Femora unspined, linear, usually of uniform thickness throughout, slightly thicker than tibiae, apically not bispinous; forefemur slightly longer than hind; tibiae straight with rounded apical sensory pad that extends slightly beyond insertion of tarsi. Anterior acetabulum open. Forefemur ventrally with dense mat of sensory hairs more abundant basally and diminishing both in area and length to about midlength of segment and thence almost bare to apex. Midfemur ventrally with scarcer hairs. Hindfemur without sensory hairs. Foretibia ventrally with sensory hairs increasing in area from base toward apex; midtibia with sensory pilosity much less abundant, and hindtibia without these. Trochanters unarmed; anterior with a dense mat, mid with scarce, and posterior without sensory hairs. Connexival segments not spined on apical angle, slightly angularly produced in some species. Pterostigma of forewing surpassing apex of abdomen; discal cell quadrangular, longer than wide, wider basally than apically. Posterior margin of hypopygium with hairy elevation or patch each side of median spine; median spine long or short, cylindrical or flattened, flattened laterally or dorsoventrally, straight or slightly curved. Claspers short, not reaching to and shorter or longer than median spine of the hypopygium, somewhat hairy apically, very slightly expanding toward apex, straight or slightly curved. Aedeagus quite simple; articulatory apparatus with anterior bridge; with simple dorsal shield (fig. 26). Eighth tergum of female vertical, as in fig. 13 and 17. Neotropical.

In Stål's key (1872) *Castolus* is closest to *Graptocleptes* as they share the following characteristics: Jugum not produced or prominent, unarmed penultimate segment and disc of posterior lobe of pronotum, and straight profemur. Their aedeagi and claspers are quite similar. They differ as follows: *Graptocleptes* has the subantennal spine short and curved forward, the membrane of the forewing wider than pronotum posteriorly, the margin of the hypopygium produced but hair on each side of the median spine, short, irregularly distributed and not on a separate structure, and the species are slender and somewhat mimic wasps. *Castolus* has the subantennal spine very short and vertical, the membrane narrower than the pronotum, with hairy patch on each side of the median spine of the margin of the hypopygium, and the species are broader, more robust, and do not mimic wasps. The aedeagi of species of *Castolus* are very close, the articulatory apparatus showing slight differences. The eighth terga of the females are also very similar. The best characters to separate the species are the abundant color differences, the spines and shape of the pronotum, and the marked differences in the details of the margin of the hypopygium.

KEY TO THE SPECIES OF CASTOLUS

1. Humeral angle of pronotum with rather long spine 2
— Humeral angle of pronotum unarmed, with very short tooth or subangularly shortly produced 5

2\. Head, legs, and anterior lobe and anterior ½ of posterior lobe of pronotum black (fig. 12) .... *bicolor* new species

— Head straw colored or only with ocellar area black; pronotum mostly light colored; legs stramineous 3

3\. Head, pronotum, and forewings straw colored; anterior femora rather stout; legs pale, annulate with fuscous .... *subinermis* (Stål)

— Head with ocellar area black; pronotum or base of forewing ornamented 4

4\. Anterior lobe of pronotum with transverse black band anteriorly and posteriorly, posterior lobe orange (fig. 1); femora with 2 apical dark annuli and fine longitudinal dark lines .... *lineatus* new species

— Pronotum uniformly colored (fig. 6); femora with 1 apical annulus .... *pallidus* new species

5\. Humeral angle of pronotum with short tooth (fig. 3) 6

— Humeral angle of pronotum unarmed or slightly subangularly dilated 7

6\. Ocelli large, elevated (fig. 2); pronotum brown (fig. 3) .... *ferox* (Banks)

— Ocelli small, slightly elevated (fig. 4); pronotum stramineous with 3 black spots on posterior lobe (fig. 5) .... *trinotatus* (Stål)

7\. Posterior and anterior lobe of pronotum concolorous, brownish or blackish brown; head reddish or brownish 8

— Anterior lobe of pronotum much lighter than posterior, posterior with extensive black or brown area; head black, straw colored or reddish 9

8\. Pronotum and forewing dark brown; posterior lobe of pronotum with basal and lateral margins reddish; scutellum reddish; hindmargin of pronotum as in fig. 16 .... *rufomarginatus* Champion

— Pronotum and scutellum brownish; clavus and corium reddish; hindmargin of pronotum as in fig. 21 .... *spissicornis* (Stål)

9\. Head black 10

— Head reddish, straw colored with black ocellar area or at least neck straw colored 11

10\. Discal brown area on posterior lobe not reaching lateral margins; forewing mostly dark brown; fig. 7 .... *multicinctus* Stål

— Brown area on posterior lobe reaching lateral margins; forewing yellowish white with small brownish areas basally, near base of membrane, and apically on membrane; fig. 9 .... *fuscoapicatus* (Stål)

11\. Head and legs reddish; clavus and most of corium whitish, pronotum as in fig. 10 .... *plagiaticollis* Stål

— Head straw colored with ocellar area black or sometimes vertex also more or less black, at least neck straw colored; 1st 2 legs brownish; forewing stramineous anteriorly, black transversely between scutellum and base of membrane, and reddish on both sides of membrane; pronotum as in fig. 11 .... *tricolor* Champion

Castolus bicolor Maldonado Capriles, new species

fig. 12, 19 17,

Male (fig. 17): Head black; small inconspicuous ivory white area on base of neck above, on base of tylus, and behind antenna including the subantennal spine. Beak black. Antenna: First segment black with 2 long yellowish-white spots near midlength; 2nd black; 3rd and 4th dark gray. From antennae to interocular depression thickly covered with whitish decumbent thick pilosity. Pronotum: Anterior lobe dorsally and laterally and collar black; posterior lobe with anterior ½, except medianly, black; posterior ½ and anterior ½ of posterior lobe medianly orange red. Pleurae and thoracic sterna black. Scutellum black with pale orange lateral margins. Forewing: Clavus and corium pale orange; membrane hyaline. Legs black; femora grayish white throughout most of anterior face. Abdominal sterna blackish brown, almost black; 2–5 sterna medianly conspicuously ivory white along anterior margin, laterally less so below level of spiracles; margin of connexivum broadly ivory white to penultimate segment; last tergum thinly margined with ivory white. Apex of hypopygeal spine ivory white. Pronotum laterally, pleurae, thoracic sterna, and basal ½ of abdominal sterna thickly covered with white, short, decumbent, thick pilosity. Legs with moderately abundant vertical and semidecumbent long fine whitish pilosity. Scutellum long pilose apically.

Head: Length 27, width across eyes 16, interocular space 9. Antennal segments: 43:13:46:20. Beak: 12:10:?. Pronotum: Length 34, across shoulders 15, across widest part of anterior lobe 21, across humeral angle of posterior lobe 41. Head with vertex slightly convex. Pronotum: Collar slightly produced laterally; individual lobes of anterior lobe globose, smooth; depression between lobes deep; posterior lobe with surface very finely and inconspicuously pitted, humeral angle produced in a long spine. Femora from above: Anterior thickest basally, slightly tapering to apex, the thickest; middle almost parallel-sided to before apex where it narrows and then slightly widens apically, thinner basally than fore (3:5); hind slightly thicker basally and apically, straight, slightly thinner than midfemur; lengths of femora: 43:38:49, the last reaching to apex of 5th abdominal segment. Tibiae straight. Length 12 mm.

Upper margin of hypopygium with long, straight, vertical, slightly club-shaped spine; hairy area well defined, elevated and extensive; a median elongate depression on lower surface of hypopygium (fig. 19).

Holotype: ♂, from Trinidad, Arima Valley, 800–1200 ft., Feb. 1966, J. G. Rozen collector, in AMNH. Easily distinguished by the black head, legs, and anterior part of pronotum. A female in my collection, from Trinidad, lacking the extensive black areas of the pronotum but otherwise similar to the described male could be the female of this species. It also has the batch of scale-like hairs behind the antenna a character that is not found in the other species.

Castolus fuscoapicatus (Stål, 1860)
fig. 9

Female (fig. 9): Head above blackish brown, with short dashes of yellow between antennae, ocelli, and along internal margin of eye; laterally blackish brown behind eye and yellowish in front; below yellowish. Beak: First segment shiny brown, 2nd brown basally and remaining part light brown, 3rd light brown. Antenna: First and 2nd segment blackish brown, 3rd blackish brown basally and then fading to brown at apex; 4th brown. Subantennal spine yellowish, black at base. Pronotum: Anterior lobe dorsally brownish yellow, anterior angle blackish brown, laterally brownish yellow with blackish longitudinal stripe from anterior angle to posterior lobe; posterior lobe dorsally yellowish contiguous to anterior lobe and more extensively so along median depression and narrowly along posterior margin, remaining dorsal parts and laterally blackish brown. Thoracic sterna and pleura light brownish yellow; with a brown or blackish-brown area ventrally in front of mesocoxa and laterally above meso- and metacoxa. Anterior coxa brownish yellow, laterally with a small brownish area; meso- and metacoxa shiny brown. Anterior femur brownish yellow, with a midlength and preapical brown annulus; meso- and metafemur dark brown, with postbasal and midlength brownish-yellow annuli. Tibiae and tarsi dark brown. Scutellum brownish yellow, a shade lighter than anterior lobe. Forewing: Clavus yellowish white, brown basally; corium yellowish white, brown basally and at apical angle; membrane mostly hyaline, brownish along caudal vein (M) of last discal cell and along anal vein. Abdominal sterna mostly brownish yellow, 1st sternum slightly darker; laterally above on basal margin and extending close to posterior margin a semicircular brown spot that includes spiracle. Connexivum brownish yellow; 3rd, 4th, and 5th segments orange on basal ⅔. Head and pronotum with moderate abundant fine short appressed grayish pilosity; antenna very short pilose; abdomen along lateral margins with moderately long vertical pilosity.

Head: Length 28, width across eyes 16.5, interocular space 9. Antennal segments 45:14:39:19. Beak 12:10:7. Pronotum: Length along median line 30, width across shoulders 14, across widest part of anterior lobe 17.2, across humeral angle of posterior lobe 33. Antennal socket closer to eye than to apex of tylus (3:6); subantennal spine 3. Vertex convex; ocelli well elevated. Anterior angle of pronotum round. Individual lobes of anterior lobe smooth, globose; disc of posterior lobe smooth, medianly broadly depressed from anterior margin to before apex; humeral angles roundly elevated, not produced laterally; posterior margin straight above scutellum. Coxae glabrous. Forefemur straight thickest basally and slightly swollen preapically; other 2 of equal thickness throughout; lengths 44:37:54; 1st at midlength the thickest (4.5:3.5:3.5). Foretibia straight, slightly thickening apically. Midtibia shaped as foretibia, both with moderately abundant semivertical fine long pilosity that does not exceed thickness of segment. Hindtibia with fine pilosity longer than thickness of segment. Length 12 mm.

Type from Brazil. Closest to *C. multicinctus*, they can be separated by the characters in the key.

Castolus lineatus Maldonado Capriles, new species

fig. 1, 14, 15

Male: Head and beak cream yellow; interocellar area black. Antenna: First segment with 3 alternating straw colored and 3 black bands, bands somewhat fused along frontal margin; 2nd pale straw colored, apex black; 3rd brown basally fading to light brown apically; 4th light brown. Pronotum (fig. 1) with a narrow black band behind collar that extends down along side of pronotum; similar band between anterior and posterior lobes also extending along sides of pronotum; anterior lobe and collar pale straw colored; posterior lobe pale straw colored anteriorly, posteriorly orange red; hindmargin narrowly pale. Mesopleuron anteriorly blackish; remaining parts of thorax straw colored. Scutellum with discal depression black or orange; margin pale straw colored.

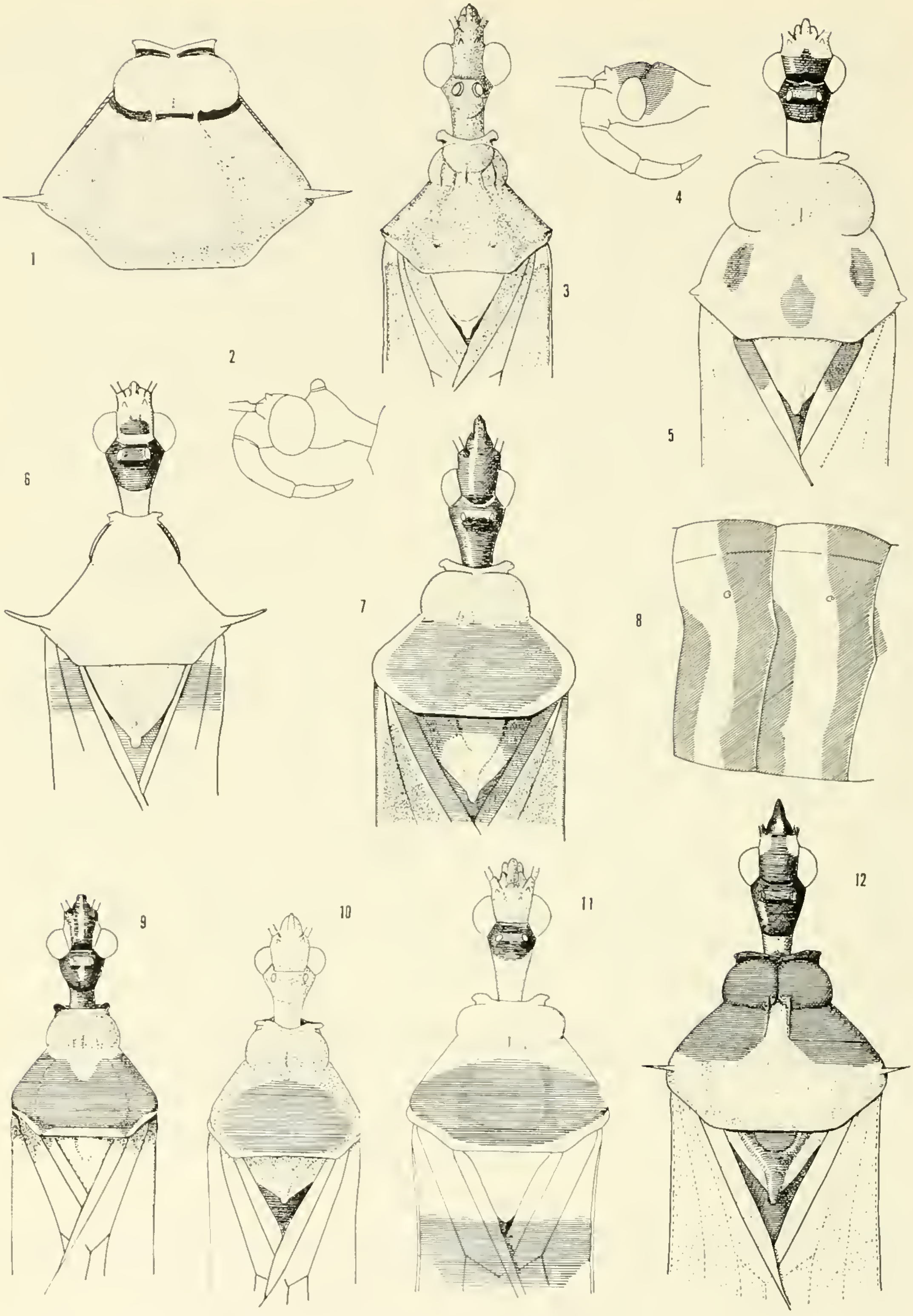

Fig. 1. *Castolus lineatus*, pronotum, dorsal. Fig. 2–3. *C. ferox*. 2, head, lateral. 3, anterior half, dorsal. Fig. 4–5. *C. trinotatus*. 4, head, lateral, 5, anterior half, dorsal. Fig. 6. *C. pallidus*, anterior half, dorsal. Fig. 7–8. *C. multicinctus*. 7, anterior half, dorsal. 8, abdominal sterna III and IV, lateral. Fig. 9. *C. fuscoapicatus*, anterior half, dorsal. Fig. 10. *C. plagiaticollis*, anterior half, dorsal. Fig. 11. *C. tricolor*, anterior half, dorsal. Fig. 12. *C. bicolor*, anterior half, dorsal.

Legs: Femora pale straw colored; with blackish annulus after midlength; apically on anterior and posterior face blackish; with interrupted thin longitudinal blackish-brown lines extending from base to apex; tibiae pale straw colored, apex brownish; with incomplete blackish postbasal annuli and longitudinal thin basal lines. Forewings: Clavus and corium very pale orange, near humeral angle with a blackish-brown area; membrane hyaline. First 5 abdominal sterna pale straw colored medially turning into pale orange towards lateral margins; connexival margin and last 2 abdominal segments very pale orange; sterna 2–5 blackish along apical margin on each side of abdomen (fig. 14). Head and antennae mostly glabrous; pronotum and forewings with scarce vertical pilosity; legs with moderately abundant long vertical and semidecumbent pale hairs, more abundant towards apex of tibiae. Black stripe of mesopleuron with short, appressed, thick, white pilosity.

Head: Length 29, width across eyes 19, interocular space 9. Antennal segments: 54, 17, 52, 16. Beak: 14, 12, 5. Pronotum: Length 36, across shoulders 15.5, across widest part of anterior lobe 22, across humeral angle 45. Subantennal spine short. Anterior angle of pronotum produced lateral as short spine; individual lobes of anterior lobe globose, smooth, depression between lobes deep only posteriorly; posterior lobe somewhat elevated on disc, inconspicuously and shallowly finely pitted, with 2 very slight elevations behind on disc. Last 2 segments of connexivum very shortly angularly produced. Upper margin of hypopygium as in fig. 15; spine long, slender; on lateral aspect long S-shaped, apex hooklike. Length 14.5 mm.

Female: Coloration and pilosity mostly as in male; black lines slightly thicker, more conspicuous; anterior lobe of pronotum straw colored; dark areas on humeral angles of forewing smaller. Head: Length 33, width across eyes 19, interocular space 9. Antennal segments: 57, 19, 59, 19. Beak: 19, 16, 7. Pronotum: Length 40, width across shoulders 16, width across widest part of anterior lobe 25, across humeral angles 49. Thorax shaped as in male. Abdomen wider than in male; connexivum exposed as seen from above, all connexival segments shortly angularly produced.

Holotype: ♂, Barro Colorado, Canal Zone, Panamá, Dec. 30, 1940, K. W. Cooper collector, in AMNH. Allotype ♀, same locality, April 21–22, 1962, H. Ruckes collector, in AMNH.

Paratypes: 1♂ from Colombia, 1♂ from Costa Rica in AMNH, and 1♀ from Barro Colorado, C. Z., 1♀ from Colombia in JMC.

In the paratypes the discal depression of the scutellum is black, orange, or straw colored and the size of the black areas on the base of the forewings varies. The coloration of the pronotum is quite constant. In some specimens the hindtibia is brownish basally instead of straw colored. Closest to *C. pallidus*, they can be separated by the characters in the key.

Castolus multicinctus Stål, 1872
fig. 7, 8

Female: Head above and laterally, beak and 1st segment of antenna polished blackish brown; from lower margin of eye diagonally to ventral side of neck with an orange stripe; 2nd to 4th segments of antenna dark brown. Pronotum (fig. 7): Anterior lobe dorsally and laterally to base of acetabula orange; posterior lobe dorsally dark brown with ivory lateral and caudal margins; lower lateral margin of pronotum dark brown along both anterior and posterior lobes. Meso- and metapleura, coxae, and legs polished very dark brown, a shade paler than head. Forewing: Clavus brown; corium lighter brown to before R vein, area between R and C ivory white, costa brown, membrane hyaline. Abdomen ventrally with a zebralike ornamentation (fig. 8). First visible abdominal sternum blackish, 2nd to 5th sterna black basally to level of spiracles, medianly ivory white to level of connexival segments, and apically again blackish to connexival segment; last sternum orange medianly, followed by an irregular brown area, and then with the same black and ivory pattern of preceding sterna. Genital segments orange. Connexival segments, above and below ivory white on basal ½, blackish on apical ½. Abdominal terga blackish brown, apical margin narrowly yellowish, white area of connexival segments shortly extending into terga at about midlength of lateral margin of each tergum. Body above, except membrane, covered with moderately abundant fine short, semidecumbent brown pilosity; antenna very short pilose.

Head: Length 30, width across eyes 17.5; interocular space 10. Antennal segments: 35, 16, 36, 16. Beak 15, 17, 6. Pronotum: Length along median line 34; across shoulder 17, across widest part of anterior lobe 25, across humeral angles of posterior lobe 43. Antennal socket closer to eye than to apex of tylus (4:10), no subantennal spine; vertex roundly convex; ocelli slightly elevated. Anterior angle of pronotum moderately produced laterad as blunt spines; individual lobes of anterior lobe globose, smooth; disc of posterior lobe slightly elevated, inconspicuously finely and shallowly pitted, with a small discal depression, humeral angle rounded. Coxae moderately pilose. Femora, from above, constricted after midlength and again before apex; lengths 47:42:52; 1st the thickest (7:5:4); last reaching to base of 5th abdominal segment. Foretibia straight, slightly thickening apically; midtibia and hindtibia straight; all with scarce long fine vertical hairs. Length 14.5 mm.

Type from Bogotá, Colombia. Closest to *C. fuscoapicatus*.

Castolus pallidus Maldonado Capriles, new species

fig. 6, 17, 18

Male (fig. 6): Mostly fuscous or straw colored; with black as follows: Vertex with rectangular spot on disc between eyes, ocellar area from behind eyes to base of neck, hooked stripe laterally on anterior lobe of pronotum, apex of femora, anteriorly on meso- and metapleura, postbasally on clavus and corium, and posterior margin of 1st 5 abdominal sterna. Antenna mostly fuscous or light brown; 1st segment blackish brown apically and 2 inconspicuous brownish annuli at about midlength, 2nd segment shortly blackish brown apically, 3rd brown basally, 4th light brown. Scutellum orange.

Head: Length 29, width across eyes 19, interocular space 9. Antennal segments 60:20:75:21; apex of antennal socket closer to eye than to apex of tylus (3:5). Beak 17:14:5. Pronotum: Length 32, width across anterior angles 15, across widest part of anterior lobe 20, across humeral angles 39; spine at humeral angle long, horizontal, 8; anterior angle of pronotum pointing laterad as conical

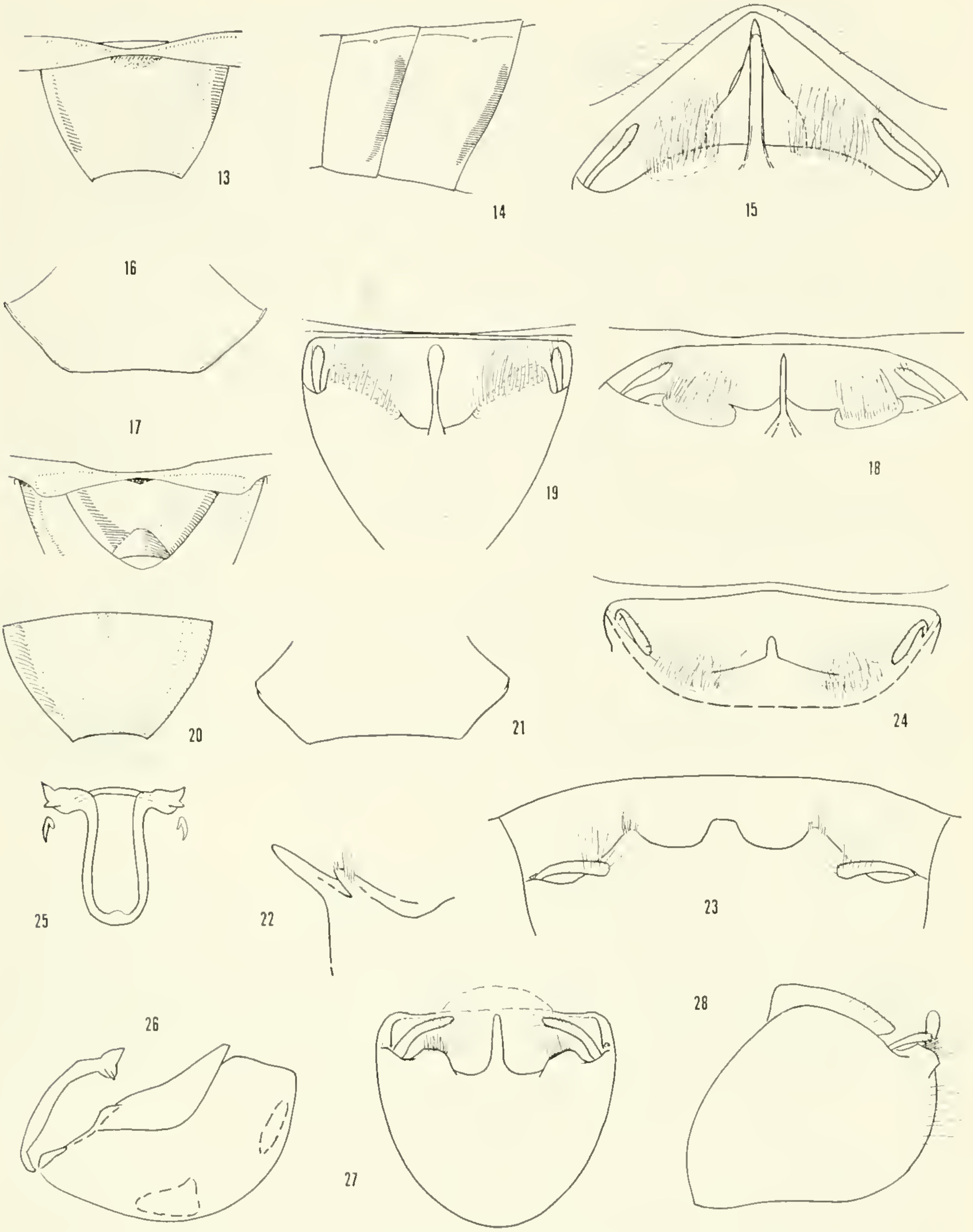

Fig. 13. *Castolus ferox*, eighth tergum, ♀, caudal. Fig. 14–15. *C. lineatus*. 14, abdominal sterna, III and IV, lateral. 15, margin of hypopygium. Fig. 16. *C. rufomarginatus*, margins of posterior lobe of pronotum. Fig. 17–18. *C. pallidus*. 17, eighth tergum, ♀, caudal. 18, margin of hypopygium. Fig. 19. *C. bicolor*, margin of hypopygium. Fig. 20–23. *C. spissicornis*. 20, eighth tergum, ♀. 21, posterior lobe of pronotum. 22, margin of hypopygium, lateral. 23, margin of hypopygium, caudal. Fig. 24. *C. trinotatus*, margin of hypopygium. Fig. 25–28. *C. plagiaticollis*. 25, articulatory apparatus of aedeagus. 26, aedeagus, lateral. 27, hypopygium, caudal. 28, hypopygium, lateral.

spines. Individual lobes of anterior lobe not globose, along posterior margin with 2 or 3 inconspicuous ridges; posterior lobe very finely pitted, disc flattened and posteriorly with 1 + 1 small conical elevations. Coxa glabrous. Femora strongly constricted before apex; forefemur thickest basally and thence tapering to apical constriction; mid- and hindfemur of almost same thickness throughout; lengths 56:45:59; first at midlength the thickest (6:4.5:4). Foretibia straight, midtibia of same thickness throughout, both tibiae with moderately abundant semivertical fine long pilosity that does not exceed thickness of segment. Hindtibia straight, fine semivertical pilosity longer than thickness of segment. Upper margin of hypopygium with patch of hairs on a well-defined, oval base; spine straight, vertical, flattened laterally (fig. 18). Length 14–16 mm.

Female: Coloration as in male. Head: Length 34, width across eyes 19, interocular space 10. Antennal segments: 61, 21, 65, ?. Beak: 19, 16, 5. Pronotum: Length 42, width across shoulders 16, width across widest part of anterior lobe 23, across humeral angles 48. Thorax shaped as in male. Abdomen wider than in male, connexivum exposed, all connexival segments shortly angularly produced. Apical margin of 7th and shape of 8th tergum (fig. 18) very much as in *lineatus*. Length 17 mm.

Holotype: ♂, Coco Solo Hospital, C. Z., at light, 20 June, 1972, D. Engleman collector, in the USNM, Cat. No. 73531. Allotype: ♀, same locality, 8 May 1972, D. Engleman collector, in the USNM. Paratypes: 7, specimens of both sexes, Barro Colorado Island, C. Z., Apr. 1962, H. Ruckes collector, in AMNH; 2 from Coco Solo Hospital and one from Barro Colorado, in JMC, 13 from Barro Colorado in the USNM.

This species is closest to *C. lineatus*.

Castolus ferox (Banks, 1910)
fig. 2, 3, 13

This North American species is mostly dark brown above and slightly lighter beneath. Forefemora darkest and all have 2 pre-apical, dark-brown annuli. Ocelli well elevated. Male lighter than female. Length, male 11 mm, female 16 mm. Specimens at hand from Arizona; reported from Texas by Elkins.

Castolus plagiaticollis Stål, 1858
fig. 10, 25–28

Head, anterior lobe of pronotum and unbanded femora brownish; tibiae dark brown. Hindmargin of posterior lobe of thorax ivory white and discally blackish brown (fig. 10). Clavus and most of corium yellowish, membrane and apex of corium dark brown. Abdomen yellowish or light brownish, narrowly transversely banded with brownish or reddish brown at sternal sutures. Male genitalia as in fig. 25–28. Length, male 11–12 mm, female 14–15 mm. Recorded from Mexico, Guatemala, and Panamá.

Castolus rufomarginatus Champion, 1899
fig. 16

Head, margins of pronotum, most of scutellum and thorax, and abdomen ventrally reddish. Pronotum above, forewings, and legs brown. Posterior margin of pronotum of female as in fig. 16. Female 17 mm. Material at hand from Caracas, Venezuela; described from Mexico.

Castolus spissicornis (Stål, 1860)
fig. 20–23

Male: Head reddish brown, antenna polished blackish brown; pronotum above dark reddish brown, somewhat deeper anteriorly, posterior margin narrowly reddish. Scutellum reddish, with discal depression blackish. Forewing with clavus and corium dark red, with conspicuous abundant decumbent grayish pilosity and irregularly dotted with rounded glabrous areas. Pronotum laterally lighter than dorsally, meso- and metapleura reddish, abdomen ventrally reddish with many irregularly distributed dark red and blackish spots. Connexival segments with blackish-red margin. Abundant short decumbent pilosity all over; thoracic sterna densely white pilose. Femora brownish, tibiae dark reddish brown. Third antennal segment thickened. Posterior margin of pronotum as in fig. 21. Margin of hypopygium as in fig. 21 and 23. Length 14–15 mm.

Female: Lighter than male. Second to 5th connexival segments reddish on basal ½, blackish on apical. Third antennal segment not thickened. VIII tergum of female as in fig. 20, thickly covered with white decumbent hairs. Length 18 mm. Specimens from Río de Janeiro, identified by H. G. Barber, in the USNM.

Castolus subinermis (Stål, 1862)

I have not seen this species. Described from Mexico; recorded from Arizona.

Castolus tricolor Champion, 1899
fig. 11

Head blackish brown with small yellow areas in front, between antennae, and above on neck. Anterior lobe, hindmargin of posterior lobe, base of forewings to level of apex of scutellum, hindfemur to before apex, thorax ventrally, and abdominal sterna straw colored. Posterior lobe mostly blackish brown (fig. 11). Anterior and posterior legs, apex of hindfemur, and posterior tibia brown. Forewing as described in key. Abdomen transversely banded with dark brown along sutures of sterna. The yellow, brown, and red of forewings explain the trivial name of the species and identify it. Female: Length 14–15 mm.

Recorded from Mexico, Belize, Guatemala, and Panamá. From Costa Rica in JMC, no males at hand.

Castolus trinotatus (Stål, 1866)
fig. 4, 5, 24

Male: Head, anterior lobe of pronotum, margins of posterior lobe of pronotum, clavus, corium, hind legs, and thorax and abdomen ventrally straw colored. Posterior lobe yellowish white discally. Thorax laterally with 2 large dark-brown spots. Blackish areas on head, thorax, and clavus as in fig. 4 and 5. Front and hind legs light brownish, slightly darker than hind legs. Abdominal sterna posteriorly transversely and narrowly banded with red. Posterior margin of hypopygium as in fig. 24; spine and hairy patches receding from margin, contrary to the other species in which they are marginal. Length 14–15 mm.

Material at hand and in the USNM from Honduras, Nicaragua, and Mexico, the latter the type-locality.

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BOOK REVIEW

Urban Entomology. 1975. By Walter Ebeling. 695 pp., 391 figs., 8 col. pls. Distributed by: Publications, Division of Agricultural Sciences, University of California, 1422 S. 10th St., Richmond, Calif. 94804. Price, $27.50.

The title of this fine book is aptly chosen because of the rapid shift of people to city and suburban living. The coverage is broad enough to include not only traditional structural pests but also pests which may annoy picnickers, campers and fishermen. The problems of people who mistakenly think that they are parasitized by insects are even discussed. Insects attacking garden vegetables and shrubs are omitted, but pests of house plants are included. Subjects not usually regarded as entomological, such as vertebrates (rats, snakes, etc.) often encountered by the outdoor person, likewise are represented.

Background on a wide variety of organized entomological efforts in the United States—the National Pest Control Association, the pest control industry as a whole, leading entomological societies, state and federal agencies whose work is related to consumers and their needs—to name a few, is supplied. Information on basic entomology sufficient to place pest species in perspective is also given, and the references mentioned throughout the text, assembled in a terminal bibliography of 50 pages, will be very useful to teachers and others accessible to libraries. There is a full treatment of pesticides and equipment for using them.

Dr. Walter Ebeling, a professor of entomology at the University of California, Los Angeles, has had a long and productive experience in the whole field of pest problems. A 1959 book, "Subtropical Fruit Pests," and numerous reports on termites, cockroaches and other domestic pests are evidence of his background. It is safe to predict that this book will be very successful.

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TWO NEW SPECIES OF MENACANTHUS (MALLOPHAGA: MENOPONIDAE) FROM WOOD-SWALLOWS (PASSERIFORMES: ARTAMIDAE)[1]

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ABSTRACT—Two new species of *Menacanthus* are described and illustrated: *M.* **nelsoni** off *Artamus cyanopterus* from Tasmania and New South Wales and *M.* **elbeli** off *A. fuscus* from Thailand. These represent the first *Menacanthus* described from the Artamidae.

In a study of the mallophagan genus *Menacanthus* Neumann from passerine hosts, I obtained 2 series of specimens from wood-swallows (Passeriformes: Artamidae: *Artamus* Vieillot), a host group from which no *Menacanthus* have previously been described. Since these lice are distinctively different from any others I have seen, it is my purpose here to describe and illustrate these new species.

In the following descriptions, morphological terminology and numbers for head setae are much as given by Clay (1969). Measurements are in millimeters. The host nomenclature follows that of Peters (1962).

Menacanthus nelsoni Price, new species
fig. 1–6

Male (fig. 1): Head with preocular slit; nodi moderately developed, associated carinae weak. Alveoli of marginal temple setae 26 and 27 closely associated, with 26 finer and shorter than 27; long occipital setae 21, 22, and 23, with alveoli in straight line; long to very long marginal temple setae 24, 27, 29, and 31; preocular setae 10 and 11 long, 9 very long, with adjacent seta 8 much shorter and finer; dorsal seta 16 mediad to setae 14 and 15 and sensillum *c*; no evidence of dorsal sensillum *d*; inner middorsal seta 17 somewhat longer than and mediad to minute outer middorsal seta 18. Antenna with slightly expanded pedicel, and undivided terminal segment, mostly concealed beneath head. Hypopharyngeal sclerites weakly developed (HS: fig. 5). With ventral spinous process (VSP: fig. 5) 0.07–0.09 long on each side arising near base of maxillary palpus. Postmental setae each side with long and short fine seta and pair of short heavier setae (PMS: fig. 5); gula with 4 or 5 setae each side in elongate transparent area (fig. 5); row of mostly fine subocular setae, as in fig. 2. Outer central pronotal seta somewhat heavier and longer than inner seta; prosternal plate well developed but without setae other than usual 1 + 1 anterior to it (fig. 6); pronotal margin with 12 long, 4 short setae. With normal vertically oblong postnotum. Mesothorax not as sclerotized ring; 4 medioanterior mesonotal setae, alveoli of each pair close together each side; mesosternal plate triangular, with

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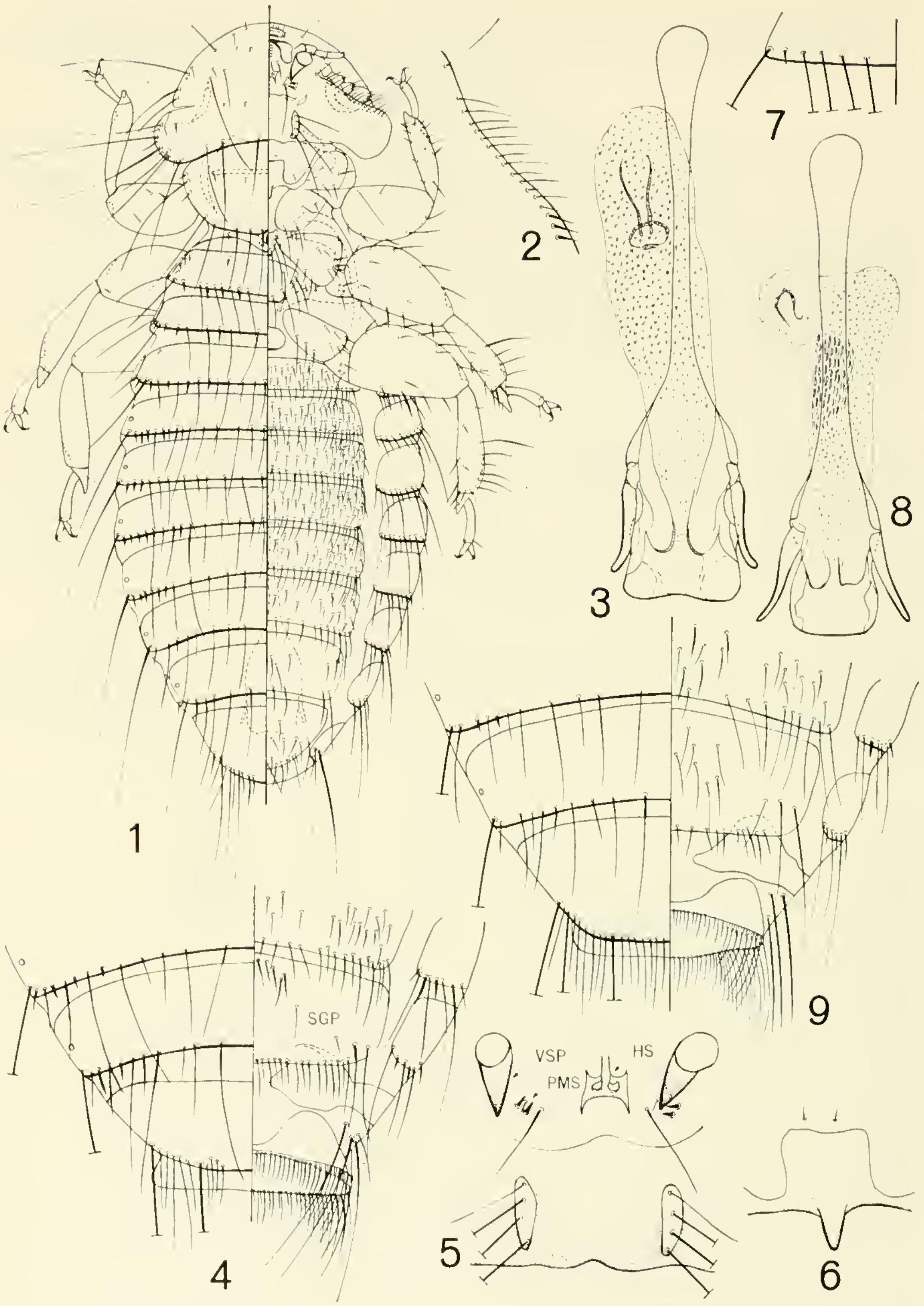

Fig. 1–6. *Menacanthus nelsoni.* 1, male. 2, subocular setae. 3, male genitalia. 4, female terminalia. 5, ventral head. 6, prosternal plate. Fig. 7–9. *M. elbeli.* 7, metanotal margin. 8, male genitalia. 9, female terminalia.

7–8 setae. Metanotum medioanteriorly with 2 short setae, marginally with 10 long, 4–10 short setae; metasternal plate with 10–12 setae. Abdominal tergites I and II with short seta lateral to postspiracular seta; postspiracular setae very long on II–VIII, slightly shorter on I; tergites I–VIII of equal lengths, undivided, and without anterior setae. Tergal setae with short among long: I, 16–18; II–IV, 24–33; V–VI, 18–27; VII, 15–18; VIII, 13–14. Last tergite marginally with 7–8 long, 9–14 short setae. Pleurites without prolonged ventroposterior corners or internal thickenings, and with only marginal setae. Weakly developed lateral brushes on sternites III–VI. Sternal setae: I, 0; II, 50–62; III, 85–90; IV–V, 95–110; VI, 75–85; VII, 44–47; VIII, 15–21. Sternites VIII and IX not fused, subgenital plate with 27–30 setae. Genitalia (fig. 3) 0.57–0.68 long, 0.13–0.15 wide, with relatively short parameres and large spiculate sac with small associated sclerites as shown.

Female: Head, thorax, and abdominal pleurites as for male. With more abdominal tergal setae: I, 21–25; II–III, 26–34; IV–V, 31–36; VI–VII, 25–35; VIII, 21–22. Last tergite marginally with 28–31 setae, with row interrupted medially (fig. 4). With more sternal setae: II, 58–75; III, 92–110; IV–V, 105–135; VI, 100–115; VII, 57–74. Subgenital plate (SGP: fig. 4) with flattened smooth medioposterior margin, and with 21–30 marginal and 17–21 anterior setae, with most of latter concentrated medioanteriorly. Anus essentially oval, without inner setae, and with 45–48 ventral, 52–58 dorsal fringe setae.

Dimensions: Preocular width, male 0.48–0.50, female 0.51–0.53; temple width, male 0.59–0.62, female 0.65–0.66; head length, male 0.30–0.32, female 0.32–0.34; prothorax width, male 0.42–0.45, female 0.48–0.49; metathorax width, male 0.52–0.60, female 0.62–0.64; total length, male 1.80–1.99, female 2.20–2.24.

Type-host: *Artamus cyanopterus* (Latham).

Type-material (all from type-host): Holotype ♂, Exeter, Tasmania, 9 Apr. 1964, R. H. Green; in the collection of the Queen Victoria Museum, Tasmania. Paratypes: 1 ♂, 3 ♀, same data as holotype; 6 ♂, 5 ♀, Dunedo, New South Wales, 4 June 1968, R. Harris.

Discussion: This species represents the first *Menacanthus* to be described from the Artamidae. It is separable from other members of this genus by the gular pigmentation, the type of postmental setae, the unique subocular setae, the absence of setae on sternite I, the very large numbers of setae on other sternites, and the details of the terminalia and the male genitalia. This species is named for Dr. Bernard C. Nelson, who furnished me with the Dunedo series and who has otherwise contributed to Mallophaga taxonomy and biology.

Menacanthus elbeli Price, new species

fig. 7–9

Male: Close to *M. nelsoni*, differing as follows. Mesosternal plate with 7–12 setae; metanotum with 12 marginal setae, including only 2 short ones (fig. 7). Abdominal tergal setae: I, 15; II–VI, 19–25; VII, 17–19; VIII, 14–16. Sternal setae: II, 34–38; III, 67–89; IV–V, 73–90; VI, 60–68; VII, 27–34; VIII, 15–18. Subgenital plate with 20–28 setae. Genitalia (fig. 8) 0.55–0.61 long, 0.11–0.13 wide, with area of elongate spicules on central portion of sac and with small sac sclerite.

Female: Likewise much as for *M. nelsoni*, with head and thorax as for male of *M. elbeli*. Abdominal tergal setae: I, 16–17; II–VII, 22–29; VIII, 18–22. Last tergite with 35–40 marginal setae, with row not interrupted medially (fig. 9). Sternal setae: II, 38–45; III, 72–110; IV–V, 92–125; VI, 88–95; VII, 47–56. Subgenital plate (fig. 9) with 18–22 marginal and 18–27 anterior setae, with most of latter distributed as shown. Anus with 46–52 ventral and dorsal fringe setae. Dimensions: Preocular width, male 0.52–0.55, female 0.54–0.59; temple width, male 0.60–0.67, female 0.66–0.71; head length, male 0.29–0.34, female 0.30–0.33; prothorax width, male 0.43–0.48, female 0.50–0.52; metathorax width, male 0.54–0.56, female 0.65–0.67; total length, male 1.76–2.06, female 2.18–2.36.

Type-host: *Artamus fuscus* Vieillot.

Type-material (all from type-host): Holotype ♂, Chiangmai Sansai, Ban San Luang, Thailand, 14 June 1962, K. Thonglongya, SEATO 1092; in the collection of the U.S. National Museum. Paratypes: 1 ♀, same data as holotype; 4 ♂, 4 ♀, Khorat, Sikiu, Pakchong, Thailand, 8 Feb. 1953, R. E. Elbel, RE-1118 and 1119, RT-B-17005; 1 ♀, Chaiyaphum, Dhu Khieo, Ban Kaeng, Ban Lat, Thailand, 19 Dec. 1952, R. E. Elbel, RE-933, RT-B-17551; 1 ♂, Lop Burl, Khao Oerawan Mt., Thailand, 10 July 1953, R. E. Elbel, RE-2770, B-21651.

Other material: 1 ♂, *A. maximus* Meyer, New Guinea.

Discussion: This species is close to *M. nelsoni*, differing from the other *Menacanthus* in the same features. It is separable from *M. nelsoni* by both sexes having only 2 short marginal metanotal setae, generally fewer abdominal tergal setae, and larger head width; the female by having a continuous row of a larger number of setae across the posterior margin of the last tergite, larger thorax dimensions, and anterior setae on the subgenital plate longer and distributed over a wider area; and the male by having fewer setae on most abdominal sternites, and the genitalia somewhat smaller, the genital sac with different spiculation and associated sclerite. This species is named for Dr. Robert E. Elbel in recognition of his role in obtaining the above material and of his numerous contributions to the taxonomy of Mallophaga.

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BIOLOGICAL INVESTIGATIONS OF GONIOZUS COLUMBIANUS ASHMEAD, A PARASITE OF THE GRAPE BERRY MOTH, PARALOBESIA VITEANA (CLEMENS) (HYMENOPTERA: BETHYLIDAE)

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ABSTRACT—Detailed biological notes of *Goniozus columbianus* Ashmead that were collected and prepared during 1914–1917 by Robert A. Cushman are published posthumously. This bethylid is a parasite of the grape berry moth, *Paralobesia viteana* (Clemens), and probably other Lepidoptera as well. Immature stages are illustrated and an assessment of the parasite's effectiveness as a biological control agent is given.

While going through the literature files of aculeate Hymenoptera in the Systematic Entomology Laboratory, Arnold Menke found an unpublished manuscript prepared by R. A. Cushman over fifty years ago. Knowing of my interest in bethylid biology, Menke turned the manuscript over to me. It is a fine paper directly pertinent to my work and the work of others, and consistent with the growing impression that biologically and behaviorally *Goniozus* and *Parasierola* overlap and perhaps should be synonymized.

The work reported here stems from research conducted by Cushman while he was stationed in North East, Pennsylvania, and engaged in studies of grape pests and their parasites. Cushman's primary interest was in the systematics of Ichneumonidae, and it seems probable that he lost interest in the present study after he developed it into a manuscript. Aside from a few minor changes to accommodate journal format, the text is essentially as Cushman wrote it, sometime during 1917.

Results

The first rearing of this parasite in connection with the grape berry moth took place on August 17, 1914, when two specimens emerged from a box of grapes infested by the larvae of that insect. On August 7 of the same year a fullgrown larva of the berry moth was found, which bore on its back three curious parasite larvae. It was not until the summer of 1916 that this parasite was again reared and that the peculiar larvae referred to above were proved to be of this species.

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During this season, and especially toward the end, it was more commonly collected, and the opportunity was seized to gather as much information concerning its life-history and habits as possible. To this end grapes containing nearly fullgrown larvae of the berry moth were placed in Doten cages with adult parasites in an attempt to secure oviposition. The parasites did not take very kindly to the confinement, but occasionally a parasitized larva was secured. These were examined daily and notes concerning the development of the parasites made. In addition to this source of information, data of considerable value were obtained from a number of cases of parasitization by *Goniozus* found in grapes brought in from the vineyard.

Oviposition: In order to make sure that the larvae supplied to the parasites for oviposition were alive, it was necessary to cut open the grapes. When a suitable grape was found, the cut flap was replaced and the grape placed in this condition in the cage. It was soon noticed that the parasites crawled into the grape through the cut, and shortly afterward larvae were found to have been parasitized. To make sure that this was the normal habit of the parasites, uncut infested grapes were placed in the cage, and the parasites were observed to gain entrance by gnawing a hole in the skin over the burrow of the larva or by forcing their way through the crack characteristic of the infested grapes.

The act of oviposition was, naturally, not observed, since it takes place within the grape. In oviposition the host larva is not killed but remains alive and actively responsive to stimuli, although it apparently does little or no feeding afterwards. The eggs are deposited on the back or sides of the host with their longitudinal axes parallel to that of the host or nearly, with the cephalic pole toward the head of the host and pressed into its skin. They are apparently merely stuck to the skin of the host, for no structure for attachment was found. From 1 to 4 eggs are placed on a single host. Of 19 larvae parasitized in the vineyard, and found when the parasites were in all stages from egg to cocoon, 4 had 1 parasite each, 10 had 2 each, 4 had 3 each and 1 had 4.

The egg: The egg (fig. 1) is semitransparent whitish, without sculpture, subcylindrical, tapering slightly toward the cephalic pole, and strongly rounded at both sides. It is 0.6 mm long by about a third as wide, and apparently slightly flattened ventrally.

Hatching: The position of the rupture in the chorion of the egg in hatching was not ascertained, but the larva remains in place, the chorion being simply pushed backward and finally deposited just below the posterior extremity of the larva. The chorion is so very thin and conforms closely to the form of the enclosed larva that it is well nigh impossible to ascertain just when hatching begins and ends, and it

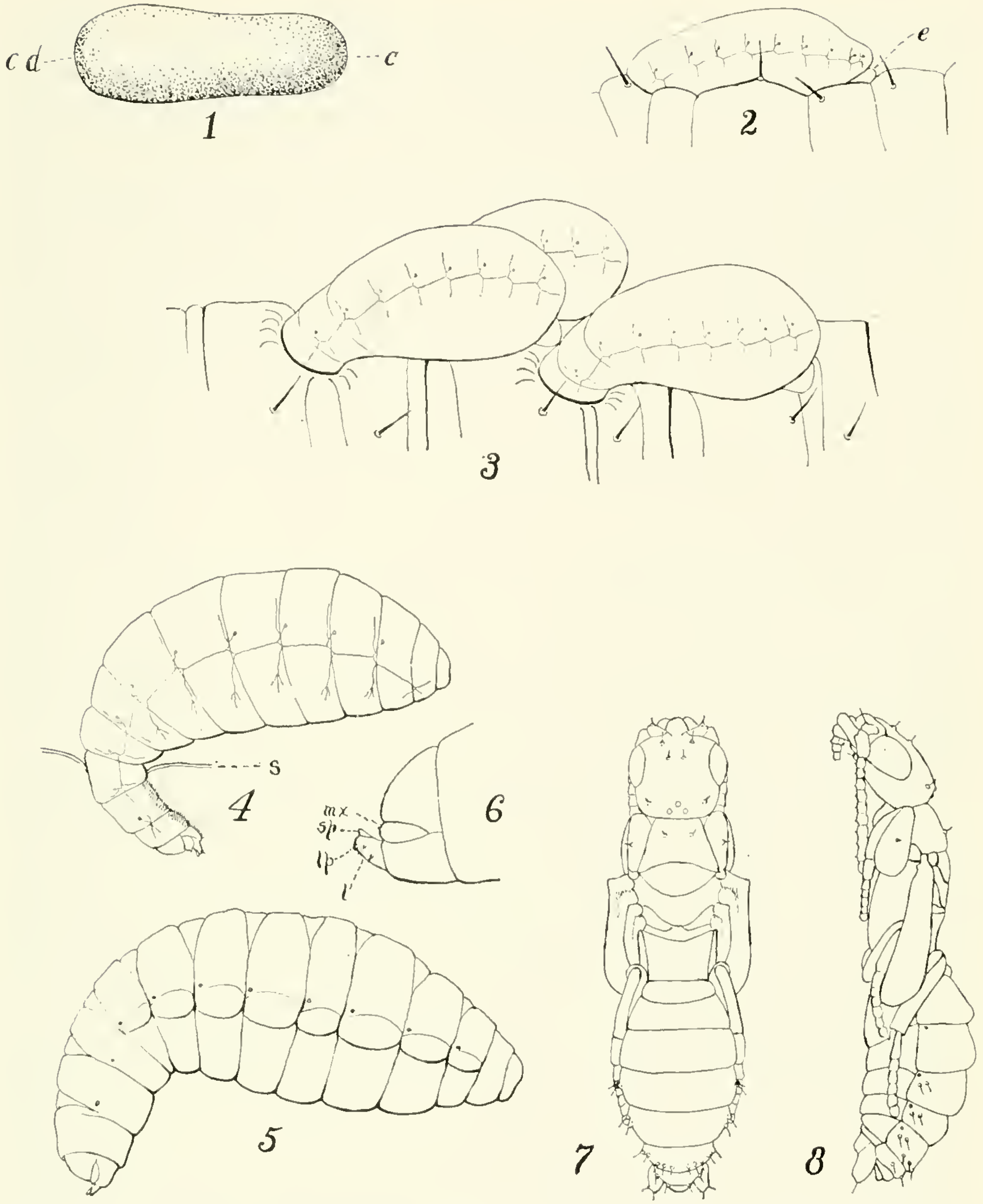

Fig. 1–8. *Goniozus columbianus* Ashmead. 1, egg, c = cephalic pole; cd = caudal pole. 2, newly hatched larva *in situ*, e = egg shell. 3, first instar larva *in situ*. 4, second instar larva, s = position of skin of host in relation to parasite. 5, fullgrown larva. 6, head of fullgrown larva, mx = maxilla; l = labium; lp = labial palpus; sp = spinneret. 7, male pupa, dorsal view. 8, male pupa, lateral view.

appears entirely probable that the larva begins feeding before it has entirely freed itself from the egg.

The larva: Immediately upon hatching and without movement from its position the larva makes a hole in the integument of its host in the thin intersegmental skin or in that between the chitinized plates on the dorsum of the segments and feeds from the inside, its head and part of the thorax being within the body of its host. The youngest larva (fig. 2) observed had already assumed this position. The visible portion of it at this time is slightly more than half a millimeter long, increasing somewhat in thickness to the posterior extremity, then tapering abruply to the rounded caudal end. The division between the thorax and abdomen is indicated by a slight constriction in the general outline of the body. As the first instar larva increases in size this suture and the one between the second and third thoracic segments become slightly visible. No other intersegmental sutures are visible, being apparently obscured by a viscid substance that covered the whole body. There are ten pairs of spiracles, one each on the mesothoracic and metathoracic and the first 8 abdominal segments, in each case situated near the front margin of the segment. The skin is very thin and the tracheae and the peristaltic action of the alimentary canal can be seen through it very clearly. The arrangement of the tracheae will be described later in connection with an older instar of the larva. Within a very short time the larva becomes much distended behind, being somewhat pear shaped (fig. 3). The head of the first instar larva is 0.20 mm broad. The larva increases in size very rapidly and apparently passes through three instars.

The second instar is very similar to the first, but the head is 0.25 mm broad, and the suture between the abdominal segments becomes, at least during the latter part of the period, faintly visible. The skin is still transparent and still has the appearance of being wet and viscid. The tracheae show through as delicate white lines. The main trunk runs in a zigzag course from the anterior margin of the second thoracic to the posterior margin of the 8th abdominal segment. At or near each intersegmental suture it sends branch tracheae up and down, the upper one branching just above its origin; one branch going to the spiracle and the other continuing up toward the dorsum. From the anterior end of the main trunk a branch extends forward into the first thoracic segment and from the posterior end another extends backward into the ninth abdominal segment. The ventral surface of the head and and first two thoracic segments are provided with a mat of dense, short hairs or spines, the function of which is probably to give the larva a secure hold on its host (fig. 4). The head and thoracic segments are very narrow as compared with the distended abdomen. The head is soft and protrudes rather prominently, especially the large labrum, which bears at its extremity the minute unjointed palpi and on its dorsal side the prominent spinnerets (fig. 6). The fully grown larva retains much the same general form as the second instar, but is opaque, yellowish white, distinctly segmented with a prominent lateral fold extending the length of the first 8 abdominal segments, with the thoracic segments relatively thicker and the head 0.30 mm broad (fig. 5). Upon attaining this stage the larva withdraws its head from the body of its host and begins immediately the construction of its cocoon.

The cocoon: The cocoon is ordinarily about 4 mm long by nearly half as thick, and more or less oval but conforming to the shape of the cavity in which it is spun. It differs from the cocoon of the ichneumonids in being made of softer, finer silk, and lacks the hard, closely woven lining commonly found in the cocoons of the ichneumonids. It is pale pinkish brown.

The pupa: When first formed the pupa is white, but as it approaches maturity it becomes shining black. It is flattened with the short, stout legs and antennae and the wing pads closely pressed to the body (fig. 7, 8).

The adult: The adult *Goniozus* is a very active jet black wasp from 2 to 3 mm long with the legs and antennae partly reddish. The body is strongly flattened and the legs short and stout. The antennae are situated very closely above the mouth. The abdomen is elongate oval, acutely pointed behind and with the sting concealed within it. It does not belong to the parasitic Hymenoptera proper, but is more closely related to the true wasps. Unlike most of the true wasps, which capture insects and store them in their nests, *Goniozus* and its relatives search out the host and deposit their eggs on it where they find it.

Developmental period: The period from the spinning of the cocoon to pupation, the pupal period, and the period from transformation to emergence of the adult were not determined separately, and are here considered under the collective heading "period in cocoon." Great difficulty was experienced in carrying the parasite through to maturity because of the molding of the host, or of the grape, and this was accomplished in only 4 out of the 30 cases of cage parasitization. In most cases the host larvae were exposed to the attack of the parasites for 24 hours, and subsequent examinations were made each 24 hours.

The average incubation period for the 30 eggs that hatched was 3.05 days; the feeding period for the 18 larvae that spun cocoons 4.67 days; and the period in cocoon and the total developmental period for the 7 individuals that matured 13.71 days and 22.14 days respectively.

(At this point I have deleted a paragraph and table, the form of which is stylistically obsolete. The pertinent information has been conveyed in the preceding paragraph—Gordh).

Action of the caged adults: The field habits of the adult are unknown, but in the cages they habitually shunned the light, crawling into the grapes almost as soon as they were placed in the cage.

Many of the larvae supplied for oviposition were killed and evidently fed upon by the parasites, for they were much shrunken and had apparently been chewed.

Importance as a parasite of the grape berry moth: In general this species must be considered as of very minor importance as a parasite of the berry moth. In 1914 only two specimens were reared, both probably from the same host, from the many hundreds if not thousands of berry moth larvae caged during the season. In 1915, a very cold, wet season, when parasitism of the berry moth was at a very low ebb, no specimens of *Goniozus* were reared. In 1916, however, when there was an abundance of hot, dry weather, it attained, especially in the late summer, a fair degree of importance. In one case at this period 19 out of 111 external parasites of the berry moth found in wormy grapes were this species. The actual percentage of parasitism was impossible to determine because most of the living larvae had left the grapes before the examination. It was, however, probably not more than 4%, and this represents by far the greatest abundance of the species encountered.

Discussion

The preceding account is probably one of the finest early reports on the biology of a species of Bethylidae. The attention to detail attests to the keenness of Cushman as an observer and at the same time provides valuable information on a parasite otherwise unknown.

The bethylid genera *Goniozus* Foerster and *Parasierola* Cameron are very closely related on the basis of morphology according to Evans (1964). In an earlier biological study of another species of *Goniozus* (Gordh, 1976) I found that on the basis of certain female behavioral attributes, such as egg shape and egg position, a gap was bridged between these genera. In a subsequent study (Gordh and Evans, 1976) further biological evidence in support of Evans' (1964) impression was given for the intimacy of *Parasierola* and *Goniozus*.

Most species of *Goniozus* deposit eggs transversely in the intersegmental membrane of the host, whereas species of *Parasierola* deposit their eggs longitudinally on the segments of the host's body. The only known exception to this generalization was *G. gallicola* (Gordh, 1976) and now *G. columbianus* has also been recognized as demonstrating this same behavior. Eggs of *Goniozus* spp. are characteristically football shaped and their chorions rather tough; eggs of *Parasierola* spp. are generally sausage shaped and the chorion thin. The only known exception to this generalization was *G. gallicola* (Gordh, 1976) and now *G. columbianus*. Thus it would seem that another species of *Goniozus* shares biological and behavioral features with species of *Parasierola*.

Another interesting feature to emerge from this study, which adds support to some of my unpublished ideas on the efficacy of using bethylids in biological control programs, is that temperate species seem to be relatively inefficient control agents whereas some tropical species are important agents in biological control attempts. Antony and Kurian (1960), Avasthy and Chaudhary (1966), Cherian and Israel (1942), Dharmaraju (1952), and Ramachandra Rao and Cherian (1928) have all stated or implied that bethylids were important biological control agents, useful against various lepidopterous pests. Such has not been the case in temperate regions however. If this observation accurately represents a natural phenomenon, the problem should be pursued in an attempt to find out why this is so.

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STUDIES ON THE GENUS APHODIUS OF THE UNITED STATES AND CANADA (COLEOPTERA: SCARABAEIDAE). IV. A TAXONOMIC REVISION OF HORN'S GROUP A

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ABSTRACT—Group A of the genus *Aphodius* is redefined, nomenclatural history discussed, and new characters proposed for the Group. I have removed *A. conspersus* Horn from Group A, transferred *A. coloradensis* Horn, *A. dentiger* LeConte, *A. dentigerulus* Brown, and *A. aculeatus* Robinson from other groups into Group A, and describe as new the following 3 taxa: *A.* **formidatus**, *A.* **henryi**, and *A.* **acutissimus**. With these changes Group A contains 10 species. Supposed phylogenetic relationships are discussed and illustrated, the probable evolutionary history of the Group proposed and habitats explained where known.

The present classification of the North American species of *Aphodius* is essentially that of Horn (1887) in which he divided the genus into 4 subgenera, and *Aphodius*, sensu stricto, into 12 groups (A–M). Brown (1927, 1928) revised Group I, series a and b, and followed this (1929b) with a revision of the subgenus *Diapterna* Horn. Van Dyke (1928) combined Horn's Groups G and M and provided a key to species; Saylor (1940) updated this treatment of the 2 Groups. Cartwright (1972) published a key to the species of the *crassulus* Group. With these exceptions, no group of North American *Aphodius* has been taxonomically treated in its entirety since 1887. Schmidt (1922) placed the species in subgenera and described a few new species, but did not change Horn's classification other than nomenclaturally. Many species have been described since, and, though Horn's treatment was excellent and is still useful, it is not possible to accurately identify species of *Aphodius* using only his paper. The revision of Group A presented in this paper is a first step toward an eventual complete reclassification of North American *Aphodius*.

Group A was designated by Horn (1887) for *Aphodius denticulatus* Haldeman and *A. conspersus* Horn. Fall (1907 and 1932) described *A. moquinus* and *A. testaceiventris*, placing them in Group A. No species have been added and the concept of the Group has not been challenged since. In the course of determining the affinities of 3 undescribed species, I have examined Group A critically and the resulting changes in and additions to Horn's classification are presented here. Horn used the appearance of the spines at the apex of the hind tibia as the first character in his key to groups. Groups A to G had these spines short and equal, Groups H to M had them long and un-

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equal. Examination of nearly all of the North American species of *Aphodius* has convinced me that this is a recurring character that has no phylogenetic significance. A primary dichotomy based on this characteristic results in the placing of closely related species in widely separated groups and, conversely, the association of dissimilar species with a single group. This character is, however, of use for separation of species within groups. *Aphodius conspersus* is not a member of Group A as I am defining it, and I here transfer it to Group E which previously contained only *A. rugatus* Schmidt. I transfer *Aphodius coloradensis* Horn, *dentiger* LeConte and *dentigerulus* Brown from Horn's Group I, Series I–d, to Group A. In all characters other than the type of spines on the hind tibiae (overall body form and male fore and middle tibial spurs), these species are closely similar to *denticulatus*. Robinson (1940) described *A. aculeatus* and placed it near *acerbus* Horn in Group K, but it has little in common with the species of Group K and belongs in Group A. With these changes and the addition of 3 new species described here, Group A contains 10 species.

The habits and habitats of most species in Group A are unknown. *Aphodius coloradensis*, *denticulatus*, and *testaceiventris* have been taken in cow dung, but most specimens have been collected at light. Large numbers may be attracted to light in a particular area, yet few or none found associated with cow manure in that same area, suggesting that their preferred habitat is not cow dung. I suspect that they are saprophytic on decaying material in the upper soil layer and are occasionally picked up in or under cow dung. The wide distributions of these 3 species would seem to preclude association with rodents, certainly with any one species of rodent. *Aphodius dentigerulus* has been taken only at burrows of the Black-tailed Prairie Dog, *Cynomys ludovicianus*, and is probably restricted to that habitat. I have suspected *dentiger* to be associated with packrats of the genus *Neotoma*. This suspicion has been confirmed by specimens collected in *Neotoma* nests by C. W. Griffin in 1969, from San Patricio Co., Texas. According to Hall and Kelson (1959), the only species of *Neotoma* there is *micropus* Baird.

I consider Group A to be rather primitive, derived directly from an ancestral form similar to *anthracinus* LeConte and related species which I judge to form the most primitive group of extant species. The male genitalia of members of Group A are not as distinctive for each species as in *anthracinus* and allies but are more so than in more recently evolved groups such as *concavus* Say and allies. In external characteristics, members of Group A are much more diverse than either the *anthracinus* or *concavus* groups. The bulky, unspecialized body form and, for the most part, lack of specialized habitat indicate

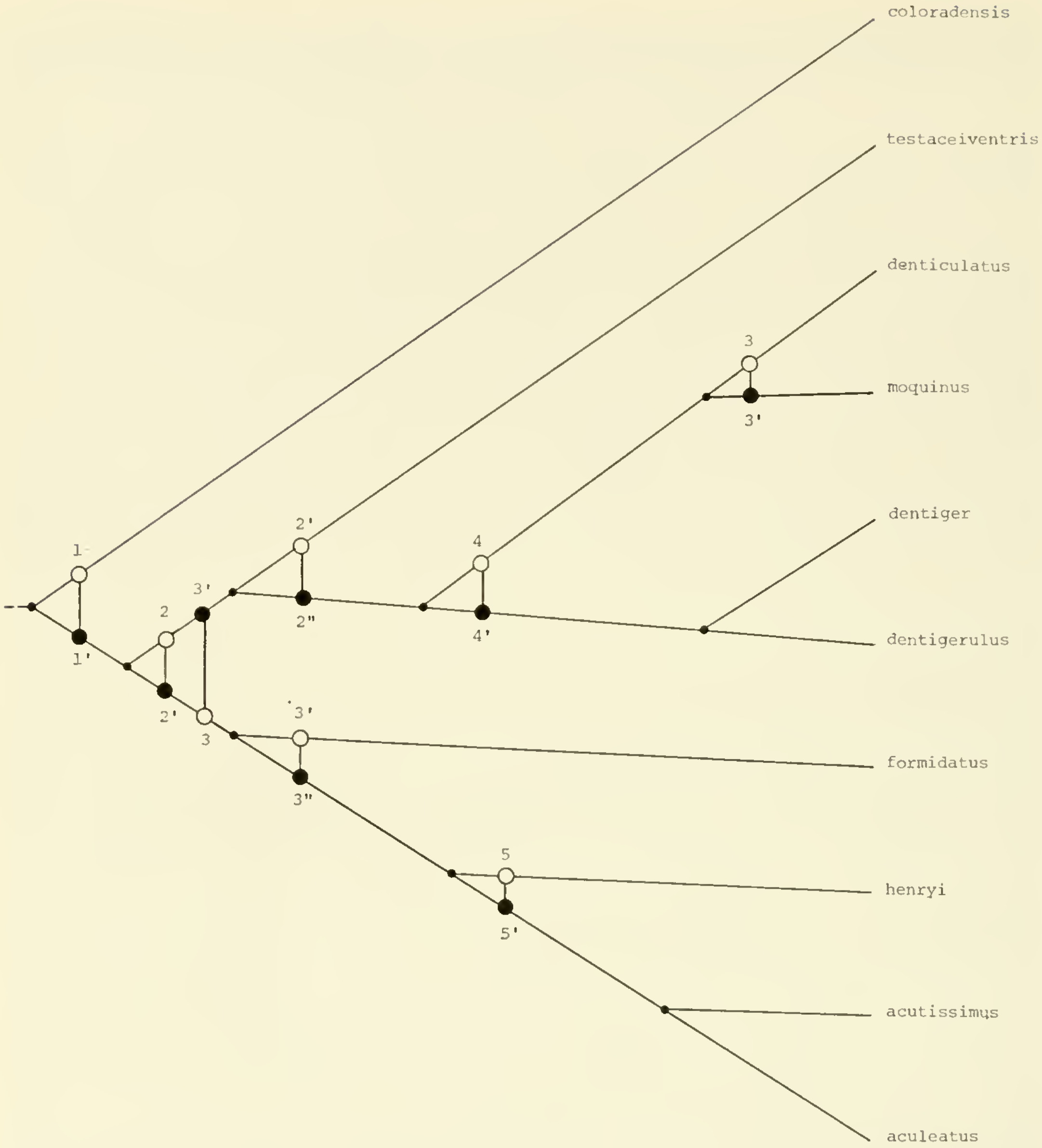

Fig. 1. Reconstructed phylogeny of species taxa of Group A of *Aphodius*. See text for explanation.

that Group A is closely related to the *anthracinus* group. There is little evidence of convergence within the group, but strong evidence of divergence throughout.

I consider *coloradensis*, representing the monobasic *coloradensis* subgroup, the most primitive species because it lacks derived characters. The form of the clypeus in particular is most like that of *anthracinus*. In all other members of Group A, the clypeus possesses more strongly specialized armature (1).

Suspected phylogenetic relationships are summarized in fig. 1, and derived character states used to support these relationships are indicated by parenthetic numbers in the following discussion. In the figures, derived character states are indicated by black dots and the corresponding number by primes, and in multi-state characters the most derived state is indicated by a double prime.

A major split occurs in the lineage with the *denticulatus* "subgroup" characterized by having oblique clypeal carinae (2′) and mostly dark body color (3). This subgroup contains the species *testaceiventris*, *denticulatus*, *moquinus*, *dentiger* and *dentigerulus*. The *acutissimus* subgroup, characterized by the lack of clypeal carinae (2) and mostly pale body color (3′), contains the species *formidatus*, *henryi*, *acutissimus*, and *aculeatus*. Within the *denticulatus* subgroup, I regard *testaceiventris* as most primitive because the clypeal carinae are weakly developed (2′) as opposed to the strongly developed carinae of the other members of the subgroup (2″). *Aphodius moquinus* and *denticulatus* have broad, triangular clypeal teeth of the *testaceiventris* type (4), whereas *dentiger* and *dentigerulus* have developed more elongate, somewhat spiniform clypeal teeth (4′) and rodent associated habits. The *acutissimus* subgroup contains species almost uniformly pale (3″) in color except *formidatus* (3′), and even *formidatus* is not black or piceous as are most members of the *denticulatus* subgroup. The species are mostly western and all have apparently restricted geographic ranges and probably restricted habitats. *Aphodius formidatus* and *henryi* have the clypeal angles produced, the clypeus appearing quadridentate (5); *acutissimus* and *aculeatus* exhibit a reduction in clypeal armature (5′) with that of *aculeatus* in particular strongly reduced. I regard *formidatus* as the most primitive member of the *acutissimus* subgroup because it is most similar to members of the *denticulatus* subgroup in color and clypeal armature. *Aphodius henryi* is primitive in clypeal armature and divergent in possessing elytral vestiture and a strong clypeal ridge. *Aphodius acutissimus* has lost the "quadridentate" appearance of the clypeus but the 2 clypeal teeth are strongly developed with the head in general presenting a formidable appearance. I regard *aculeatus* as the most advaced member of the subgroup because almost all clypeal armature has been lost and the spur of the male middle tibia is weakly modified. Divergent characters of *aculeatus* are the rugose clypeal surface, small size, and lack of dense setae on lateral margin of the pronotum and abdomen.

All species in Group A are native to North America and are restricted to an area from the Great Plains westward to the Pacific Northwest, Nevada and Arizona. They are not represented in California with the exception of *denticulatus* in northern California, or in Mexico, with the exception of *coloradensis* which occurs as far south as Mexico City.

The genus *Aphodius* is largely Holarctic with a few elements extending into Central and South America. With few exceptions (e.g., *coloradensis*) there is no overlap between the northern fauna and that of Mexico and Central America. Members of Group A are most probably survivors of an *Aphodius* fauna that was generally spread throughout the present Great Plains and Great Basin which were forested during the Eocene (Macginitie, 1958). The ensuing drying and cooling climate that followed during and after the Oligocene resulted in the forest being replaced by grassland (well developed by the Pliocene) and desert (except at high elevations). This in turn reduced the favorable habitat for species of *Aphodius*, causing the isolation and resultant speciation of Groups of *Aphodius*. At least two species of Group A, *dentigerulus*, and *dentiger*, evolved the habit of using the shelter and food of rodent burrows and nests.

By the upper Pliocene, conditions were essentially the same as those at present (Frye and Leonard, 1957) so the modern species of Group A have evolved to their present condition since that time. The climatic fluctuations of the Pleistocene strongly influenced the present distribution of members of Group A. Some species (*coloradensis*, *testaceiventris*) were probably least affected, but I regard the speciation of the *acutissimus* subgroup now evident to be a result of climatic changes during that period. The present distribution of *testaceiventris* (fig. 27) shows a wide gap between southern Texas and Colorado. I cannot satisfactorily separate specimens from the 2 extremes on a morphological basis and am regarding them as the same species. This separation, if not an artifact of inadequate sampling, is relatively recent and it may be that differences will evolve in the future to the point where specimens from southern Texas are morphologically separable from Colorado and Kansas specimens. The distribution maps of *coloradensis* and *denticulatus* (fig. 26, 27) show that *denticulatus* is primarily a Great Basin species whereas *coloradensis* occurs mostly east and south of the Great Basin. The 2 species are nearly completely allopatric. *A. coloradensis* is either more tolerant of a greater range of climatic conditions (occurring from Alberta to Mexico City) than *denticulatus*, or *denticulatus* has adapted to a more restricted habitat (such as rodent burrows or nests) than that of *coloradensis*.

For the loan of types and other specimens in their care I am indebted to the following: John Lawrence, Museum of Comparative Zoology, Harvard University (MCZ); Robert Bechtel, Nevada Department of Agriculture, Reno (NDA); Henry Howden, Carleton University, Ottawa (HH). The Scanning Electron Microscope time for this paper was supported in part by the University of Maryland Center of Material Research, Department of Mechanical Engineering and Electron Microscope Central Facility, College Park, Maryland. Special thanks

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GROUP A

Body robust, fimbriate with setae, convex, elongate; posterior pronotal border margined; anterior clypeal margin dentate, either quadridentate, or bidentate with anterolateral angle projecting (except *aculeatus*, *acutissimus* and *coloradensis*); median area of clypeus with ridge, carinate or not; frontal suture raised, distinct; short outer spur of male middle tibia modified (thickened, or apex truncate, or appearing bifurcate, or simply bent inward).

Except for 3 species, *coloradensis*, *acutissimus* and *aculeatus*, the species in Group A have more or less quadridentate anterior clypeal margins. *Aphodius coloradensis* is closely related to *testaceiventris* despite having a feebly bidentate or biangulate clypeal margin. The overall body form and the modifications of the male fore and middle tibial spurs of *coloradensis* indicate a close relationship to *denticulatus* and *testaceiventris*. Both *acutissimus* and *aculeatus* lack certain characteristics of Group A as defined here. Both have bidentate clypeal margins, but *acutissimus* has the median clypeal ridge reduced. The male tibial spurs in both species are not as strongly modified as in the rest of the group. The facies of both species are typical of Group A however, and they fit more readily here than in any other group of *Aphodius* presently defined.

Schmidt (1922) placed *denticulatus*, *moquinus* and *conspersus* in his subgenus *Tetraclipeoides* along with a species from Cuba and another from Senegal. As in Horn's classification, Schmidt's reliance on one character (in this case the quadridentate clypeus) caused him to group species of different phyletic lineages together. He placed *coloradensis* and *dentiger* in the subgenus *Pseudagolius*. As previously indicated (Gordon, 1973), the North American species do not conform well to the subgenera of *Aphodius* as used by Schmidt (1922), and I do not formally place new species of *Aphodius* in subgenera.

KEY TO SPECIES OF GROUP A

1. Apical margin of clypeus between teeth with 2 short, oblique carinae forming a triangle on surface of clypeus (fig. 10) 2
— Apical margin of clypeus between teeth lacking oblique carinae (fig. 4) 5
2. Apical clypeal armature consisting of 2 short, bluntly rounded teeth, anterolateral angle slightly produced, rounded (fig. 11) 3
— Apical clypeal armature consisting of 2 generally acute, triangular teeth, anterolateral angle distinctly produced, angulate or dentate (fig. 8) 4
3. Clypeus depressed, flattened anterior to median ridge, densely punctured, smooth between punctures (fig. 10) .... *dentiger* LeConte
— Clypeus not depressed or flattened anterior to median ridge, roughly sculptured, rugose (fig. 13) .... *dentigerulus* Brown

4. Clypeus appearing quadridentate, anterolateral angle acute (fig. 8); male outer tibial spur broad, with lateral tooth (fig. 9) .... *denticulatus* Haldeman
— Clypeus not appearing quadridentate, anterolateral angle abrupt; male outer tibial spur slender, hooked inward at apex .... *moquinus* Fall
5. Anterolateral angle of clypeus rounded, angulate or produced (fig. 5) 6
— Anterolateral angle of clypeus smoothly rounded or nearly straight, not produced (fig. 2) 8
6. Anterolateral angle of clypeus acute or angulate, more prominent than anterior teeth (fig. 5) .... *testaceiventris* Fall
— Anterolateral angle of clypeus less prominent than anterior teeth 7
7. Pubescence not visible on 10th elytral interval or apical declivity of elytron; color dark reddish brown; length usually more than 5.40 mm .... *formidatus*, new species
— Pubescence visible on 10th elytral interval and on apical declivity of elytron; color light reddish brown; length usually less then 5.40 mm .... *henryi*, new species
8. Color piceous to black; clypeal teeth reduced, angulate or rounded apically (fig. 2); anterolateral angle evenly rounded .... *coloradensis* Horn
— Color light reddish brown to yellowish brown; clypeal teeth prominent or reduced, anterolateral angle evenly rounded or nearly straight 9
9. Length 5.50 mm or more; clypeus smooth, median ridge reduced, anterior teeth prominent, strongly reflexed (fig. 20) .... *acutissimus*, new species
— Length less than 5.00 mm; clypeus rough, rugose, with median ridge, anterior teeth reduced, feebly reflexed (fig. 22) .... *aculeatus* Robinson

Aphodius coloradensis Horn
fig. 2, 3, 26

Aphodius coloradensis Horn, 1870:130. Horn, 1887:45.
Aphodius (*Pseudagolius*) *coloradensis*: Schmidt, 1913:150. Schmidt, 1922:237.
Aphodius flohri Bates, 1887:86. Schmidt, 1913:150, established synonymy.

Remarks: The clypeus of this species is not armed with the distinct teeth and angulations possessed by most species of this group, and the clypeal ridge is reduced to a convex swelling. In all other respects, however, including overall appearance, *coloradensis* is a typical member of Group A, resembling *denticulatus* and *testaceiventris* in color and form. The clypeal teeth are small and blunt, often appearing as feeble, angulate projections rather than teeth; the anterolateral angle is not apparent, the clypeal border from anterior tooth to posterolateral angle is smoothly rounded (fig. 2). The outer spur of the middle tibia of the male is truncate apically, the inner apical angle bent inward (fig. 3).

The habitat preference of *coloradensis* is unknown but is probably as discussed for *denticulatus*. The range of *coloradensis* is greater than that of other native North American *Aphodius* except *vittatus* Say, extending from Alberta, North Dakota and Iowa to Mexico City.

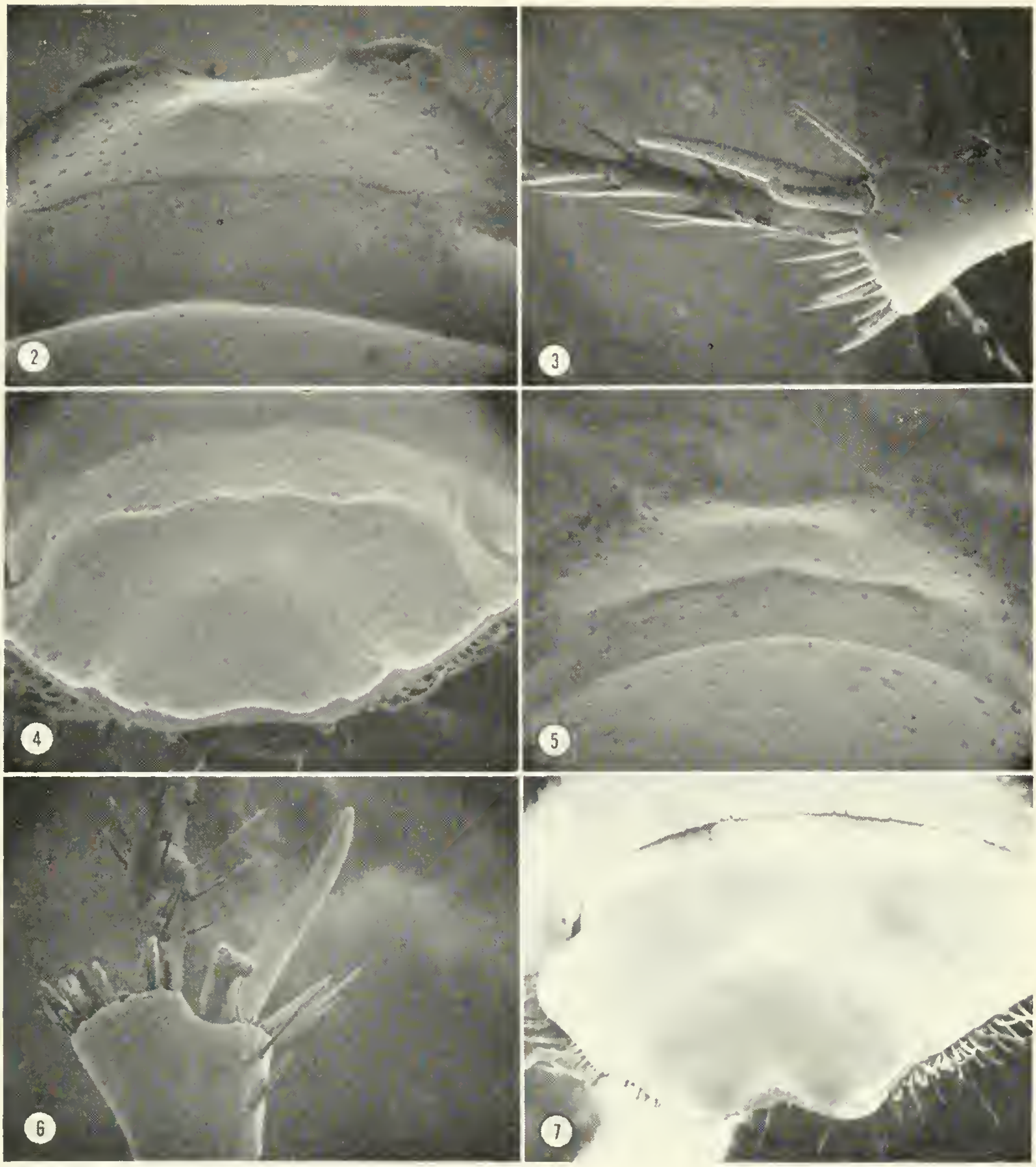


Fig. 2–7. Dorsal views of head, views of apices of middle tibiae. 2–3, *Aphodius coloradensis*. 4–6, *Aphodius testaceiventris*. 7, *Aphodius denticulatus*.

The lectotype (here designated and so labeled) of *Aphodius flohri* Bates in the British Museum (N. H.) has been examined. It is from Durango City, Mexico, and is, as indicated by Schmidt (1913), the same species as *coloradensis*. The lectotype is labeled "Type (white disc with orange border) Durango City, Mexico, Hoge/flohri Bates." A specimen in the USNM collection bearing the same labels except "U.S.N.M. Paratype No. 49713" is here designated paralectotype and so labeled. Horn (1870) plainly indicated that he saw more than one type-specimen of *coloradensis*, so the single female remaining in his collection at the MCZ, labeled "Col./Type No. 3591, Aphodius coloradensis G. H. Horn/A. Coloradensis Horn" is here designated LECTOTYPE.

Specimens examined: Total 324 (fig. 26) (Mexican localities not included). ALBERTA: Medicine Hat. ARIZONA: Chiricahua Mts.; Flagstaff; Fort Grant; Gila Co.; Nogales; Palmerlee; Portal, S. W. Research Station; Santa Rita Mts.; White Mts.; Williams. COLORADO: Buena Vista; Colorado Springs; Denver; Florissant, La Plata Co., Durango; Mesa Verde; Pueblo; Trinidad. IOWA: Iowa Co. MINNESOTA: Alexandria; Glenwood. MONTANA: Havre. NEBRASKA: Lincoln; Meadville. NEW MEXICO: Alamagordo; Gallup; Koehler; Mescalera Res. NORTH DAKOTA: Eddy Co., Lake Coe; Fargo; Northwood, Goose River; Richland Co.; Walcott. OKLAHOMA: Fort Sill. SOUTH DAKOTA: Britton; Brookings; Chamberlain. WYOMING: Cheyenne; Laramie.

Aphodius testaceiventris Fall
fig. 4–6, 27

Aphodius testaceiventris Fall, 1932:185.

Remarks: At first glance, *testaceiventris* appears to be conspecific with *denticulatus*, but *testaceiventris* lacks the oblique clypeal carinae (fig. 4, 5), and the outer spur of the male middle tibia is slender and more or less truncate apically (fig. 6). In addition, the average size of *testaceiventris* is smaller than that of *denticulatus,* and the anterolateral clypeal angle is more prominent than the clypeal teeth. The 2 species are nearly allopatric.

No more is known of the habits of this species than is known of *denticulatus*; speculations as discussed under *denticulatus* apply here.

Fall (1907) stated that he had received 3 specimens from F. H. Snow. Of these, only a single female remains in his collection. It is labeled "Hamilton Co., Ks., 3350 ft., F. H. Snow/June '02/n. sp. near denticulatus/Type testaceiventris/M.C.Z. Type 24763." This specimen is here designated lecototype and is so labeled. As indicated in fig. 27, there is a wide gap in the distribution of *testaceiventris* between southern Texas and Colorado and western Kansas. Specimens from south Texas are slightly larger, the clypeal armature is more pronounced and the elytral intervals are usually more convex. These differences are minor however, and the male genitalia and tibial spurs are the same, so I consider this to be one species. There is a male in the USNM type collection, from Brownsville, Texas, labeled "Holotype, Aphodius texana, Mark Robinson". This is apparently a manuscript name as I cannot find a description in the literature. The head and thorax are missing, but the elytra, male genitalia and tibial spurs all indicate that the specimen is *testaceiventris.*

Specimens examined: Total 46 (fig. 27). COLORADO: Baca Co; Boulder; Canon City; Cherry Creek; Greeley. KANSAS: Hamilton; Meade. TEXAS: Brownsville; College Station; Palo Duro Canyon; Sonora; Uvalde; Zavalla Co., Nueces River.

Aphodius denticulatus Haldeman
fig. 7–9, 27

Aphodius denticulatus Haldeman, 1848:104. Horn, 1870:116. Horn, 1887:9.
Aphodius (*Tetraclipeoides*) *denticulatus*: Schmidt, 1913:139. Schmidt, 1922:156.

Remarks: This species has the most pronounced clypeal armature of any species in Group A, approached in this respect only by *moquinus, testaceiventris* and *formidatus.* The anterolateral angle of the clypeus is less prominent than the anterior teeth and is strongly reflexed, apically acute or at least sharply angulate (fig. 7, 8). The outer apical spur of the male middle tibia is strongly thickened and laterally toothed (fig. 9), much more strongly modified than in any related species.

Specimens of *denticulatus* in the USNM collection were mostly taken at light, but a few were collected at horse dung, cow dung and one specimen from a dead rabbit. The collecting of this species at dung of domestic animals is so rare as to indicate that it is not the normal habitat. *A. denticulatus* is probably saprophytic on decaying plant material in the upper soil layer. It is also possible that it is associated with rodents, but if so, the wide distribution of *denticulatus* dicates that several species of rodents would have to be involved, whereas other rodent associated *Aphodius* are usually nearly completely host specific.

The type is a female in the MCZ labeled "(green disc)/Type 8353 (red paper)/H. denticulatus Hald." It is apparent from Haldeman's description that he had only a single specimen so this must be considered the holotype.

Specimens examined: Total 157 (fig. 27). ALBERTA: Medicine Hat. CALIFORNIA: Hackamore. IDAHO: Bingham Co; Burley; Custer Co., Mackay; Milner; Mullan; Payette; Pocatello. MONTANA: Havre; Helena. NEVADA: Humboldt Co., Martin Cr. OKLAHOMA: El Reno. OREGON: Baker Co., Unity; Dalles. UTAH: Lookout Mt.; Mt. Timpanogos; Park Valley; Promontory; Tooele Co., Dugway Proving Ground; Vernal. WASHINGTON: Henifer (not located). WYOMING: Carbon Co.; Green River; Lamont; Laramie; Medicine Bow; Rock Springs.

The Oklahoma record listed above may be mislabeled as it is widely disjunct.

Aphodius moquinus Fall
fig. 27

Aphodius moquinus Fall and Cockerell, 1907:242
Aphodius (*Tetraclipeoides*) *moquinus*: Schmidt, 1913:139. Schmidt, 1922:156.

Remarks: The oblique clypeal carinae are reduced, extending only slightly inward from the clypeal apex, and are intermediate in this respect between *denticulatus* and *testaceiventris.* The median clypeal ridge is strongly carinate, much more so than in *denticulatus* or *testa-*

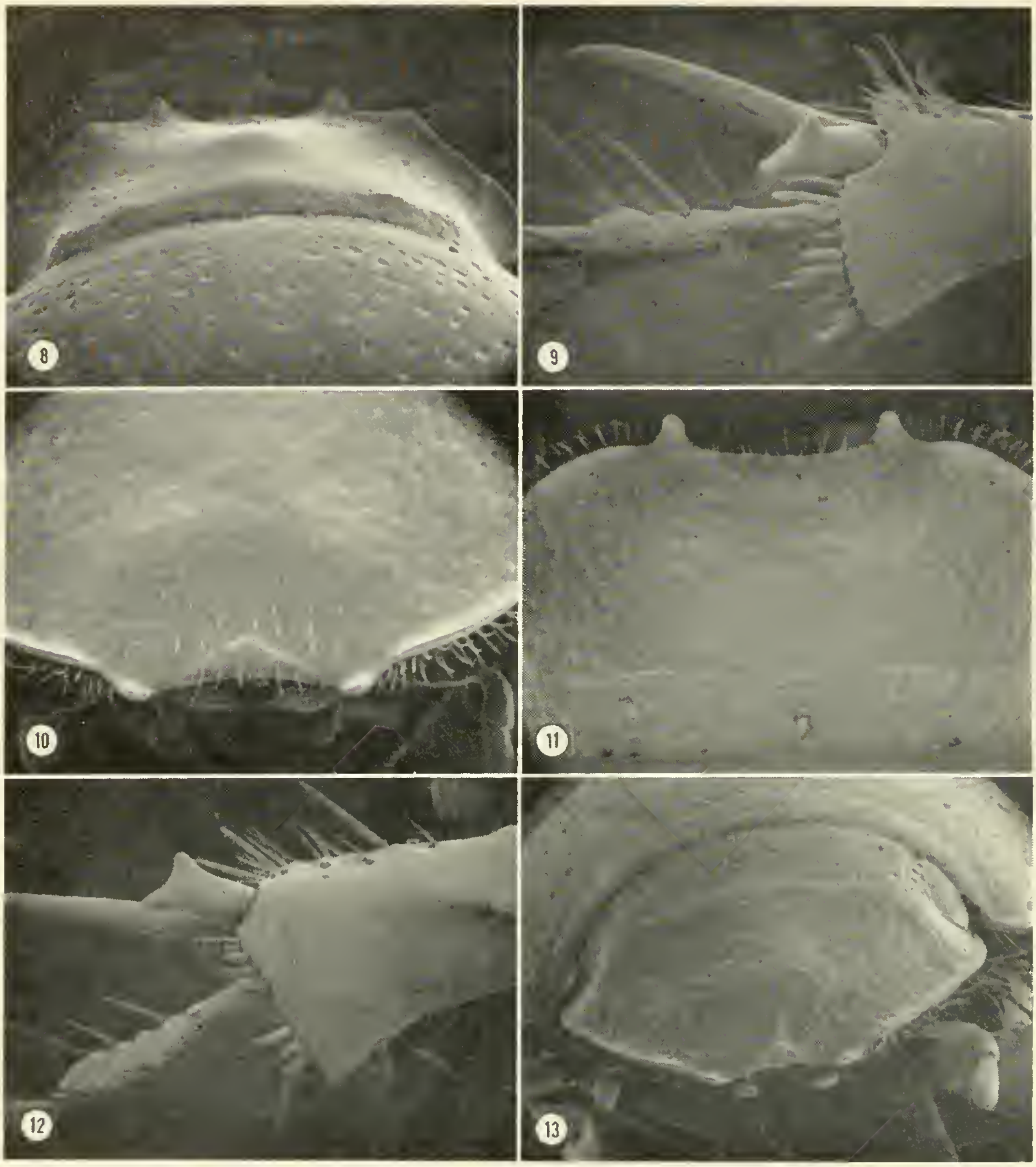


Fig. 8–13. Dorsal views of head, views of apices of middle tibiae. 8–9, *Aphodius denticulatus.* 10–12, *Aphodius dentiger.* 13, *Aphodius dentigerulus.*

ceiventris, and the overall color is light yellowish brown. The outer apical spur of the male middle tibia is slender and apically truncate.

The habitat is unknown and only 3 specimens have been recorded, all from Holbrook, Arizona. Fall (1907) had a male and a female of this species (a pair sent him by Wickham) but only the male remains in his collection. This male, labeled "Holbrook, Ariz./IV-13-VII/moquinus Type/M.C.Z. Type 24758" is here designated LECTOTYPE and so labeled.

Specimens examined: Total 3 (fig. 27). ARIZONA: Holbrook.

Aphodius dentiger LeConte

fig. 10–12, 28

Aphodius dentiger LeConte, 1858 (1859):65. Horn 1870:130. Horn, 1887:45. Brown, 1929:209.

Aphodius (*Pseudagolius*) *dentiger*: Schmidt, 1913:150. Schmidt, 1922:237.

Remarks: This species is very closely allied to *dentigerulus* Brown, but, in addition to the differences presented in the key, *dentiger* is larger (4.80 mm or more in length), the elytral intervals are more densely and obviously punctate, and the male anterior tibial spur is distinctly bent inward at the apex. Brown (1929a) noted that the outer spur of the middle tibia of the male was truncate apically in *dentigerulus*, dilated and emarginate in *dentiger*, but I've examined several large series of *dentigerulus* and the shape of this spur varies from truncate to almost exactly like that found in *dentiger*. Views of the head and apex of the middle tibia are presented in fig. 10–12.

Aphodius dentiger is a rarely collected species that is associated with packrats of the genus *Neotoma* Say and Ord. The type is a unique male in the LeConte collection (MCZ), labeled "(silver disc)/A. dentiger LeC., Copper mines Webb/Type 3745 (red paper)." This specimen is the holotype because LeConte specifically stated that he had only one specimen from Dr. Webb collected at the "copper mines of the Gila". Copper mines in the vicinity of Globe (Gila Co.) and Morenci (Greenlee Co.) may have been in existence long enough to have been type-localities of species described by LeConte, but the type-locality could be one of many places along the Gila in Arizona or New Mexico.

The locality "Sharpsburg, Texas", listed below doesn't appear on current maps, but old maps and gazetteers place it in San Patricio Co.

Specimens examined: Total 13 (fig. 28). ARIZONA?: "Copper mines of the Gila" (type loc.). NEW MEXICO: Clovis. TEXAS: Brownsville; Corpus Christi; San Patricio Co., US Hwy. 77. 1.2 mi. from Int. with State Hwy. 9, from *Neotoma* nest; Sharpsburg.

Aphodius dentigerulus Brown

fig. 13–15, 28

Aphodius dentigerulus Brown, 1929a:208. Helgeson and Post, 1967:38.

Remarks: *Aphodius dentigerulus* resembles only *dentiger* in the group of species having oblique clypeal carinae. See remarks under that species. Views of the head and apex of the middle tibia are presented in fig. 13–15. Brown's specimens were from Oklahoma, and he stated that they occurred "in the burrows of the common prairie dog" (*Cynomys ludovicianus ludovicianus* Ord.). The species has been recorded since by Helgeson and Post (1967) from prairie dog burrows in southwestern North Dakota. I have taken it at the same locality in 1969 and in southwestern South Dakota in 1973 in prairie dog burrows. The species is apparently restricted to the burrows of the Black-tailed Prairie Dog and may be found in tremendous numbers in May and June. The populations disappear during the dry periods of the summer, and I have not been able to collect this species in the fall. *Aphodius dentigerulus* is an external associate of the prairie dog in that this species does not seem to occur deep within the burrow but feeds on dung pellets around the mound, buried within the mound, or just within the burrow entrance.

The holotype of *dentigerulus* is No. 2946 in the Canadian National Collection, Ottawa. The type-locality is Noble Co., Oklahoma, and I have examined 10 paratypes from that locality in the USNM collection.

Specimens examined: Total 331 (fig. 28). NORTH DAKOTA: Billings Co., Theodore Roosevelt Memorial Park. OKLAHOMA: Noble Co.; Noble Co., 101 Ranch; Noble Co., Otoe Pasture. SOUTH DAKOTA: Custer State Park.

Aphodius formidatus Gordon, new species

fig. 16–17, 23, 28

Holotype: Male, length 6.00 mm, greatest width 2.90 mm. Form elongate, nearly parallel sided, widest just posterior to middle of elytra. Color dark reddish brown except ventral surface paler yellowish brown. Head shining, a raised ridge extending across front, ending in small tubercle at each end, feebly tuberculate medially; clypeus coarsely punctured, median ridge present, apex emarginate between 2 strong, triangular teeth, lateral margin uneven, deeply excised as in fig. 16. Pronotum smooth, shining, densely, coarsely punctured, punctures separated by less than the diameter of a puncture; anterolateral angle abrupt, lateral border evenly curved, strongly margined, fimbriate with short setae, posterolateral angle broadly rounded, posterior border distinctly margined. Elytron smooth, shining, lateral margin fimbriate with short setae, striae deep, distinct, strial punctures fine, separated by the diameter of a puncture; intervals slightly convex, each interval with fine punctures arranged in 2 irregular rows. Ventral surface shining medially, alutaceous laterally; metasternum with some coarse, irregularly scattered punctures medially. Upper surface of fore tibia with reticulate surface sculpture composed of elongate cells oriented parallel to axis of tibia, lateral teeth strong, posterior tooth basad of middle of tibia, apical spur dorsoventrally flattened, apex hooked inward; apex of middle tibia with 2 spurs, outer spur ½ the length of inner, robust, apex bent inward (fig. 17), inner spur slender, straight, apex pointed; apex of hind tibia fringed with long, unequal spines. Anterior tarsus with basal segment ½ as long as segment 2, segments 2–4 subequal, 5th segment slightly longer than segment 4; middle and hind tarsi with basal and apical segments long, subequal, middle 3 segments subequal, each segment ¾ as long as 5th. Abdominal sterna dull, alutaceous, pubescent. Genitalia as in fig. 23.

Type-material: Holotype, ♂, Texas, Garza Co., 12 mi. N. Post,

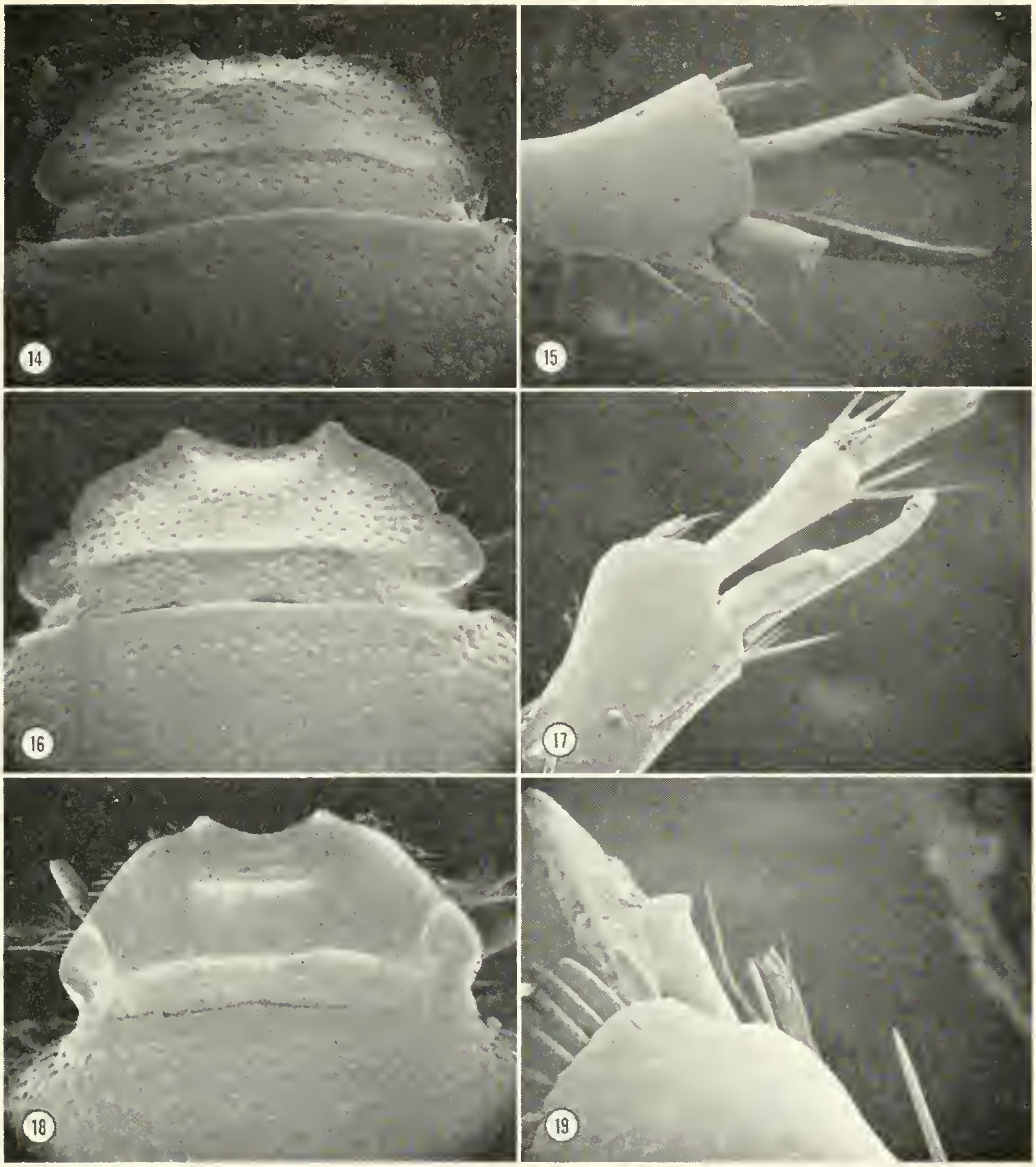


Fig. 14–19. Dorsal views of head, views of apices of middle tibiae. 14–15, *Aphodius denticulus*. 16–17, *Aphodius formidatus*. 18–19, *Aphodius henryi*.

Montgomery Ranch, X-2-1970, C.R. Ward, at u.v. light (USNM 73406). Paratypes, 6 ♂, with same data as holotype (USNM) (fig. 28).

Variation: Length ranges from 5.40 mm to 6.00 mm, greatest width from 2.52 mm to 2.90 mm.

Remarks: Of the previously described species, *denticulatus* and *testaceiventris* most nearly resemble *formidatus*. In addition to the characters used in the key, the body of *formidatus* is more elongate and parallel than that of either of the other 2 species; the anterior tibial spur of the male is flattened and bent inward in *formidatus*, simply thickened and very slightly or not at all bent inward in the others; the outer apical spur of the middle tibia of the male is slightly bent inward at the apex in *formidatus*, not secondarily toothed or apically truncate as in *denticulatus* or *testaceiventris*. In addition, the anterior clypeal angles are rounded in *formidatus*, acute or sharply angulate in both of the other species.

All type-specimens are males taken at u.v. light and this may indicate that the females are not attracted to light or not present.

The specific name is a Latin adjective (past participle of *formido*) referring to the formidable appearance presented by the clypeal margin.

Aphodius henryi Gordon, new species
fig. 18, 19, 24, 28

Holotype: Male, length 5.41 mm, greatest width 2.65 mm. Form elongate, robust, widest posterior to middle of elytra. Color light reddish brown, ventral surface except tibiae light yellowish brown. Head shining, a raised ridge extending across front, ending in small tubercle at each end; clypeus finely, sparsely punctured, short, median, carinate ridge present, ridge weakly emarginate medially, apex emarginate between 2 strong, triangular, slightly recurved teeth, anterolateral angle broadly angulate, reflexed, lateral margin reflexed (fig. 18), not excised. Pronotum smooth, shining, coarsely punctured, punctures separated by less than to 2× the diameter of a puncture; anterolateral angle abrupt, lateral border evenly curved to midpoint, fimbriate with long, dense setae, slightly explanate near anterolateral angle, posterolateral angle broadly rounded, posterior border distinctly margined. Elytron shining, feebly alutaceous, fimbriate with long setae, striae shallow, strial punctures fine, separated by the diameter of a puncture; intervals flat, nearly impunctate, each interval with an occasional puncture, entire 10th interval and all intervals on apical declivity with short, distinct pubescence. Ventral surface shining medially, alutaceous laterally; metasternum with several coarse, irregularly scattered punctures medially. Fore tibia as described for *formidatus* except apical spur short, stout, curved ventrally; middle tibia as described for *formidatus* except outer spur shorter, broader, apex only slightly bent inward, inner spur curved (fig. 19); apex of hind tibia fringed with short, equal spines. Anterior tarsus with basal segment nearly as long as segment 2, segments 2–4 subequal, fifth segment ¼ longer than segment 4; middle and hind tarsi with basal segment as long as segments 2–3 combined, segments 2–4 subequal, 5th segment ⅓ longer than segment 4. Abdominal sterna dull, alutaceous, pubescent. Genitalia as in fig. 24.

Allotype: Female, length 4.60 mm, greatest width 2.41 mm. Similar to male except anterior spur of fore tibia more slender, elongate; outer spur of middle tibia slender, apex acute, not bent.

Type material: Holotype, ♂, Utah, 14 mi. S. Hanksville, Fairview Ranch, 21-VII-1973, Robert Gordon, collected in sand-oak area, dead under dry cow chips (USNM 73407). Allotype, ♀, same data as holotype (USNM). Paratypes, 17 (9 ♂, 8 ♀): 10 with same data as holotype; 5, Utah, Hanksville, VIII-9-1968, A.T. Howden (CNC) (HH) (USNM). (fig. 28).

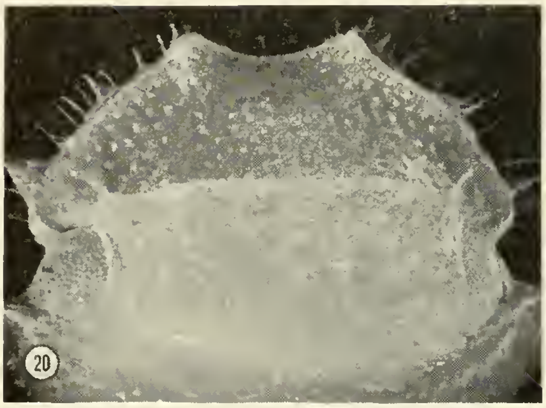
Variation: Length ranges from 4.00 mm to 5.41 mm, width from 2.10 mm to 2.65 mm.

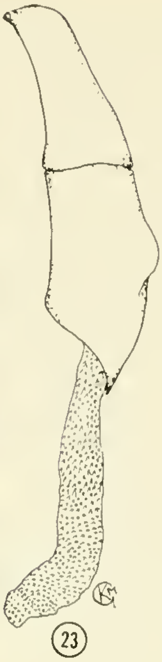
Remarks: The presence of distinct pubescence on the apical declivity of the elytron and the 10th elytral interval along with the carinate, medially emarginate clypeal ridge distinguish *henryi* from any other member of Group A. It is a relatively pale species, as are most desert dwelling *Aphodius*, similar in this respect to *acutissimus* and *aculeatus.* All type-specimens were collected dead under dry cow chips so the period of flight activity for this species is obviously earlier in the year than July and August. Because of the dry desert conditions of the Hanksville area, most of the specimens collected were in good condition, either intact or missing parts of the legs. The collection site is, in general, a sandy sagebrush desert area, and the specimens were collected along a dry, sandy wash lined with dwarf Gambel's Oak (*Quercus gambeli* Nutt.) ranging from a few inches to 6 feet in height. These dead specimens almost certainly had taken refuge under the cow dung and were not using it as a food source. This species is either saprophytic as postulated for *denticulatus,* or associated with a species of rodent. Throughout the area described above are rock ledges with numerous packrat (*Neotoma* sp.) nests. It is quite possible that *henryi* is associated with these packrats, particularly since another species of Group A, *dentiger,* is associated with a species of packrat.

The specimens taken in 1968 were referred to me by Henry Howden and the species is named both for him and for the Henry Mountains as the type-locality is at the northern edge of these mountains.

Aphodius acutissimus Gordon, new species
fig. 20–21, 25–26

Holotype: Male, length 5.60 mm, greatest width 2.65 mm. Form elongate, slender, widest posterior to middle of elytra. Color light reddish brown, ventral surface except tibiae light yellowish brown. Head shining, coarsely punctured, punctures separated by the diameter of a puncture or less, frontal ridge sharply raised, not tuberculate; median area of clypeus nearly impunctate, no median ridge present, surface slightly convex, apex deeply emarginate between 2 large, triangular, slightly recurved teeth, anterolateral angle obsolete, lateral margin reflexed as in fig. 20. Pronotum smooth, shining, coarsely punctured, punctures separated by less than to twice the diameter of a puncture; anterolateral angle rounded, projecting, lateral border slightly flattened, straight medially, finely margined, fimbriate with short setae, posterolateral angle rounded, posterior border finely margined. Elytron shining, lateral border fimbriate with short setae, stria distinctly impressed, strial punctures coarse, separated by twice the diameter of a puncture; intervals convex, each interval with a row of irregularly spaced fine punctures. Ventral surface shining medially, alutaceous laterally.





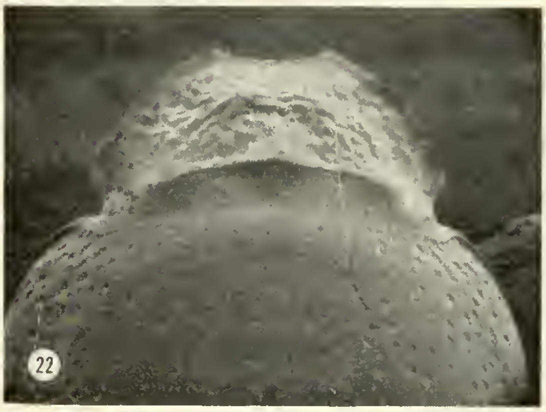


Fig. 20–25. Dorsal views of head, view of apex of middle tibia, lateral views of male genitalia. 20–21 and 23, *Aphodius acutissimus*. 22, *Aphodius aculeatus*. 24, *Aphodius henryi*. 25, *Aphodius acutissimus*.

Fore tibia as described for *formidatus* except anterior half of upped surface polished, apical spur long, thickened, abruptly bent inward at apex (fig. 21); middle tibia with apical spur broken; apex of hind tibia fringed with long, unequal spines. Anterior tarsus as described for *formidatus*; middle and hind tarsi as described for *formidatus*. Abdominal sterna dull, alutaceous, coarsely, sparsely punctured, pubescent. Genitalia as in fig. 25.

Allotype: Female, length 6.00 mm, greatest width 2.91 mm. Similar to male except anterior spur of fore tibia slender, acute apically, not bent inward at apex.

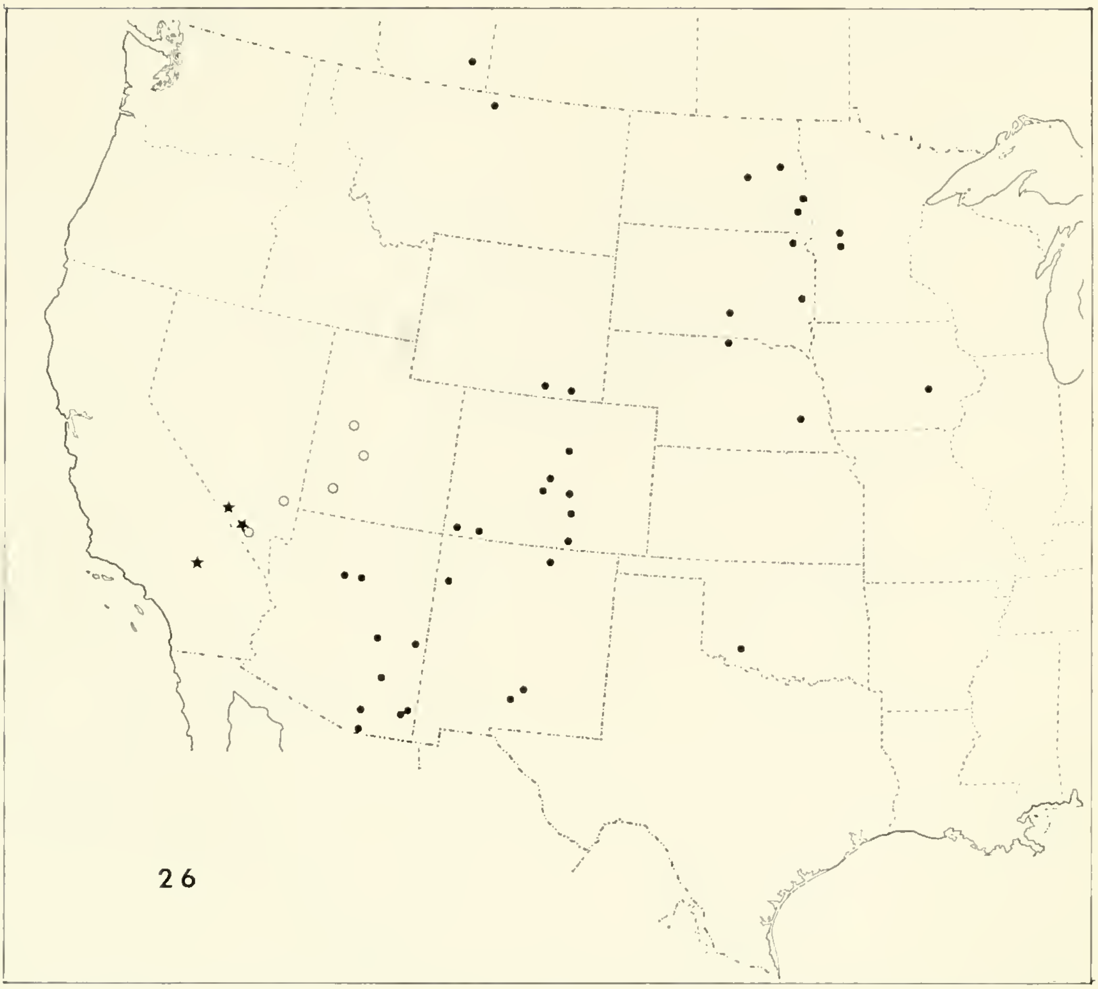


Fig. 26. Distribution of *Aphodius coloradensis* (dots), *Aphodius acutissimus* (stars), and *Aphodius aculeatus* (circles).

Type material: Holotype, ♂, Nevada, Nye Co., Pahrump, IX-11-1960, R. C. Bechtel, at u.v. light (USNM 73408). Allotype, ♀, same data as holotype. Paratypes (50), 4 ♀, same data as holotype; 1 ♀, Nevada, Nye Co., Amargosa Desert sand dunes, 11-X-1972, u.v. light, Derham Giuliani; 21 ♂, 24 ♀, California, Yermo, IX-29-1939, W. M. Pearce. (CAS) (NDA) (USNM) (fig. 26).

Variation: Length ranges from 5.60 mm to 7.00 mm, width from 2.65 mm to 3.41 mm. The clypeal teeth are larger and sharper on some specimens than on others.

Remarks: The absence of a central clypeal ridge and the presence of only 2 teeth on the clypeal margin distinguish *acutissimus* from other species in Group A. In both respects this species most nearly resembles *coloradensis* Horn, but *coloradensis* is a dark brown to black species and the clypeal teeth are indistinct, not prominent. The type-series was taken at light and no habitat information is available.

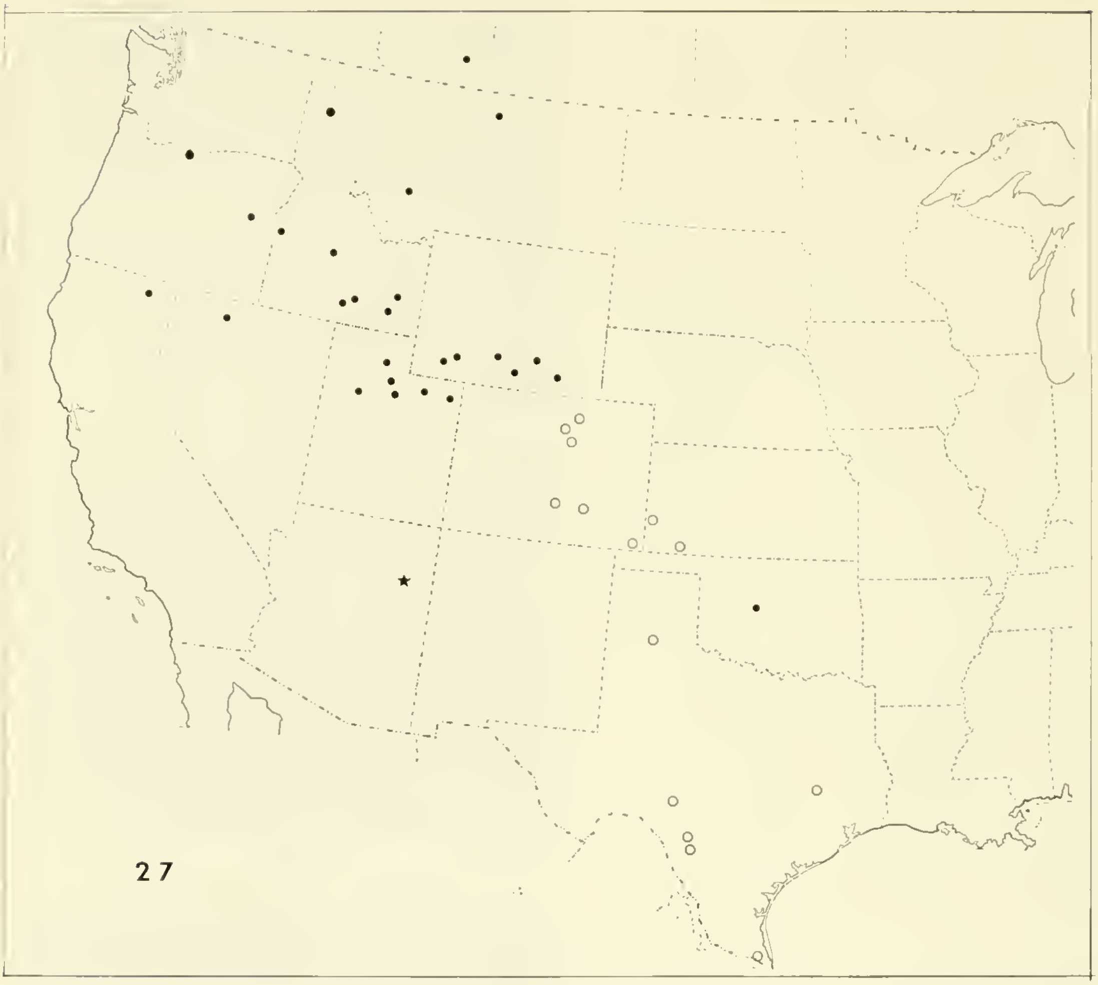


Fig. 27. Distribution of *Aphodius testaceiventris* (circles), *Aphodius denticulatus* (dots), and *Aphodius moquinus* (star).

The species name is a Latin adjective referring to the prominent, acute clypeal teeth.

Aphodius aculeatus Robinson
fig. 22, 26

Aphodius aculeatus Robinson, 1940:143

Remarks: This is the most atypical member of Group A because of the combination of small size, pale color and reduced clypeal armature. I place it in this Group because of the carinate clypeal ridge, raised frontal suture and dentate clypeal margin. The body form and facies are also characteristic of Group A despite the small size (4.30 mm or less in length). The clypeus of *aculeatus* is rugosely sculptured, the ridge carinate and the anterolateral angle rounded (fig. 22). The color is light reddish brown as in *henryi*.

The few specimens that have been collected have all been taken at light. It is probable that *aculeatus* is associated with some species

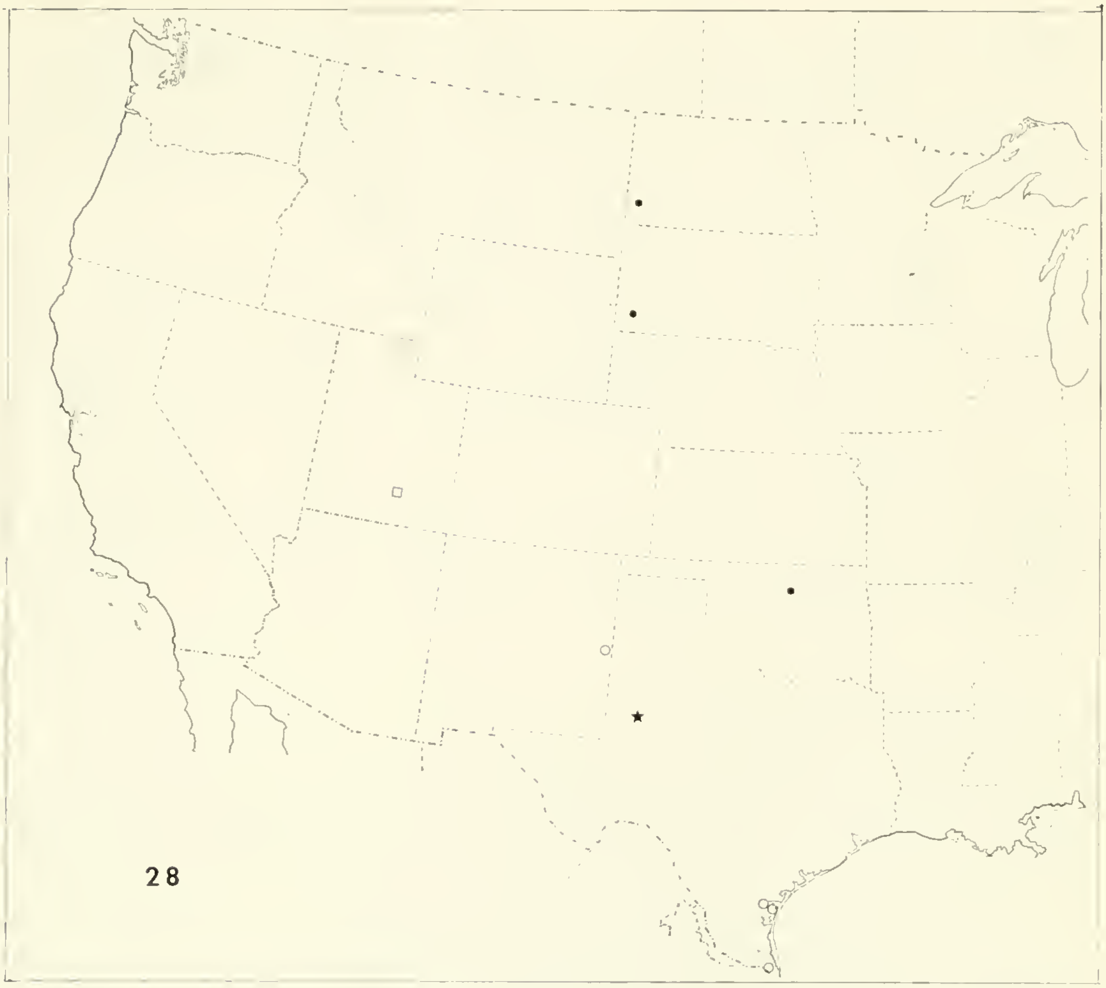


Fig. 28. Distribution of *Aphodius dentiger* (circles), *Aphodius dentigerulus* (dots), *Aphodius formidatus* (star), and *Aphodius henryi* (square).

of rodent, and I suspect that this rodent would be a member of the genus *Neotoma* because *aculeatus* does not possess any of the morphological adaptations that species associated with burrowing rodents usually have.

Specimens examined: Total 11 (fig. 26). NEVADA: Lincoln Co., Oak Springs Summit; Nye Co., Pahrump. UTAH: Millard Co., Delta; Paragonah; Sevier Co., Richfield.

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A NEW SPECIES OF GONIOZUS IMPORTED INTO CALIFORNIA FROM ETHIOPIA FOR THE BIOLOGICAL CONTROL OF PINK BOLLWORM AND SOME NOTES ON THE TAXONOMIC STATUS OF PARASIEROLA AND GONIOZUS (HYMENOPTERA: BETHYLIDAE)

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ABSTRACT—*Goniozus* **aethiops** Evans, new species, is described and information about its biology is provided. The parasite was imported, propagated and released in California for control of the pink bollworm, *Pectinophora gossypiella* (Saunders). Some comments regarding the taxonomic status of *Parasierola* and *Goniozus* are made.

The purpose of this paper is to provide a name for a parasite introduced into the southwest United States for the control of pink bollworm, *Pectinophora gossypiella* (Saunders). Collections made by B. R. Bartlett, Division of Biological Control, University of California, Riverside, in Arba Minch, Ethiopia, during September 1970, revealed a new species of *Goniozus* attacking pink bollworm at that locality. Although the taxonomic status of the parasite was unknown to Bartlett at the time, he did import, propagate and release it at several localities in southern California. It is unknown whether the parasite has become established, but publication of a description and some detailed notes on the parasite's biology will alert field workers as to its potential presence.

In the following account investigative responsibilities have been divided thus: Evans has described the parasite, and Gordh has performed the biological studies. Joint authorship seems desirable for the sake of brevity and keeping the information together.

Description

Goniozus aethiops Evans, new species
fig. 1–2

Holotype: ♀, labeled: *Goniozus ex* Ethiopia, Lab. reared on PBW [Pink Bollworm], Riverside, Calif. I-XII/1973 (Gordh). Stock originated from Arba Minch, Ethiopia, 4–6 Sept. 1970, *ex Pectinophora gossypiella* on tree cotton (collector B. R. Bartlett). [Type to be deposited in California Academy Sciences, San Francisco.]

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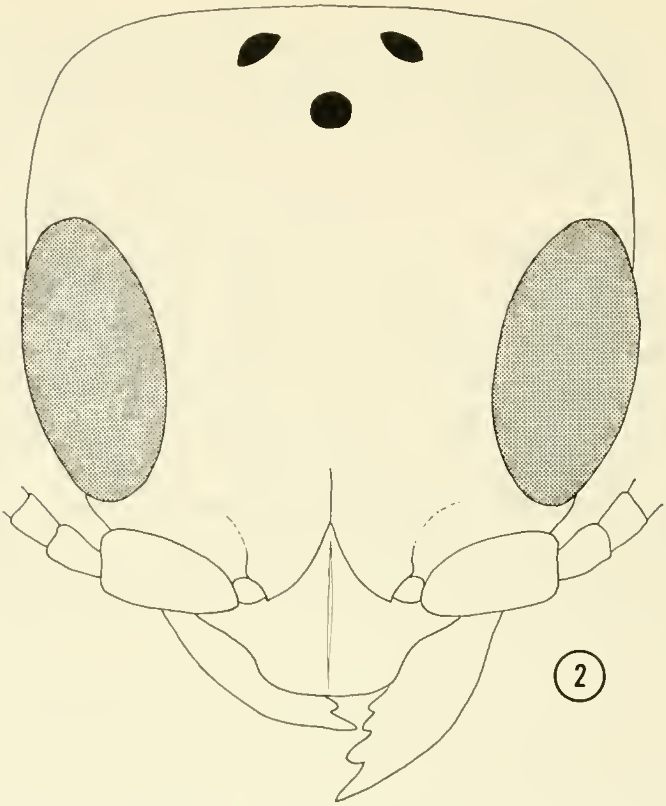

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Fig. 1. Fore wing of female. Fig. 2. Head of female, anterior view (holotype).

Description of type: Length 2.8 mm; fore wing 2.4 mm. Body entirely shining black; mandibles black, palpi brown; antennae testaceous, slightly darker on upper surface and on all of scape and apical 3 segments; coxae and femora dark brown, trochanters, tibiae, and tarsi testaceous except middle and hind tibiae partially suffused with brown. Wings clear hyaline, veins translucent, very light brown, except costa, subcosta, prostigma, and stigma dark brown. Mandibles with 4 teeth. Clypeus with a broadly projecting median lobe, rounded laterally and subtruncate medially, bearing a strong median carina which is weakly arched in profile, carina extending from clypeal margin to point opposite tops of antennal insertions. Antennal scrobes not margined by carinae. First 4 antennal segments in ratio of 14:5:4:4, segments 3–6 slightly wider than long, outer segments (9–13) slightly longer than wide, somewhat moniliform. Head strongly shining, with only very faint surface sculpturing, punctures small and sparse, those on center of front separated by 5–10× their own diameters. Head slightly longer than wide, its width slightly less than maximum width of thorax; width of front 0.58× height of eye; distance from eye tops of vertex crest 0.65× eye height; in anterior view, sides of head converging weakly behind eyes, then, abruptly, roundly convergent to broad, nearly straight vertex; in lateral view, temples subequal in width to eye. Ocelli in about a right triangle well above eye tops, close to vertex crest; ocello-ocular line 1.2× width of ocellar triangle. Pronotum slightly more evidently alutaceous than head, but mesoscutum very smooth, polished, almost wholly devoid of surface sculpturing; scutellar pits elongate, separated by 4× their own length; propodeal disc with broad median polished band, otherwise strongly alutaceous, disc separated from posterior declivity by fine carina which is broadly incomplete medially. Front femur approximately 2× as long as its maximum width. Fore wings as figured. Abdomen somewhat flattened ventrally, apical segment strongly depressed.

Allotype: ♂, same data and disposition as type.

Description of allotype: Length 2.1 mm; fore wing 2.1 mm. Color of body and appendages as in female, surface sculpturing also as in female. Clypeus shaped as in female, but median carina less sharply defined. Head very slightly wider than long, vertex much more rounded than in female; width of front 0.53× width of head, 1.05× eye height; ocelli somewhat larger than in female, ocello-ocular line only 0.75× width of ocellar triangle. First 4 antennal segments in a ratio of 12:4:4:5, segments 3–10 about as long as wide, 11–13 slightly longer than wide. Structure of thorax and propodeum as in female, but carina margining propodeal disc posteriorly very weakly defined. Front femur 2.3× as long as its maximum width. Wing venation as figured for female. Abdomen short, depressed.

Paratypes: 50 ♀, 13 ♂, bearing same data as type. To be deposited at California Academy Sciences, University of California Riverside, U.S. National Museum, Comparative Zoology Harvard, University of Kansas, British Museum (Natural History).

Variation: The females vary in length from 2.4 to 3.0 mm, the males from 2.0 to 2.4 mm. As is common in Bethylidae, there is some variation in size of the eyes, the distance from the eye tops to the top of the vertex in the females varying from about 0.5 to 0.7× the eye height, width of the front from 1.1 to 1.25× eye height in the females, 1.0 to 1.1 in the males. There is some variation in the development of the carina bordering the propodeal disc behind, but it is always present as at least a slightly elevated clear streak on each side.

Remarks: In Kieffer's (1914) key to species of the world, this species runs to *foveolatus* Ashmead, but this is a North American species differing in several features from *aethiops*: The clypeus is of different form, the vein arising from the basal vein is shorter, and the mandibles and antennae are yellowish. In Kurian's (1955) key to the species occurring in India, this species runs (although poorly) to *fulvicornis* Rohwer, a species having tridentate mandibles, a median groove on the propodeum, and other features not present in *aethiops*. We have also considered carefully the descriptions of the African species *G. etiellae* Risbec (1955), *G. procerae* Risbec (1956), and *G. similis* Fouts (1934). All of these differ in various details from *aethiops*, particularly in the shape of the clypeus. C. G. Nagy, of the Marine Research Institute, Agigea-Constantza, Romania, informs us that he knows of no described Palaearctic or Ethiopian species with a clypeus of this unusual form. The strongly polished integument of the head and thorax and the propodeal sculpturing provide additional characters of diagnostic importance.

Etymology: *Aethiops* is a Greek adjective meaning "burned" or "black", with reference to the coloration of this species. It is also the base of the word Ethiopia, the country of origin of the type-series.

Biological Observations

Materials and methods: The parasite was cultured in the laboratory on pink bollworm in the following manner: Individual females were placed in 2 oz plastic jelly cups with a single final instar pink bollworm host. For specific biological studies, cups were examined daily for parasite development and emergence. Female parasites, newly emerged and mated, were placed in 2 dram plastic snap-cap vials with a bollworm host. Daily observations were made for host paralysis and parasite egg deposition. The parasite was removed when it was determined that the host had been parasitized. Female parasite age, the host's position in the parasitization history of a given female, number of eggs deposited, egg mortality, and the sex ratio of the brood were recorded for each parasitized host. Studies of immature parasites consisted of daily observation and notation of parasite development. After the larvae spun their cocoons, these were cut open and pupal development was observed.

In addition to the dispensation of paratypical material, voucher specimens have been deposited in the following collections: University of California, Riverside, and the Introduced Beneficial Insect Voucher Collection, Beneficial Insect Introduction Laboratory, IIBIII, ARS, USDA, Beltsville, Maryland.

Results: Males emerge approximately one to two days before the females. Some time after emergence the male chews his way into a female's cocoon (a sister) and copulation takes place. Insemination requires less than 15 minutes. The copulatory stance assumed by the male is such that the individuals are venter to venter. After insemination the male leaves the cocoon and chews into another cocoon and mates with a second female. This procedure is repeated until usually all females are inseminated. Copulation may take place outside the cocoon with females that have already emerged but not previously mated usually because a brood was composed only of females. In such instances the male assumes a position on the dorsum of the female with his fore tarsi and middle tarsi on the female's thorax and wing margins respectively. Insemination in such instances requires seven to thirteen minutes. Studies with mated females that had emerged indicate that they are unreceptive to male copulatory attempts. Although a male may mount the female and continually press the apex of his gaster to the apex of the female's gaster, the female response is negative, characterized by movement, attempting to dislodge the male or both.

Courtship behavior on the part of the male is simple. He approaches the quiescent female, mounts her dorsum, and presses his genitalia to the apex of the female gaster several times. Some antennal vibrations are apparent, but the antennae do not come in contact with the female's body.

Prey attack is such that the female parasite leaps onto the caterpillar near its head or quickly shifts to that area, grabs the host's cuticle with her mandibles and injects the sting several times into the region near the gula. Paralysis overcomes the caterpillar within several minutes while the parasite walks over the host's body antennating it in pulses. Often, during parasite antennation, the caterpillar writhes and attempts to bite the parasite, sometimes successfully. Frequently, older female parasites are missing legs, antennae and wings. Several instances of host-induced parasite mortality have been observed. These generally involve the caterpillar decapitating the parasite.

Oviposition varies with age and previous ovipositional experience of the parasite. Thus a two day old nulliparous female will sting a caterpillar several times and oviposit on it within an hour or so but a female that has oviposited recently (a day or two earlier) will sting a host and then wait several days (four or five) before ovipositing on the host.

The ovipositional stance of the parasite consists of her grasping the host with all three pairs of legs probing with the apex of her gaster. During probing the antennae are held horizontal and spread approximately 90 degrees. Football-shaped eggs are about one millimeter long and are deposited transversely in the intersegmental folds of the host's cuticle.

To determine the dispersion pattern of eggs the following experiment was conducted. Recently mated, newly emerged females were isolated in two dram snap-cap plastic vials with honey streaks provided for food and the containers were numbered. Mature bollworm larvae were given to each parasite and daily observations were made for host paralysis and parasite oviposition. Parasitized larvae were removed and placed inside gelatin capsules and the female's number, date of parasitization, number of eggs and their position were recorded. Another bollworm larva was then given to the parasite and the procedure was repeated throughout the female's lifetime. Fifteen parasites were counted in each group and the experiment was replicated twice. However, host induced mortality necessitated using more than 15 parasites in each replicate. Data collected for parasites that had been killed by their hosts are not presented.

There was no statistical difference between the replicates for any parameter examined, and therefore the data were lumped. The 30 female parasites lived 13.35 ± 4.60 days, parasitized 3.47 ± hosts each and deposited 16.23 ± 8.18 eggs during the course of a lifetime.

Table 1 indicates the total number of eggs deposited per segment for 30 female parasites. In addition the sites were scored with respect to left, right, dorsal and ventral aspects. The female parasites exhibit a definite preference for the middle segments of the host's body. The

Table 1. Total number of eggs deposited by thirty female *Goniozus aethiops* per segment of host body and the aspect upon which the eggs were deposited (dorsal, ventral, right or left). Eggs were scored for the segment of host body immediately posterior to the intersegmental fold in which the egg was placed.

Aspect of Host's Body	Host Body Segment												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
Right	0	2	6	18	41	40	49	66	34	8	1	0	265
Left	0	2	0	8	30	32	62	52	47	14	2	0	249
Dorsal	0	0	0	2	2	3	6	8	4	0	0	0	25
Ventral	0	0	0	2	1	0	5	0	0	0	0	0	8
Total	0	4	6	30	74	75	122	126	85	22	3	0	547

nearly normal distribution of eggs probably reflects a random component of oviposition behavior, depending on the direction the parasite was facing while ovipositing (i.e., toward or away from the host's head). There was no significant difference in the number of eggs deposited on the left versus the right side ($t_{obs} = 0.086$), thus suggesting that there is no side preference exhibited by the ovipositing wasp. Statistical analysis also revealed no significant difference in the site preference when dorsal aspect was compared to ventral aspect, although more eggs were deposited on the top ($t_{obs} = 0.893$). In sharp contrast, however, analysis did reflect a strong difference in the number of eggs deposited on the side versus those laid on the dorsal and ventral surfaces ($\chi^2 = 905.76$, $p < 0.001\%$).

Table 2 gives the pattern of egg deposition for the 30 parasites throughout their lives. Instances of more than eight eggs laid on a host were not observed, nor has this been observed during routine culture maintenance. Characteristically, females deposit seven eggs on a host.

Table 2 deserves further comment. The totals row shows that the frequencies of clutches consisting of three and four eggs closely follows seven eggs per clutch. In turn, these clutch sizes are considerably separated from other clutch sizes. Some circumstantial evidence suggests a female probably does not deposit a full complement of eggs during one ovipositional session. During the experiment if a female was on a host the cell remained unchanged. Parasitized hosts were removed only if the female was wandering around the cell. Thus many instances of three and four eggs deposited on a host were recorded. In fact the data show that 48 instances of this occurred. Often the parasite would deposit three or four eggs on the subsequent host, thereby laying seven eggs on two consecutive hosts.

Analysis of the number of hosts parasitized versus day of adult life

Table 2. Frequency of parasite clutch size on sequential hosts.

Host Number	Clutch Size 1	2	3	4	5	6	7	8
1		3	5	7		5	14	2
2	2	4	8	6		3	6	
3		1	2	2	4		5	2
4	1		2	5	3	2	4	
5			4	4	2	1	1	
6			1				1	
7								
8			2					
9								
10								
Totals	3	8	24	24	9	11	31	4

is presented in Graph 1. The linear regression equation best fitting these data was $Y = 0.158 + 0.305X$. These data suggest that females parasitize the majority of their hosts early in adult life.

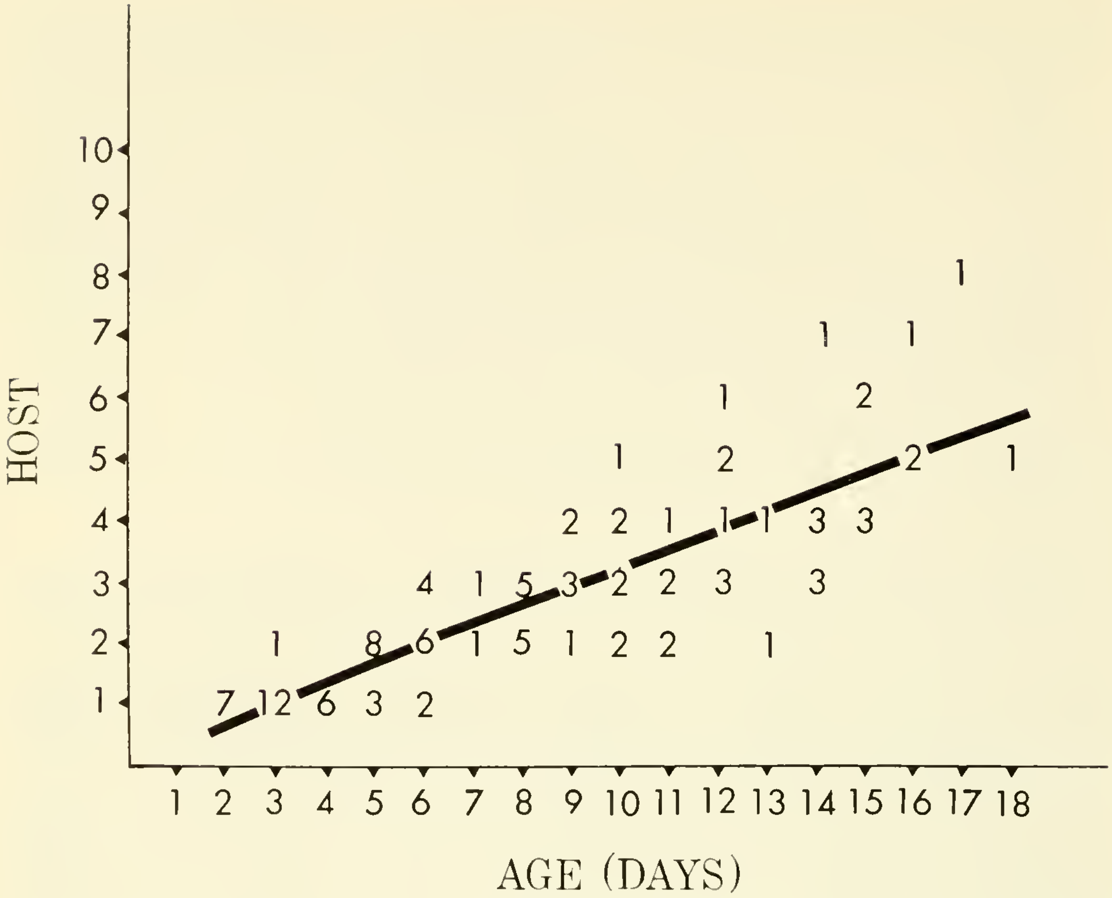
Data collected from this experiment also show that newly emerged females are capable of stinging hosts, but that a two day period precedes oviposition. Often the host partly recovers from the effect of the venom, but it is always lethargic. If the host is stung during the period immediately preceding pupation, the caterpillar pupates.

The larval feeding period lasts five days (based on 37 replicates at 75 ± 3°F. RH = 50 ± 5%). (No instance of parasite larva death due to superparasitization was noted). The host is consumed so all that remains is a shriveled integument and head capsule.

Feeding completed, the larvae detach themselves from the host's integument, disperse over an area of a few square centimeters and spin loosely woven, white cocoons. Under conditions of high humidity the parasites did not spin cocoons, and if the humidity remained high they ultimately died.

The pupal period lasts eight days at the temperature and relative humidity specified. The deposition of pupal pigmentation is similar to that reported for *G. gallicola* by Gordh (1976).

Little immature immortality has been observed in this species. Casual observations of two females with a single host show some defense of a host by the female possessing the caterpillar, but this does not result in vigorous combat. Threatening posture, characterized by spread mandibles, raised antennae and movement toward the invader seems in most instances to be adequate to discourage the second female.



Graph 1. Linear regression analysis of number of hosts parasitized versus day of adult life for female *Goniozus aethiops.*

The sex ratio at adult emergence is spanandrous, ranging up to 100% female. In some instances where the brood is small the ratio approaches 1:1 but in general there seems to be only one male per brood. In no instance did a female produce all males, which would imply exhaustion of sperm supply on the part of the ovipositing female. This also suggests that males are capable of adequately inseminating up to seven females. In instances where a brood yielded more than one male, combat between the males was not observed. Males die less than four days after emergence.

Some useful references, not otherwise mentioned in the text of this paper, are included in the References: Antony and Kurian, 1960; Gifford, 1965; Iwata, 1961; Kishitani, 1965; Nickles and Pinkney, unpubl. ms.; Venkatraman and Chacko, 1961; Voukassovitch, 1924.

Discussion

The method of host attack, duration of development, immature stages and copulatory behavior of *Goniozus aethiops* are similar to other species of *Goniozus* we have studied. The length of adult life

Table 3. Distribution, adult behavior and biological attributes of various species of *Goniozus* Foerster and *Parasierola* Cameron.

	Attribute							
	Distribution	Host(s)	Paralysis	Oviposition site Preference	Eggs/Host	Feeding Larva (Days)	Egg Position	Authority
Goniozus								
aethiops Evans	Ethiopia, ?U. S.	gelechiids	P[a]	L[b]	7 usually	5	Interseg.	Present Study
claripennis (Fors.)	Europe	tortricids	R		varies w/size			Voukassovitch (1924)
gallicola Fouts	U. S.	gelechiids	P	D	varies w/size	3–5	Interseg.	Gordh (1976)
indicus Mues.	India	*Scirpophagus*		V & L	9–40; X = 20		Interseg.	Gifford (1956)
japonicus Ashm.	Japan	pyralids, tortricids, gelechiids	R	Middle seg.	2–16		Interseg.	Kishitani (1961) Iwata (1961)
marasimi Kurian	India	jowar leaf roller	R	rarely on Dorsum	1–12	2	Interseg.	Venkatraman & Chacko (1961)
Parasierola								
cellularis (Say)	U. S.	*Acrobasis*, *Laspeyresia*		D	1–18	2–3	longitudinal	Nickles & Pinkney (unpubl.)
emigrata (Rohwer)	U. S.	gelechiids	P	V	varies w/size?	2–3	longitudinal	
nephantidis Mues.	India	xylorictids, pyralids		L	3–18 varies w/size			Antony & Kurian (1960)
nigrifemur (Ashm.)	S. Amer.	gelechiids	P	D	1–15	2–3	longitudinal	Gordh (in prep)

[a] P = permanent; R = recovers.
[b] D = dorsal; V = ventral; L = lateral.

and total number of eggs produced seem to differ drastically compared to other species of *Goniozus* and the related genus *Parasierola.*

Gordh (1976) has noted that the North American *G. gallicola* lives 62.43 ± 8.48 days and deposits 153.78 ± 48.59 eggs. This is in sharp contrast to the 13.35 ± 8.48 days of adult life and 15.53 ± 8.18 hosts parasitized by *G. aethiops.* Moreover, *gallicola* deposits its eggs on the longitudinal body axis whereas *aethiops* deposits eggs transversely between body segments.

Attack behavior is similar to other species of *Goniozus* and *Parasierola.* All species in both genera (for which biological information is available) sting their caterpillar hosts at or near the gula.

There is some question as to the taxonomic status of *Parasierola* and *Goniozus.* Evans (1964) has suggested that on the basis of morphological characters they are nearly identical. Table 3 lists biological attributes of species of *Parasierola* and *Goniozus* as reported in the literature. It would seem that on the basis of various aspects of behavior, host preference and immature development sufficient variation is generated as to cause overlap between them.

Two features which nearly create a dichotomy between the genera are paralysis of the host and egg position. It appears that species of *Goniozus* paralyze their hosts temporarily, and their hosts may partly recover from the venom. Temporary or incomplete paralysis of the host may permit the female to oviposit unmolested by the host and at the same time insure that the host remains suitable for the developing larvae. To our knowledge the only species of *Goniozus* which paralyzes its host strongly is *G. gallicola.*

Egg position is the second feature which may provide difference between the genera. *Parasierola* seems to deposit its eggs longitudinally, but *Goniozus* deposits its eggs transversely. Again, however, this attribute breaks down with *G. gallicola.* It may be that eggs deposited on the body segments rather than in the intersegmental folds are more susceptible to damage and as a consequence permanent paralysis is required.

More comparative studies on the biologies of members of these genera are obviously necessary before any firm decision can be made regarding their proper status. Also, modern taxonomic revisions of these genera are needed to clarify the value of characters presently being used, as well as to provide keys to the species, many of which are of potential value in biological control.

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NOTICE

The recently published book "Sphecid Wasps of the World" by R. M. Bohart and A. S. Menke contains the statement "issued June 25, 1976". However, approximately 150 copies were mailed to advance subscribers on April 27 and 28, 1976 by the University of California Press. Thus the April 27 date should be considered the true publication date for nomenclatorial purposes.

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BOOK REVIEWS

The Butterflies of the Far East USSR. A. I. Kurentzov. 1970. Academy of Sciences of USSR, Siberian Division, Institute of Pedobiology of the Far-Eastern Branch, 164 pp., 104 text figs., 14 colored plates, cloth bound (price not given). Available through natural history booksellers such as Antiquariaat Junk, Lochem, Holland.

This work will be of considerable interest to North American lepidopterists and others interested in holarctic zoogeography. For the butterflies it goes a long way toward satisfying ones curiosity about the species that occur on the other side of the Bering Strait. Although the text is in Russian, much of the content is still meaningful to the non-Russian reader because of the illustrations and the Latin scientific names. In addition to the colored plates, the book is illustrated with many black and white drawings of adults, male genitalia, distribution maps (some of which show both Siberian and American distributions), and a few habitat photographs. About 320 species are treated, with keys to families, genera and species; 247 species, subspecies or forms are illustrated in color. At least 38 of the species mentioned occur also in North America, and for some of these the relationships between the palaearctic and nearctic subspecies are discussed in detail. The bibliography consists of 277 entries, including references to 41 papers on the nearctic fauna.

The classification is conservative. For example, the species of "blues" treated as only four genera by Kurentzov would be distributed among at least 13 genera in the arrangement followed by Higgins and Riley in *A Field Guide to the Butterflies of Britain and Europe* (Houghton Mifflin Co., Boston. 1970). Similarly, the four genera of small fritillaries of those authors are all lumped into *Brenthis* by Kurentzov. The work includes original descriptions of new species and subspecies; among these I noted one homonym: *Oeneis magna mongolica* Kurentzov, 1970, is preoccupied by *Oeneis mongolica* (Oberthür), 1876. The typography is generally good and there appear to be few errors. However, two misspellings, *Colias palaeno schippewa* (for *chippewa*) and *Brenthis euphrasyne* (for *euphrosyne*) are used consistently.

The original paintings for the colored plates, by N. Kondakov, would appear to have been nearly equal in quality to those of Brian Hargreaves (*In* Higgins and Riley, 1970, *A Field Guide to the Butterflies of Britain and Europe*) or William H. Howe (1975, *The Butterflies of North America*, Doubleday & Co., Garden City, New York), but they suffered somewhat in reproduction. The main fault is a familiar one—poorly superimposed printings of the various color separations, resulting in fuzzy margins and double antennae. On plate 3 of my copy the red missed the mark by a full millimeter, and on plate 4 all colors are conspicuously offset. Although here and there the colors may appear faded or unreal, most of the other plates are good, and some are very good. The figures should make possible the immediate identification of nearly all the illustrated species, even without reference to the text. For an expensively illustrated work, however, the text is printed on a surprisingly poor grade of paper, not much better than ordinary newsprint, and the hard covers of the binding have warped badly.

Dr. Kurentzov's book is nevertheless an outstanding contribution to our knowledge of the fauna of this remote region of which we know so little; my main regret is that an English translation is not available.

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Evolutionary Strategies of Parasitic Insects and Mites. P. W. Price, editor. Plenum Press, New York and London, 224 pp. Cost $25.00.

If one considers the number of species that adhere to a life form as an indicator of the successfulness of that life form, then parasitism is quite successful because there are numerous species of parasites. Many ecologists and evolutionary biologists have focused their attention on free-living forms as a vehicle for the development of general evolutionary principles and have ignored the phenomenon of parasitism. Thus, it is not without some enthusiasm that I note the publication of *Evolutionary Strategies of Parasitic Insects and Mites* because this work provides the fulcrum on which to develop principles explaining the evolution of arthropods that live parasitically.

The text stems from 8 papers presented at the 1974 annual meetings of the ESA. Chapters include: "The Parasitic Way of Life and its Consequences" (P. W. Price), "Biochemical Coevolution between Parasitoids and their Hosts" (S. B. Vinson), "Models for Parasite Populations" (R. Mitchell), "Courtship in Parasitic Wasps" (R. W. Matthews), "Reproductive Strategies of Parasitoids" (P. W. Price), "Succession of r and K Strategists in Parasitoids" (D. C. Force), "The Organization of Chalcid-Dominated Parasitoid Communities Centred upon Endophytic Hosts" (R. R. Askew), "Interactions of Seeds and their Insect Predators/Parasitoids in a Tropical Deciduous Forest" (D. H. Janzen), and "Sympatric Speciation in Phytophagous Parasitic Insects" (G. L. Bush).

The introductory chapter by Price discusses the phenomenon of parasitism and its consequences to the host and to the parasite. In a later chapter he shows that fecundity is highly correlated with ovariole number in tachinids and ichneumonids, and that in the Tachinidae the probability of finding a host is correlated with the number of ovarioles per ovary. Price also provides extensive tabular data on ovariole number and estimated fecundity for various species of tachinids and ichneumonids.

Traditional views have divided parasitism into host-habitat location, host finding, host acceptance, and host suitability. It is apparent that chemicals are important in determining a parasite's relative success. Recognition of this fact has prompted Vinson to propose another category of factors that are involved in successful parasitism which he calls host regulation. Factors included in this category are evasion or suppression of host internal defenses and regulation of host growth and development.

Ecological models are placed in two general categories—population models (those which explain the way a population is related to its resource) and Darwinian models (those which explain the dynamics of natural selection when several characters are used). The concept of r- and K-selection has been developed for population studies, but for various reasons the validity of such analysis has been questioned by some ecologists. Mitchell, in his treatment of population models, develops an alternative approach in which he characterizes l- and m-parasites.

According to Mitchell, l-parasites are limited numerically as a function of the host as a food source; m-parasites are limited numerically by the extent to which host fecundity is affected by the parasites. Mitchell also discusses Darwinian models.

Behavior is recognized as an important consideration in any in-depth analysis of evolution. Sexual behavior of biparental insect species is important because copulation and insemination are essential for reproduction. In species which copulate, courtship displays are often elaborate. R. W. Matthews provides information on courtship of parasitic wasps and gives a detailed survey of sexual behavior in the parasitic Hymenoptera. He correctly points out that sex ratios in parasitic Hymenoptera tend to be spanandrous and he views this as a mechanism for maximizing efficiency (less sperm wastage) and the distribution of male sperms.

The concept of r- and K-selection in parasite communities is discussed by Force who provides an historical account of the concept and then discusses his data on a cecidomyiid midge on coyote brush in California.

The discussion of chalcidoid-dominated parasite communities attacking gall-making cynipids on oak and leaf-mining Diptera, Lepidoptera, Coleoptera and Hymenoptera on deciduous trees by R. R. Askew is superb. The treatment synthesizes over 15 years of work by Askew and has a sound systematic foundation. Askew shows that in both communities different parasite reproductive-strategies can be identified. R-strategists are characterized by endoparasitism and monophagy; K-strategists are polyphagous external parasites that carry fewer eggs than r-strategists.

Ecologists interested in the coevolution of tropical insects and plants will find D. H. Janzen's contribution stimulating. The chapter deals with the interaction of bruchid beetles and the seeds of various legumes. Janzen treats a multitude of factors which must be considered when studying this problem. The chapter is difficult to digest because the chapter is long, it contains several digressions, it briefly touches many parameters affecting seeds and seed predators, and it lacks concrete conclusions.

The book concludes with a chapter by Guy Bush in which he presents a model for sympatric speciation that is consistent with his studies of *Rhagoletis* species. Bush contends that new races of phytophagous insects can develop with a minimum of change in the genome, that strong reproductive isolation barriers can develop thru subtle changes in host-plant preference, and that these barriers can be reinforced by changes in seasonality and the behavior associated with courtship.

In summary, I found this to be a positive contribution to entomological literature. I find only two disturbing factors associated with this book. First, the cost is $25.00 for offset reproduction of 224 pages of typescript. (I purchased my copy of this book and feel justified in making this criticism.) Second, the title includes mites, but nowhere in the text is reference made to parasitic acarines. It seems their inclusion in the title is for the sake of completeness. It remains to be established that the principles outlined in the text for parasitic insects also hold for parasitic mites.

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The Insects of Australia, Supplement. 1974. CSIRO, Canberra, Australia. 146 pp., 42 figs. Melbourne University Press. Available in U.S.A. from International Scholarly Book Service, P.O. Box 555, Forest Grove, Oregon 97116. $14.00.

This useful supplement to the outstanding text "The Insects of Australia" (first issued in February 1970) is a bound volume in the same format. Each of the original 37 chapters is represented, though for some there is no additional information. However, an attempt is made to bring significant changes in the classification and other aspects up to the level of literature for the end of 1973 or a little beyond. The following additions are among those meriting special comment: 1. A new key to the families of bees, by Charles D. Michener; 2. A new section on insect vision, by G. A. Horridge; 3. A new section on insect behavior, by R. M. M. Traynier; 4. An updated treatment of thrips, chiefly anatomical, by L. A. Mound; 5. Perhaps the most notable part of the supplement, a new key to the families of Coleoptera based on larvae, by E. B. Britton. The families included in this key cover 98 percent of the Australian species of beetles. Five of the current authors were not represented before. Although dated 1974, the Supplement copy under review has been obtained only recently.

There are 18 pages of references, 4 pages of corrections for the 1970 volume, and an index. The text and illustrations of the supplement maintain the high standards of the parent work. There is a striking frontispiece which shows an excellent picture by scanning electron microscope of a moth egg magnified 450 times, compared to a glimpse of the Earth at 450,000,000 magnifications.

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SOCIETY MEETINGS

828th Regular Meeting—December 11, 1975

The 828th Regular Meeting of the Entomological Society of Washington was called to order by President Rainwater on December 11, 1975, in the Baird Auditorium of the National Museum of Natural History. Twenty-six members and 8 guests were present. Minutes of the previous meeting were read and approved.

President Rainwater summarized the accomplishments of the Society during the past year.

Corresponding Secretary Gagné reported that the present membership of the Society is 498 regular members, a net loss of 29 over the previous year.

Treasurer Spilman presented a report on the Society's finances. Previously effected increases in page charges and other fees continue to be beneficial, especially in the reduction of loan balances.

Editor Knutson presented a report on the status of the *Proceedings*, stating that pages published in 1975 totalled 508, and issues begining in 1976 will be dated January, April, July and October. Knutson also presented the Custodian's Report for D. R. Miller, stating that sales of publications over the past year had amounted to $947.06.

After President Rainwater had thanked the Officers for 1975, the names of the new Officers for 1976, as listed in the Minutes of the previous meeting, were presented to the Society. There were no further nominations from the floor and a motion was made to record a unanimous ballot in favor of the proposed slate. It was carried, with one dissenting vote. The 1976 slate of officers was declared elected, effective at the close of the meeting.

L. V. Knutson suggested that the Society place on record their appreciation for the fine service that T. J. Spilman has provided during his tenure as Treasurer for the Society, a motion that was passed unanimously.

President Rainwater introduced a proposed amendment to the Bylaws to increase life membership dues from $100.00 to $150.00.

C. W. Sabrosky reminded the audience of the approaching International Congress of Entomology to be held in Washington, D.C. in August, 1976.

In the absence of Membership Chairman Kingsolver, T. J. Spilman read for the first time the names of the following new applicants for membership: Edward M. Barrows, Georgetown University, Washington, D.C.; Clifford O. Berg, Cornell University, Ithaca, New York; William H. Robinson, Virginia Polytechnic Institute and State University, Blacksburg, Virginia; Carl W. Simpson, New York State Department of Health, Albany, New York; Virginia A. Spaeth, University of Tennessee, Knoxville, Tennessee.

Notes and Exhibitions: A. B. Gurney read a doggerel poem that had been presented by L. O. Howard at the Society meeting of June 4, 1931. The poem had first been presented to the Society at the 100th Regular Meeting.

The principal speaker for the evening was Mr. Jack Lipes of Plant Protection and Quarantine, APHIS, who presented a fascinating account of problems created by certain insect species in Central America.

President Rainwater officially transferred leadership to newly elected President Steyskal, who closed the meeting at 9:30. Punch and cookies were served following the meeting.

GARY F. HEVEL, *Recording Secretary*

829th Regular Meeting—January 8, 1976

The 829th Regular Meeting of the Entomological Society of Washington was called to order by President Steyskal on January 8, 1976, in the Lecture Room of the National Museum of Natural History. Twenty-three members and 7 guests were present. Minutes of the previous meeting were read and approved.

Membership Chairman Kingsolver read for the first time the names of the following new applicants for membership: James W. Cottrell, Washington, D.C.; Frank T. Hovore, Van Nuys, California; Gorgas Mendez, Panamá; Richard Murkoffer, Normal, Illinois; Robert F. W. Schroder, Agricultural Research Service, Beltsville, Maryland; H. S. Telford, Washington State University, Pullman, Washington.

F. C. Thompson asked about an amendment to the Bylaws to raise life membership dues, as proposed by Ivan Rainwater at the previous meeting. After a short discussion, the amendment was passed unanimously.

C. W. Sabrosky informed the audience that greater numbers of registrations for the XVth International Congress of Entomology are being received, and that those who register prior to February 1 will save $10.00 in fees.

Notes and Exhibitions: Ted Bissell displayed several attractive color photos of aphids that had been recently published in an agricultural journal.

The main speaker of the evening was Mr. Tom McIntyre, Program Manager for the Gypsy Moth Program of the USDA, who presented a thorough discussion of the current cooperation in evaluating and combating insect species that are damaging to forests in the United States. He emphasized that recent progress in the total effort has mainly resulted from increased manpower and accountability.

After introduction of visitors, the meeting was adjourned at 9:30. Tasty selections of pudding were served following the meeting.

GARY F. HEVEL, *Recording Secretary*

830th Regular Meeting—February 5, 1976

The 830th Regular Meeting of the Entomological Society of Washington was caller to order by President Steyskal on February 5, 1976, in the Lecture Room of the National Museum of Natural History. Twenty-nine members and 6 guests were present. Minutes of the previous meeting were read and approved.

Membership Chairman Kingsolver read for the first time the names of the following new applicants for membership: Loreen Chang, Animal and Plant Health Inspection Service, USDA, Hyattsville, Maryland; Bruce Harrison, North Carolina State University, Raleigh, North Carolina; Chris T. Maier, University of Illinois, Urbana, Illinois; Dave Ruiter, Rifle, Colorado.

President Steyskal presented invitations received from Eugene W. Skinner and Ted Gates for members of the Society to participate in judging local Science Fair Projects. After a few minutes of discussion, Lou Davis volunteered to offer his services for the worthy cause.

Vic Adler announced that the Insecticide Society was to have its 300th meeting on February 18th at the National Agricultural Library at Beltsville, Maryland.

Notes and Exhibitions: Bob Nelson brought greetings to Society members from Arthur Goedings at the University of Idaho and Maurice T. James of

Washington State University. Raymond A. St. George reported that Ted Bissell had suffered a recent stroke but was recuperating nicely. Lou Davis announced the death of Gordon T. Mickel. C. W. Sabrosky mentioned that he had received word that Mrs. A. L. Melander is in good health at the age of 98. A. B. Gurney noted that a question had arisen about which insect is referred to as the "palmetto bug," and, after obtaining opinions from members present, reported on results of an investigation made with the cooperation of T. J. Walker of the University of Florida. In Florida, one or more large cockroach species which are often encountered both indoors and outdoors (usually in scrub-land where the cabbage palmetto is a frequent source of concealment) are sometimes called the "palmetto bug." *Eurycotis floridana* (F. Walker) appears to receive the name most often, but several species of *Periplaneta* are also involved, and in southern peninsular Florida and the Keys *Blaberus craniifer* Burmeister may be included. Occasionally, the name has been applied to insects of other Orders. T. J. Spilman announced that Botha de Meillon has been awarded the Honorary Degree of Doctor of Medicine by the University of the Witwatersrand, Johannesburg, Republic of South Africa, in recognition of great distinction in the field of medical entomology and in particular for the benefits that have flowed from his achievements in combating insect-borne diseases.

The principal speaker for the evening was Mr. Ivan Rainwater of the Animal and Plant Health Inspection Service, USDA, who presented comments on the history of entomology and discussed the fascinating details and problems associated with the acquisition of 53 Bonsai trees from Japan. With the use of kodachrome slides, Mr. Rainwater explained the painstaking cautions undertaken to protect these trees that are valued at nearly four million dollars.

The meeting was adjourned at 9:30, after which punch and cookies were served.

GARY F. HEVEL, *Recording Secretary*

831st Regular Meeting—March 4, 1976

The 831st Regular Meeting of the Entomological Society of Washington was called to order by President Steyskal on March 4, 1976, in the Lecture Room of the National Museum of Natural History. Thirty-five members and 12 guests were present. Minutes of the previous meeting were read and approved with one correction.

President Steyskal announced that Helen Sollers-Riedel had requested volunteers for Hospitality Committee duties. A sheet of paper was then circulated at the meeting for signatures of volunteers.

Membership Chairman Kingsolver read for the first time the names of the following new applicants for membership: Steve Dennis, Environmental Protection Agency, Washington, D.C.; Riad Traboulsi, Lebanon; Thomas Michael Logger, St. Cloud State College, St. Cloud, Minnesota; Marlene Palmer, University of Michigan, Ann Arbor, Michigan.

Vic Adler announced that the Annual Banquet will be held June 2, 1976, at the CPO Club, Washington Navy Yard. The combined meeting of the Entomological Society of Washington and the Insecticide Society of Washington will include a social hour, door prizes and live entertainment. The announcement that two bartenders would be in attendance was met with enthusiasm by members of the Society.

Notes and Exhibitions: Raymond A. St. George reported that Ted Bissell continues to enjoy improving health and hopes to be back at meetings soon. President Steyskal reported that Doris Leonard, widow of Mortimer Leonard, had died in the past week. President Steyskal thanked Muriel Hoover for donating a cake for the refreshments of the evening, and noted, with a few added, historical anecdotes, that he had recently enjoyed a pleasant time at the 300th meeting of the Insecticide Society of Washington. C. W. Sabrosky humorously commented that in the second volume of Osborn's Fragments of Entomology, William Doyle Reed was mistakenly recorded as being born in 1797.

President Steyskal introduced the two principal speakers of the evening, Mr. Joseph E. Browne of Tulane University and Dr. Robert D. Gordon, Systematic Entomology Laboratory, USDA, with the information that the originally intended speaker was not able to attend the meeting, and that good fortune prevailed in locating such fine substitutes. Mr. Browne discussed his efforts in taxonomic and biological studies of biting midges, especially of the genus *Culicoides*, in Southwest Colombia. Mr. Browne discovered that use of insecticides was not effective for control of *Culicoides* in the study area, and that biological control through the use of myrmithid worms has had favorable results. Dr. Gordon presented an outline of collecting procedures necessary to obtain particular aphodiine scarab beetles that inhabit the burrows of certain rodents. Extensive digging is required, often with disappointing results.

After introduction of visitors, the meeting was adjourned at 9:15. Punch and cookies were served following the meeting.

GARY F. HEVEL, *Recording Secretary*

832nd Regular Meeting—April 1, 1976

The 832nd Regular Meeting of the Entomological Society of Washington was called to order by President Steyskal on April 1, 1976, in the Lecture Room of the National Museum of Natural History. Twenty-three members and 7 guests were present. Minutes of the previous meeting were read and approved.

President Steyskal announced that Fred Poos is recuperating, and then circulated a get-well card for signatures of friends.

Membership Chairman Kingsolver read for the first time the name of one new applicant for membership: Douglas E. Barnett, Animal and Plant Health Inspection Service, USDA, Hyattsville, Maryland.

Maynard Ramsey briefly reminded the audience of the approaching Annual Banquet, for which tickets would be availible in a few days.

C. W. Sabrosky announced that registration for the International Congress of Entomology was progressing well, with 1500 total applications, 500 of which were foreign.

President Steyskal mentioned a letter that he had received from Monte Lloyd of the University of Chicago, requesting recognition of the preservation of Osa Peninsula National Park, a rain forest area in Costa Rica. President Steyskal then read in Spanish a letter of congratulations that he had sent to President Oduber, with copies to 5 newspapers. Al Stone noted that an article on the rain forest appeared in the current issue of *Living Wilderness*.

Notes and Exhibitions: W. W. Wirth displayed an article from a 1780 issue of a Dutch journal concerning the life histories of segmented worms, and commented that the detailed artwork was excellent enough to allow probable generic determination. C. W. Sabrosky announced the death on February 28 of C. P. Clausen in Oklahoma. G. A. Foster recounted a humorous incident that occurred many years ago while C. P. Clausen was his boss. T. J. Spilman displayed and discussed a recent book by Ebeling entitled *Urban Entomology*. The volume was described as comprehensive and timely.

President Steyskal introduced the principal speaker of the evening, Dr. Galen Dively of the University of Maryland, who discussed the current procedures utilized in the developing management of insect pest species. Dr. Dively explained the statistical methods that allow prediction of pest outbreaks, mostly by use of raw data obtained from counts of specimens collected in blacklight traps. He also detailed progress made in biological control of the Mexican Bean Beetle by a eulophid parasite.

After introduction of visitors, the meeting was adjourned at 9:30. Punch and cookies were served following the meeting.

GARY F. HEVEL, *Recording Secretary*

PRELIMINARY ANNOUNCEMENT

BELTSVILLE SYMPOSIUM II: BIOSYSTEMATICS IN AGRICULTURE

BELTSVILLE AGRICULTURAL RESEARCH CENTER

BELTSVILLE, MARYLAND

May 8–11, 1977

In five symposium sessions leading investigators will lecture or engage in panel discussions on the role that biosystematics has in agriculture. Main topics will include new techniques, taxonomic theories, uses of taxonomic and biosystematic data, especially predictive applications, and the planning and direction of biosystematic research. In addition, a poster session is scheduled for the evening of May 9.

For further information, send your name and address to:

Dr. James A. Duke
Publicity Chairman, BARC Symposium II
Plant Taxonomy Laboratory
Room 117, Bldg. 001, BARC West, USDA
Beltsville, Maryland 20705 U.S.A.

OBITUARY

ALEKSANDR ALEKSANDROVITCH STACKELBERG
1897–1975

A. A. Stackelberg (center) in a light moment with friends E. P. Nartshuk (left) and G. J. Bey-Bienko (right) on a street in Leningrad, May, 1971. Photo by C. W. Sabrosky.

With great regret the passing of A. A. Stackelberg on 23 November 1975 is announced. Stackelberg, one of the most distinguished Soviet zoologists, was born in St. Petersburg (now Leningrad) on 22 April 1897. He began the study of entomology early, specializing on flies. His first scientific paper was published in 1914. Entomology in Russia was then in its infancy and the fly fauna was almost unknown. The greatest native dipterist of the preceding generation, C. R. Osten Sacken, forsook his homeland for America and his compatriots, Portschinsky and Pleske, while producing fine studies and descriptions of various flies, never produced monographs such as those of their European contemporaries, Loew, Rondani, and Schiner. Stackelberg filled this void, so that today many of the finest manuals on Diptera are his work or that of his students. His first concise key to Diptera appeared in 1926, followed by long sections on Diptera in *Insect Keys of the European Part of the USSR* (1928, 1931, 1948, 1970). He also monographed an essential group as the mosquitoes for the Fauna of the USSR (1937 & 1967, in part), a series he helped initate. While the writings of Stackelberg run into the hundreds, including more than 160 scientific papers, and undoubtedly had considerable influence, it was through the various positions

Stackelberg held that he was able to shape the nature and scope of Systematic Entomology in the USSR. In 1920 Stackelberg joined the staff of the Zoological Museum of the Academy of Sciences; in 1927 he became a senior scientific officer; in 1929 he was made the Director of the Diptera Division; and from 1942 he was the Head of the Department of Entomology. During his last years he was the Honorary President of the All-Union Entomological Society. In addition Stackelberg taught numerous students who have extended his influence further. I. A. Rubtsov, B. B. Rohdendorf, Ye. N. Savchenko, and N. A. Violovitch are a few of these students.

Stackelberg was always generous, and many people throughout the world called him a friend. The senior author of this note specializes in Syrphidae, a favorite family of Stackelberg's, and corresponded with him in the past few years on that group. The junior author was privileged to meet him at the Congresses of Entomology in London (1964) and Moscow (1968) and to visit him and the Diptera Section of the Zoological Institute at Leningrad in 1971. He was a generous, kindly, friendly, gentle man, a gentleman with the courtesy of an older generation, a valued counselor, and a respected leader in Russian entomology and taxonomy.

The honors and tributes given to Stackelberg are too numerous to mention and are an insufficient measure of his stature. Only in our remembrances of him in his work as well as that of his students is there a true measure of the man. That measure is without question one of greatness and will be missed.

F. Christian Thompson and Curtis W. Sabrosky, *Systematic Entomology Laboratory, IIBIII, Agr. Res. Serv., USDA, c/o U.S. National Museum, Washington, D.C. 20560.*

NEW MEMOIR

ANT LARVAE: REVIEW AND SYNTHESIS

George C. Wheeler and Jeanette Wheeler
Laboratory of Desert Biology, Desert Research Institute
University of Nevada System
Reno, Nevada

"An exhaustive monographic study of ant-larvae would certainly repay the investigator, as they present a bewildering array of interesting characters in the various tubercles, 'poils d'accrochage,' etc., with which they are provided."—W. M. Wheeler 1903:209.

The Entomological Society of Washington is pleased to be able to present G. C. Wheeler's and J. Wheeler's response to W. M. Wheeler. The authors are well known for their many fine publications on the taxonomy and morphology of ant larvae. Their work has appeared in 53 papers scattered throughout 12 journals over a period of 45 years. In this summing-up, the results of study of 692 species in 182 genera of ants are presented. Keys to subfamilies, tribes, and genera are included, with many illustrations. Bionomic information is included in addition to taxonomic and morphological data.

108 pp., paper covers, $11.00. Please order from the Custodian, Entomological Society of Washington, c/o Department of Entomology, Smithsonian Institution, Washington, D.C. 20560.

BOOK REVIEW

Mites of Moths and Butterflies. Asher E. Treat. 1975. Cornell University Press, Ithaca, New York, 362 pp., 150 figs. Price $35.00 (20% discount on prepaid individual orders).

This book is one of those rare contributions which is not only full of much valuable information but is also a delight to read. Dr. Treat, Research Associate, American Museum of Natural History, and Professor Emeritus, City University of New York, has spent the past twenty years studying the systematics and host relationships of mites associated with moths and butterflies and has presented his findings in this excellently written book. He explores a relatively unknown field, although his first reference is dated 1754. His principal interest is mites associated with the tympanal organs of noctuid moths; nevertheless he presents discussions of all forms of parasitic, transient, and stowaway mites. His observations relative to the behavior of mites will be considered classical studies. In addition to Treat's own observations, biological information on all lepidopterous mites is summarized.

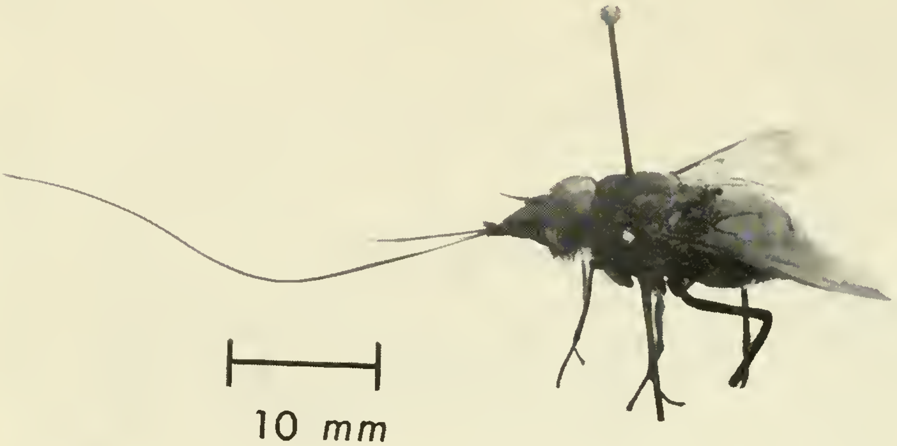
The book is divided into sections on history, equipment and methods, mites in general, and the systematics and biology of the mites found associated with Lepidoptera. Keys are given for the separation of mites as they appear in life on their hosts, and for specimens mounted on slides. The book is completely cross indexed.

Although his book is primarily for lepidopterists, it should be of interest to the general entomologist and to acarologists who wish to learn something about these fascinating mites. Studies in mite-insect relationships appear to be infinite, at least for the time being.

Edward W. Baker, *Systematic Entomology Laboratory, IIBIII, Agr. Res. Serv. USDA, Beltsville, Md. 20705*

UNUSUAL PROBOSCIS ON A NEW WORLD HORSE FLY (DIPTERA: TABANIDAE)

The longest known proboscis for a New World tabanid occurs in a female *Fidena* species (fig. 1) which was swept from low vegetation on 7 August 1970, 5.6 Km SW of Rincon de Osa, Puntarenas Province, Costa Rica. The proboscis is twice as long as any previously reported but less than that typical of the Oriental species, *Philoliche longirostris* (Hardwicke) (fig. 2). Tetley (1918, Bull. Entomol. Res. 8:253) reviewed the feeding behavior of tabanids with extended mouth parts and concluded that the long labium of the latter species was bent



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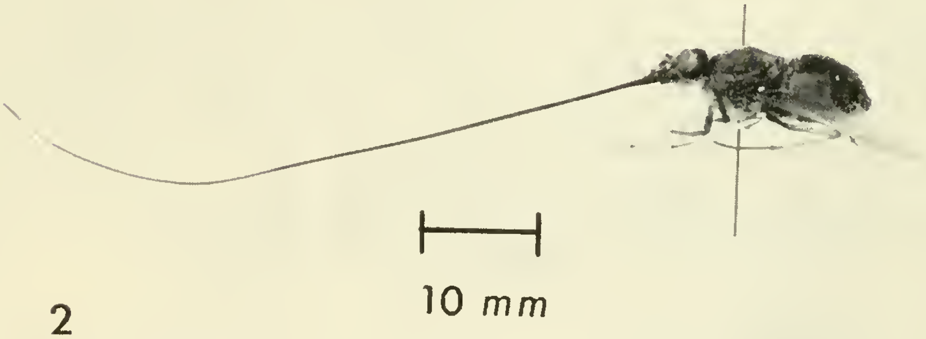

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aside during biting to permit penetration of the shorter, less flexible stylets. The blood was then sucked up through the proboscis. Speculation that such mouth parts evolved to assist nectar feeding from flowers with deep corollas is unsupported, both by the lack of observed pollen on the mouth parts and adjoining vestiture and by the unequal development in the two sexes. So far is known, the females of both *Philoliche* and *Fidena* in the eastern and western hemispheres take vertebrate blood for ovarian development.

Richard W. Merritt, *Department of Entomology, Michigan State University, East Lansing, Michigan 48824 and* Cornelius B. Philip, *California Academy of Sciences, Golden Gate Park, San Francisco, California 94118.*

PUBLICATIONS FOR SALE BY THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

Miscellaneous Publications

Cynipid Galls of the Eastern United States, by Lewis H. Weld	$ 5.00
Cynipid Galls of the Southwest, by Lewis H. Weld	3.00
Both papers on cynipid galls	6.00
Identification of Alaskan Black Fly Larvae, by Kathryn M. Sommerman	.25
Unusual Scalp Dermatitis in Humans Caused by the Mite *Dermatophagoides*, by Jay R. Traver	.25
A Short History of the Entomological Society of Washington, by Ashley B. Gurney	.50

Memoirs of the Entomological Society of Washington

No. 1.	The North American Bees of the Genus *Osmia*, by Grace Sandhouse. 1939	$15.00
No. 2.	A Classification of Larvae and Adults of the Genus *Phyllophaga*, by Adam G. Boving. 1942	15.00
No. 3.	The Nearctic Leafhoppers, a Generic Classification and Check List, by Paul Wilson Oman. 1949	15.00
No. 4.	A Manual of the Chiggers, by G. W. Wharton and H. S. Fuller. 1952	15.00
No. 5.	A Classification of the Siphonaptera of South America, by Phyllis T. Johnson. 1957	15.00
No. 6.	The Female Tabanidae of Japan, Korea and Manchuria, by Wallace P. Murdoch and Hirosi Takahasi. 1969	15.00
No. 7.	Ant Larvae: Review and Synthesis, by George C. Wheeler and Jeanette Wheeler. 1976	11.00

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