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THE
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MEETINGS.—Regular meetings of the Society are held in Room 43, 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*.

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STATEMENT OF OWNERSHIP

MORPHOLOGICAL AND BEHAVIORAL POLYMORPHISM IN PLASTOSCIARA PERNICIOSA (DIPTERA: SCIARIDAE)[1]

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ABSTRACT—The two widely divergent morphotypes of both adult males and adult females of *Plastosciara perniciosa* Edwards are described and figured. All external morphological features except the genitalia of the micropterous morphotype are greatly reduced or absent. The behavior of the larvae, pupae and adults of the micropterous morphotype is significantly different and apparently enables this form to take maximum advantage of a stable larval habitat. The capability for migration from deteriorating habitats, dispersal, and maintenance of gene flow are retained in the macropterous morphotype. The determination of which of the two developmental pathways is selected is apparently based on an environmental switch mechanism.

Polymorphism occurs very frequently among insects and ranges from the many morphs with marked external dissimilarities found in some species of Aphididae to chromosomal polymorphism in *Drosophila* with little or no external differences. Richards (1961) lists a number of examples in 16 orders of insects. For Diptera he includes color polymorphism in Syrphidae (*Volucella, Merodon, Criorhina*), brachyptery in Sphaeroceridae, allometric variation in horn-like projections in Phytalmiidae (*Laglaisia*) and Drosophilidae (*Zygothrica*); physogastry in adult females of a number of species in the Phoridae, Streblidae, and Carnidae and chromosomal polymorphism in Drosophilidae.

Wing reduction, not necessarily associated with polymorphism, is commonly found in most other orders and has evolved independently in many different families of Diptera. Many papers, too numerous to mention here, have been published on wing reduction or loss in many different taxa. Hackman (1964) published a survey of the environments in which short-winged or wingless Diptera have been found and

discusses ecological and evolutionary implications. He states that wing reduction is known from more than 20 families of Diptera. Brues, Melander and Carpenter (1954) list 29 families with reduced or absent wings.

Wing reduction or loss of wings in most Diptera is restricted to one sex, usually the female. This is commonly the case in Sciaridae. In *Pnyxia scabiei* (Hopkins), the males are fully winged to brachypterous with a continuous variation in wing size, while the female is always wingless (Gui, 1933). In *Plastosciara brachyptera* Kieffer and *Caenosciara alnicola* Tuomikoski, the male is fully winged but the female may be either macropterous or brachypterous (Tuomikoski, 1957).

According to Hackman (1964) dimorphism or polymorphism of wings in both sexes is very rare in natural populations of Diptera. Brauns (1938) reported fully winged and brachypterous individuals of both sexes of *Conioscinella brachyptera* (Zetterstedt) (Chloropidae) from one sample in a dune area in Germany. Alexander (1959) reported macropterous, stenopterous and micropterous forms of both sexes of *Dicranota reducta tehamicola* Alexander (Tipulidae) from Mt. Lassen, California. Other examples are mentioned in Hackman (1964). In many cases of wing reduction, there are no or only slight changes in other morphological features. Usually the legs remain functional. Richards (1951) states that loss of wings can lead to consequential changes in other parts of the body until ultimately all characters normally of generic importance in the family are affected. However, in his studies of wing polymorphism in Sphaeroceridae, he finds that legs show no marked changes, other than some reduction in their bristles. In this respect, *Plastosciara perniciosa* Edwards is unsual in that all adult characters except the genitalia are greatly modified in heteromorphs of both sexes.

Venturi (1964) revised the European genera of Sciaridae with brachypterous, subapterous and apterous species. He treated 16 genera and classified them into 3 groups based on the number of segments of the maxillary palpus. This is somewhat artificial since many species, including *P. perniciosa*, show fusion of palpal segments within the same species. In his classification he lists 5 species in which the male is fully winged and female with reduced wings, 8 species with the male fully winged and the female apterous, 5 species with the female fully winged and the male with reduced wings, 10 species in which the female has reduced wings but the male is unknown, and 7 species in which the female is apterous and the male unknown.

Mohrig (1967, 1969, 1970a, 1970b), Mohrig, et al. (1968) and Mohrig and Mamaev (1970a, 1970b) review and discuss most of the northern European brachypterous, micropterous and apterous Sciaridae and describe several new Sciaridae with reduced wings. Mohrig

(1967) gives an extensive review of the ecology and distribution of the brachypterous Diptera, including Sciaridae, of the northern German biotopes. Neither Venturi nor Mohrig cite any examples of both sexes having fully winged and reduced winged forms.

The discovery of micropterous morphotypes of *Plastosciara perniciosa* Edwards in laboratory cultures in our Hawaiian Sciaridae studies was therefore highly significant, especially since this was assumed to be a normally winged species (Steffan, 1973c, 1973d). The ease of maintaining cultures, the presence of giant salivary gland chromosomes and its apparent economic importance make *P. perniciosa* an ideal subject for in-depth studies of polymorphism and its evolutionary and economic implications.

MATERIALS AND METHODS

Laboratory cultures of *P. perniciosa* were started from single gravid macropterous females collected inside the Bishop Museum, Honolulu. The colonies were reared in glass shell vials (25 × 95 mm) and glass petri dishes (16 × 25 mm) containing an agar substrate. The rearing method was nearly the same as that described by Steffan (1973a), differing only in the type of rearing container used for the micropterous morphotypes and method of transferring eggs or adults to new culture plates. Petri dish culture plates were used since it was easier to transfer the emerged adults. The micropterous morphotypes pupated and adults remained in the pupal chambers beneath the agar surface. Transfers to new culture plates were made by cutting out an agar plug containing a pupal chamber in which eggs were noted. Attempts to extract gravid females or eggs from the pupal chambers usually resulted in the death of the females before oviposition or failure of eggs to hatch. Also, there was a very high egg mortality if the pupal chambers were opened prior to hatching. An aseptic rearing technique such as described by Kennedy (1971) would probably reduce much of the mortality of the eggs and adults.

Terminology for types of wing reduction is used in the sense of Hackman (1964). "Macropterous," used for the fully winged adult, was not applied by Hackman. Measurements are given in millimeters and were made with a Wild M20 microscope using a 10× measuring eyepiece.

MORPHOLOGICAL POLYMORPHISM

Four distinct morphotypes of *P. perniciosa* exist and were commonly found in our laboratory cultures: macropterous males, macropterous females, micropterous males and micropterous females. Some intermediate forms were occasionally found, but these were rare. The intermediate forms were either macropterous morphotypes with only the wings reduced to either a brachypterous or stenopterous condition or micropterous morphotypes with legs intermediate in size between the macropterous and micropterous morphotypes. The intermediate-sized legs of these exceptional micropterous morphotypes were apparently functional.
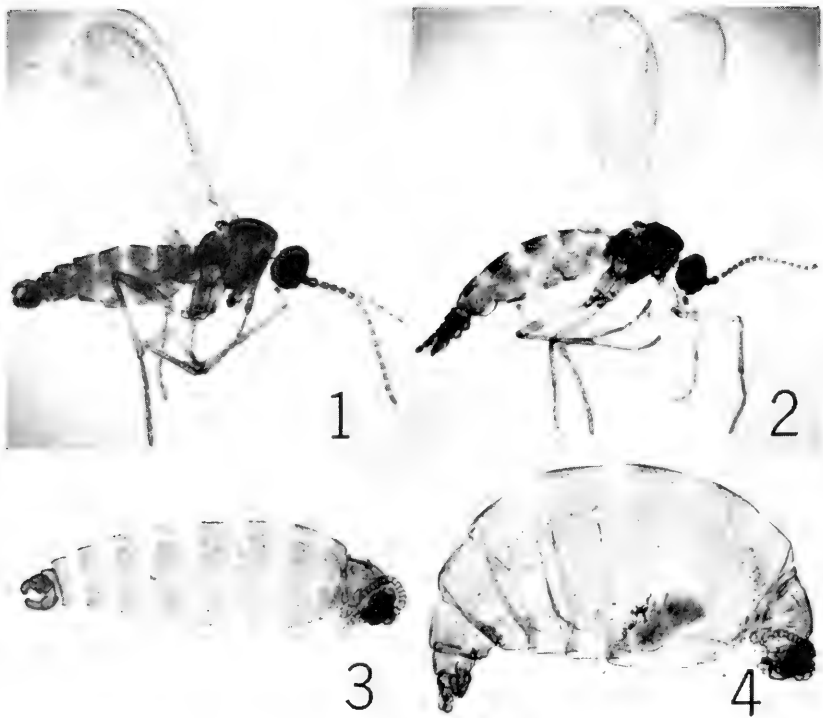
Fig. 1–4. Adult *P. perniciosa*. 1, male macropterous morphotype. 2, female macropterous morphotype. 3, male micropterous morphotype. 4, female micropterous morphotype.

The macropterous male (Fig. 1) has been described by Edwards (1922) and Hardy (1956, as *Plastosciara brevicalcarata*, synonymized by Steffan, 1973b). Other than its reduced, 2-segmented maxillary palpi and small size, it resembles most Sciaridae in basic form. The macropterous female (Fig. 2) is similar except for sexual differences, i.e., shorter flagellomere necks and generally longer wings. The specimens measured for Table 1 were somewhat abnormal in that the mean wing length of the females was shorter than that of the males. These specimens were reared in the laboratory. Wild females usually have longer wings.

The micropterous male and female morphotypes are so different from the macropterous morphotypes that they would be placed in different genera using any existing key. Even the family placement would be different using Brues, Melander and Carpenter (1954) or Borror and Delong (1970), where the micropterous morphotypes would key out to Mycetophilidae.

Essentially all external morphological features except the genitalia

of the micropterous morphotypes are greatly reduced or absent. In addition to the differences listed in Tables 1 and 2, setation on all parts of the body except the genitalia in the micropters is greatly reduced or absent. All structures on the head are reduced, especially the antennae, compound eyes, ocelli and proboscis. The flagellomeres are shortened and the flagellomere necks, very well developed in the macropterous morphotypes, are absent. Flagellomere 4 is reduced in length (including the neck) by about $\frac{1}{2}$ in the male and by slightly less than $\frac{1}{2}$ in the female; however, the width is increased slightly in both sexes. Flagellomeres 1 and 2 are frequently fused. Both micropterous morphotypes show a slight extension of the compound eyes above the antennae, but the eyes are reduced and widely separated ventrally. The ocelli are reduced by about $\frac{1}{2}$. The maxillary palpi are usually 1-segmented but may have a small lobe fused to segment 1 where the 2nd segment would normally be. Some of the macropterous morphotypes occasionally show some fusion of segment 2 to the 1st. The proboscis is about $\frac{1}{2}$ that of the macropterous morphotype.

The thorax of the micropterous morphotype is reduced to the point where discrete sclerites are no longer discernable. The scutellum is either absent or reduced to the extent that it is no longer distinguishable. The metanotum, which in the macropterous morphotypes is triangular and extends into the abdomen, is truncate and does not extend into the abdomen. The wings are reduced to short flaps about $\frac{1}{10}$ the length of those of the macropterous morphotypes. None of the wing veins are developed and the wing is obviously not functional. The halters are reduced to about $\frac{1}{3}$ the length of the normal halteres. They are also different in structure. Those of the macropterous morphotype have the typical stem and knob while those of the micropterous morphotypes have been reduced to a narrow flap. The legs are also reduced and non-functional. They are about $\frac{1}{5}$ the length of those of the macropterous morphotypes. The various segments are frequently deformed and tarsomeres are usually partially fused. The tarsal claws are also greatly reduced.

The abdomen of the female micropterous morphotype is basically sac-like and greatly enlarged with no discernable sclerites. The genitalia are the only structures similar in both morphotypes and they differ somewhat in size. In contrast to the relative reduction of other external thoracic and cephalic structures, the genitalia of the micropterous morphotype are slightly larger than those of the macropterous morphotype.

Behavioral Polymorphism

The behavioral differences of the larvae and adults of the micropterous and macropterous morphotypes are as distinct as their morphol-

Table 1. Morphological differences between macropterous and micropterous morphotypes of *Plastosciara perniciosa*.

Morphological Structure	Male				Female			
	Macropterous		Micropterous		Macropterous		Micropterous	
	Range	x̄	Range	x̄	Range	x̄	Range	x̄
Flagellomere 4								
Length	0.030–0.038	0.031	0.019–0.021	0.020	0.024–0.030	0.027	0.015–0.024	0.019
Width	0.025–0.027	0.026	0.035–0.038	0.036	0.026–0.030	0.028	0.025–0.039	0.035
Neck	0.010–0.015	0.013	0	0	0.006–0.007	0.006	0	0
Hairs	0.030–0.033	0.031	0.009–0.015	0.012	0.024–0.030	0.027	0.004–0.018	0.010
Wing								
Length	1.04–1.19	1.13	0.12–0.14	0.13	1.06–1.22	1.12	0.12–0.18	0.15
Width	0.42–0.46	0.45	0.05–0.06	0.05	0.40–0.45	0.42	0.05–0.07	0.06
Haltere								
Length	0.22–0.34	0.27	0.07–0.08	0.08	0.22–0.28	0.24	0.06–0.09	0.07
Foreleg								
Femur	0.21–0.27	0.25	0.05–0.06	0.06	0.26–0.30	0.28	0.05–0.09	0.07
Tibia	0.26–0.33	0.30	0.07–0.09	0.08	0.29–0.34	0.30	0.05–0.12	0.09
Female Genitalia								
Cercus II					0.047–0.050	0.048	0.043–0.046	0.044
Stem of vaginal furca					0.060–0.068	0.063	0.068–0.091	0.076
Male Genitalia								
Length of distimere	0.56–0.060	0.058	0.066–0.069	0.067				

Table 2.   Morphological differences between macropterous and micropterous male morphotypes of *Plastosciara perniciosa*.

Morphological Structure	Macropterous	Micropterous
HEAD		
Compound eye		
eyebridge	1–2 facets wide	absent
interfacetal hairs	moderately abundant	sparse
Ocelli	well formed	reduced in size
Antenna		
flagellomere 4		
length/width	1.1–1.4	0.2–0.4
neck/length	0.4–0.5	0
hairs/width	1.0–1.2	0.2–0.4
Maxillary palpus	2 segments	1 segment
THORAX		
Pleural sclerites	normal	fused
Scutellum	normal	absent
Metanotum	extends into abdomen	reduced
Wing	normal	micropterous
Haltere	normal	reduced to flap
Legs	normal	reduced, tarsomeres fused
ABDOMEN		
Terga	sclerotized	membranous
Sterna	sclerotized	membranous

ogy. The behavior of the various stages of the macropterous morphotypes is similar to that of *Bradysia sexdentata* (Pettey) as described by Steffan (1966).

The female macropterous morphotype oviposits on the surface of the substrate and eggs are generally laid singly or occasionally in batches. The female micropterous morphotype oviposits within the pupal chamber and eggs are laid in a batch. The larval macropterous morphotype generally feeds and remains on the surface of the substrate or feeds between the surface of the agar and any organic debris which may be present. The larval micropterous morphotype burrows, feeds, and generally remains under the surface of the substrate.

The late 4th-instar larvae of the macropterous morphotype usually construct individual pupal cases on the surface of the substrate. However, the late 4th-instar larvae of the micropterous morphotype construct pupal cases below the surface and each contains 2 to 5 individuals. All pupae are generally oriented in the same direction within each chamber. Also, each pupal case will contain at least

cne individual of each sex and will usually contain more females than
males.

Pupae of the macropterous morphotype force their way out of the
pupal cases before the adults emerge. Males generally emerge before
females and mating takes place as described by Steffan (1966). Males
approach females with a scissoring of the wings before attempting
to copulate. After coupling, the male turns around facing the opposite
direction. Pupae of the micropterous morphotype remain in the pupal
cases and the adults emerge within these cases. Mating also takes
place within the pupal cases, with very little courtship behavior.
Males removed from pupal cases and placed near female microp-
terous morphotypes move towards the female by strenuous movement
of the abdomen using their distimeres to grasp objects. The adult
micropterous morphotypes remain and die within the pupal cases.
The 1st-instar larvae feed on the bodies of their parents before
leaving the chambers.

Distribution, Biology and Ecology

Plastosciara perniciosa is probably a cosmopolitan species spread
throughout the world by man. It was originally described by Edwards
(1922) from a series of specimens reared from larvae feeding on
cucumber roots and stems in England. It is considered a common
greenhouse pest in that country. *Plastosciara perniciosa* was subse-
quently recorded from Samoa (Edwards, 1928) where it was reared
from rotting grass, Fiji (Edwards, 1928), the Philippines (Edwards,
1929), and the Marquesas Islands (Edwards, 1933). Hardy (1956)
recorded it from the Hawaiian Islands (as *P. brevicalcarata*).

I have reared *P. perniciosa* from rotting wood and frequently col-
lected it inside buildings. I have also collected a single male microp-
terous morphotype on the surface of a dead branch of *Coprosoma*
covered by a dense layer of moss in a bog at the top of Mt. Kaala,
Oahu I., 1219 m. Normally the micropterous morphotypes would be
difficult to find in nature.

In Hackman's (1964) ecological classification of short-winged or
apterous Diptera, *P. perniciosa* would be placed in his group g
"Diptera in various terricolous and hypogeous habitats." *Plastosciara
perniciosa*, as mentioned above, breeds in decayed wood, is found in
the soil where it usually feeds saprophagously, but can feed phytoph-
agously and undoubtedly is also mycetophagous. It should probably
be classified as primarily saprophagous and facultatively phytophagous.

Plastosciara perniciosa is very easy to rear in the laboratory on the
standard sciarid rearing medium (Steffan, 1973a). One colony was
reared in our laboratory for 28 generations. The mean development
time for eggs, larvae and pupae at $20°C \pm 2°$ was 27.3 days (Steffan,
1973c).

Every female macropterous morphotype, collected and subsequently producing progeny in the laboratory, has produced micropterous morphotypes. When adults from a single pupal case are placed in a fresh culture plate or vial every generation, only micropterous morphotypes are produced. When several generations are retained in a single plate or vial, macropterous morphotypes are produced. This species is digenic, i.e., progeny from one female include more or less equal numbers of males and females. This is in contrast to the other type of reproduction commonly found in Sciaridae called "monogenic," where progeny from one female are either all males or all females.

The only *Plastosciara* that has been investigated genetically is *P. pectiventris* Edwards (Fahmy, 1949) which has 4 pairs of chromosomes (3 submedicentric and 1 subterminocentric) and 1 to 4 (usually 2) limited chromosomes. The general features of the 2 meiotic divisions of spermatogenesis are similar to those of other sciarids investigated; however, there are some differences which suggest a more primitive condition. The most important difference is temporary pairing early in the first meiotic prophase, but apparently with no chiasmata being formed. Fahmy (1949) suggests that the *Plastosciara* meiotic mechanism fits between the mycetophilid chiasma-lacking type and the sciarid type.

Discussion

Several mechanisms may be involved in determination of polymorphism in various insects. Wigglesworth (1961) suggests that all characters are of genetic origin and the two types of polymorphism proposed by many authors, environmental and genetic, differ only in the degree to which the "genes" in question are subject to the environment, whether humoral or external.

As stated by Lees (1961), the differentiation of the polymorphic organism involves the selection of one developmental pathway from several potential routes. In *P. perniciosa* there seem to be only 2 potential developmental routes. In Lees' studies (1961, 1966) of clonal polymorphism in aphids, he concluded that although the nuclear genes participate in the realization of polymorphic characters, genetic mechanisms are not known to play any part in controlling the choice of alternatives. He believes this role is usually assumed by the environment directly or in some cases by long-range environmentally set intrinsic timing mechanisms. In *P. perniciosa* it seems apparent that the environment also controls the choice of which of the two developmental pathways will be followed.

The type of polymorphism encountered in *P. perniciosa* is strictly alternative, micropterous or macropterous, and these, as in aphids, probably result from the operation of switch mechanisms which direct morphogenesis along one or the other of the two alternate paths.

Many authors, including Wigglesworth (1961, 1966, 1970), Lees (1961), Noirot (1969), and Madhavan (1973), believe that the various controlling mechanisms, extrinsic or intrinsic, act eventually on the endocrine system of the differentiating individual. Southwood (1961) reviews the information available on alary polymorphism in the Heteroptera in respect to the theory of some kind of hormonal control. He agrees with other authors that short-wingedness is a juvenile character and is brought about by excessive influence of the juvenile hormone leading to juvenile characters in the adult, a condition he calls metathetely. This may be the case in *P. perniciosa*, but extensive experimental studies need to be done before the immediate (physiological) mechanism of determination of these polymorphic forms can be given.

In some insects, the determination of wing polymorphism is due to genetic segregation (Brinkhurst, 1959; Bowden, 1963; Tazima, 1964). In some species of *Gerris* (Heteroptera) a combination of genetic and environmental control is involved in determination of wing polymorphism (Brinkhurst, 1959). The dominant homozygote is lethal or semilethal. The heterozygote is short-winged but has been eliminated in most species. The recessive homozygote should be long-winged but this genotype is polymorphic and is subject to an environmental switch mechanism. Wing polymorphism in *P. perniciosa* does not appear to be due to genetic segregation.

Based on the laboratory studies, it seems probable that under optimal conditions the micropterous morphotype is the form usually produced in the field and that the macropterous morphotype is produced when the microhabitat becomes unfavorable. The particular environmental switch mechanism operating in this system could be crowding, nutritional deficiencies, or low moisture content. Probably this mechanism operates on the 1st- or 2nd-larval instars (Fig. 5). It seems unlikely that it operates at the adult level since adults that have already oviposited when transferred from crowded colonies to fresh agar plates continue to produce micropterous morphotypes. Adults transferred to fresh agar plates prior to oviposition also produce micropterous morphotypes. If the environmental switch mechanism operates at the adult level, one would expect these F_1 progeny to be macropterous. The effect of pupal transfer to fresh plates has not yet been investigated.

The ecological and evolutionary significance of the unusual degree of polymorphism in *P. perniciosa* is that it enables this species to take advantage of a favorable microhabitat without exposing the adult to the dangers of predation, inability to find a food source or inability to find a mate. All these dangers are greatly reduced by the behavior of the micropterous morphotype. If environmental conditions reach a threshold where the microhabitat is no longer favorable, the macrop-
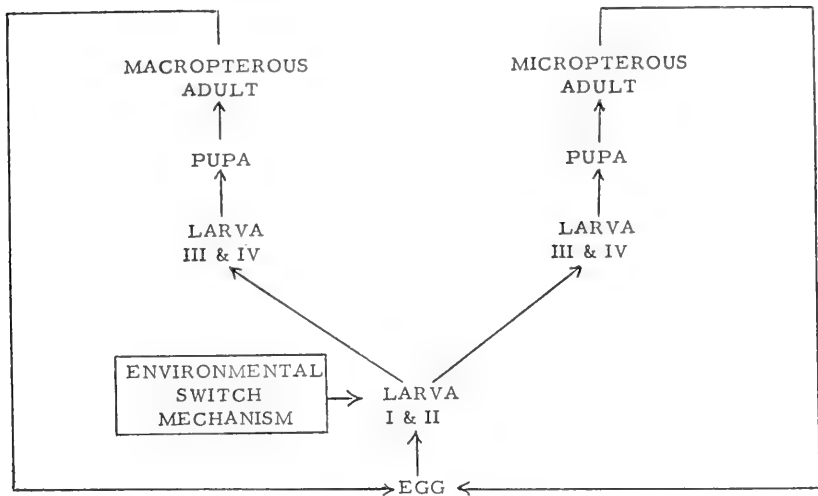
Fig. 5. Developmental pathways in *P. perniciosa*.

terous morphotype is produced and the individuals can seek other favorable habitats. In this respect, the response is similar to that found in some Heteroptera where the production of the fully winged morphotype is probably a facultative response to environmental conditions (Southwood, 1962). The macropterous morphotype makes gene flow and dispersal possible. Conceivably, if a micropterous population occurred in a permanently favorable habitat, isolation, and subsequent speciation, could occur in a very small area.

In addition to the advantages of remaining in a favorable microhabitat and protection of the adult, the micropterous morphotype can divert some of the energies and space used for locomotion to egg production and storage. Eggs are found in the thoracic area of the female micropterous morphotype. The eggs, being deposited in the protected pupal case, are also protected from predators and adverse environmental conditions. In many respects this little fly seems to have found an ideal mode of life to take maximum advantage of favorable environmental conditions without sacrificing capacity for dispersal and for migration from deteriorating habitats.

Our knowledge of the genetic background of wing reduction in Diptera is based almost entirely on the studies of *Drosophila*. Sciaridae, like Drosophilidae, have giant salivary gland chromosomes and are known to be excellent organisms for genetic studies. A thorough genetic study of *P. perniciosa* should elucidate some of the evolutionary implications of wing reduction and polymorphism.

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BOOK REVIEW

Trichoptera (Köcherfliegen). Hans Malicky. 1973. Handbuch der Zoologie,
    Band IV, Hälfte 2, Teil 2/29, 114 pages, 96 figures. Walter de Gruyter &
    Co., Genthiner Strasse 13, 1000 Berlin 30, Germany. DM 130.

In this thin volume the author attempts to present, in German, an overview of
our knowledge of the insectan order Trichoptera. Within the limited space
available for such a sizeable undertaking, he has succeeded, on the whole, very
well. He treats all stages, with considerable emphasis on the larvae and pupae,
in a well organized and illustrated manner.

He has short chapters on (freely translated): Research History, Recognition,
Paleontology and Evolution, Distribution, Economic Importance, Physiology,
Reproduction and Development, and Index of Scientific Names Mentioned. The
longer chapters deal with Systematics, Ecology, Morphology, and Ethology.

He recognizes 37 families, following the latest classification by H. H. Ross.
For each family and subfamily he gives a few characters of the adults and, if
known, the larvae. Unfortunately these characters are generally not enough to
permit certain identification to family, nor is there a key to families. Certain
typical genera are mentioned in each category and the overall distribution is
given. There are a number of subfamilies and family-subfamily changes in status
that have been proposed over the years that are not mentioned.

In the chapter on Ecology he discusses the types of habitats, rhythms, and
parasites and predators. Although this chapter is devoted primarily to the larval
stage, there are discussions of adult flight periods, pupal respiratory movements,
etc. The chapter on Ethology is wholly devoted to the marvelous larval nets
and cases for which this order is noted. The long chapter on Morphology treats
in detail the head, thorax, and abdomen with their appendages in the larval,
pupal, and adult stages. Also discussed are the respiratory organs, nervous system,
sense organs, digestive tract, glands, internal reproductive system, and cytology.

The literature cited list contains about 450 citations, through the end of 1970,
with a preponderance of recent references which gives the reader easy access
to the total literature.

All in all, this is a most valuable reference not only to the Trichopterist who
wishes information on all parts of his field, but especially to the general worker
who wants in one compact source information on all aspects of this most in-
teresting order.

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HORSE FLIES OF ARIZONA IV. NOTES ON AND KEYS TO THE ADULT TABANIDAE OF ARIZONA, SUBFAMILY TABANINAE, GENUS TABANUS (DIPTERA)

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ABSTRACT—A key and short descriptions are given for the 16 species of *Tabanus* presently known to occur in Arizona, with notes on distribution and adult activity. A pallid form of *Tabanus subsimilis*, *T. subsimilis* var. *nippontucki*, is reduced to a variety due to lack of definitive evidence for subspecific differentiation. Five species are added to the list of Tabanidae found to occur in Arizona since publication of the North American Diptera catalog in 1965, *Stenotabanus guttatulus*, *Hybomitra opaca*, *Tabanus caenosus*, *T. mogollon*, and *T. pruinosus*. Three species are deleted from the list of Tabanidae occurring in Arizona, *Chrysops brunneus* and *Chlorotabanus crepuscularis*, old erroneous records, and *Tabanus monilus*, a synonym of *T. dorsifer*.

Genus *Tabanus* Linnaeus

Tabanus Linnaeus, Syst. Nat. 1758:601.

There are 16 species of *Tabanus* presently known from Arizona. They vary from ubiquitous (*T. punctifer* Osten Sacken) to extremely precinctive (*T. dietrichi* Pechuman). This genus often is separated from others by negative characters, but the combination of size (greater than 12 mm), unmarked wings, bare to densely pilose eyes, absence of ocellar tubercle and stump vein from R_4 of wing, and basal callosity (except in *T. dietrichi*) nearly as wide as frons will serve to separate this genus from others in Arizona. A few species such as *T. punctifer* and *T. subsimilis* Bellardi may be abundant enough to be pests of livestock and wildlife but most are neither abundant nor widely distributed enough to be economically important.

KEY TO TABANUS SPECIES IN ARIZONA

1. Females 2
— Males 18
2. Body and legs entirely dark brown or black .... *morbosus* Stone
— Body and legs not as above 3
3. Abdomen black; thorax reddish brown dorsally, with creamy, appressed hairs .... *punctifer* Osten Sacken
— Abdomen never wholly black; thorax otherwise colored dorsally 4
4. Thorax and abdomen very pallid dorsally, blackish markings very indistinct, abdomen yellowish brown sublaterally; eyes densely pilose
.... *oldroydi* Philip

15

—   Thorax and abdomen not predominantly pallid dorsally, at least narrow, dark markings clearly visible on abdomen; if pallid, eyes not densely pilose 5

5. Abdomen dorsally with median pale stripe 6

—   Abdomen dorsally lacking median pale stripe 8

6. Median stripe on abdomen rather narrow, not enlarged posteriorly on each tergum; sublateral markings nearly straight along outer margin, not strikingly jagged .... *similis* Macquart

—   Median stripe on abdomen broad, noticeably enlarged posteriorly on each tergum; sublateral markings conspicuously jagged and irregular along outer margin 7

7. Thorax blackish- and grayish-brown pollinose dorsally; abdomen dorsally dark yellowish-brown except for pale median stripe and sublateral markings .... *subsimilis* Bellardi

—   Thorax grayish pollinose dorsally; dark yellowish-brown abdominal markings reduced to faint spots or lines; pallid form .... *subsimilis* var. *nippontucki* Philip

8. Abdomen with pale median triangle evanescent or absent on tergum 2, very large on terga 3–4, very small on tergum 5 .... *dorsifer* Walker

—   Abdomen with pale median triangles on terga 2–5, sometimes rather small but never absent 9

9. Basal plate of flagellum with dorsal angle obtuse, excision absent; basal callosity small, only half the width of frons, emarginate below .... *dietrichi* Pechuman

—   Basal plate of flagellum with dorsal angle at least moderately acute, excision present; basal callosity as broad as or nearly as broad as frons, not emarginate below 10

10. Antennal scape strongly inflated above, extending hoodlike over pedicel and basal portion of flagellum 11

—   Antennal scape not strongly inflated above, never extending over pedicel and flagellum as above 12

11. Antennae black; abdomen dorsally blackish with pale median and sublateral markings .... *abditus* Philip

—   Antennae reddish to base of flagellum, remainder black; abdomen yellowish-brown and black, with large pale median triangles and sublateral patches .... *erythraeus* (Bigot)

12. Basal plate of flagellum short and very stout, yellowish-orange to orange, annulate portion black .... *eurycerus* Philip

—   Basal plate of flagellum not unusually short and stout, black beyond dorsal angle 13

13. Subcallus denuded, shining yellowish-brown to black, denuded area crescentic .... *caenosus* Burger

—   Subcallus pollinose or irregularly denuded 14

14. Thorax and abdomen strongly reddish to grayish pruinose 15

—   Thorax and abdomen grayish to blackish gray 16

15. Basal plate stout, about as long as tall, dorsal angle well-developed; 2nd palpal segment moderately stout basally; appressed hairs on notum black and yellowish to golden .... *boharti* Philip

—   Basal plate narrower, longer than tall, dorsal angle well-developed; 2nd

palpal segment very stout basally, abruptly tapered apically; ap-
pressed hairs on notum black and rusty-reddish .... *pruinosus* Bigot

16. Basal plate of flagellum narrow, elongate, noticeably longer than tall,
dorsal angle weak, obtuse; thorax predominantly grayish pollinose
dorsally, appressed hairs grayish to straw-colored .... *stonei* Philip

— Basal plate of flagellum broader, at most only slightly longer than tall,
dorsal angle moderately developed, acute or obtuse; thorax blackish
dorsally, with grayish pollinose lines, appressed hairs pale yellowish
to golden 17

17. Hairs on ventral surface of antennal scape mostly black; abdominal sterna
2–4 with black hairs medially .... *gilanus* Townsend

— Hairs on ventral surface of antennal scape mostly white; abdominal sterna
2–4 with white hairs, or, at most, a few scattered black hairs
medially .... *mogollon* Burger

18. Body black, except reddish-brown and creamy pilose laterally on dorsum
of thorax and on scutellum .... *punctifer* Osten Sacken

— Color not as above 19

19. Basal plate of flagellum lacking excision, dorsal angle very low, obtuse;
eyes with single, diagonal purplish band sometimes retained in
preserved material; crossveins and bifurcation of veins R₄ and R₅
faintly margined with brown; stout, brownish black species ....
.... *dietrichi* Pechuman

— Not with above combination of characters 20

20. Hairs on abdomen entirely yellowish .... *oldroydi* Philip

— Hairs on abdomen white, brown or black 21

21. Abdomen dorsally with a pale median stripe 22

— Abdomen dorsally lacking a pale median stripe 24

22. Abdomen dorsally with very narrow median stripe, not noticeably ex-
panded posteriorly on each tergum, sublateral markings strongly
yellowish, outer margins not noticeably irregular; eyes essentially
bare .... *similis* Macquart

— Median stripe on abdomen rather broad, moderately widened pos-
teriorly on each tergum, sublateral markings very pale yellowish-gray,
outer margins conspicuously jagged and irregular; eyes pilose 23

23. Thorax grayish-brown pollinose dorsally, sublateral brown stripes con-
spicuous; abdomen dorsally yellowish-brown, with a pale median
stripe and sublateral markings .... *subsimilis* Bellardi

— Thorax pale grayish pollinose dorsally, sublateral brown stripes very
faint; yellowish-brown abdominal color reduced to narrow lines, often
faded and very pale yellowish; pallid form ....
.... *subsimilis* var. *nippontucki* Philip

24. Abdomen with broad, median pale triangles on terga 3 and 4 only
(rarely an evanescent triangle on tergum 5) .... *dorsifer* Walker

— Abdomen otherwise marked 25

25. Abdominal terga 1–3 entirely light grayish pollinose and white pilose,
except 2 submedian black spots along anterior margin of tergum 3 ....
.... *pruinosus* Bigot

— Abdominal terga 1–3 with dark markings of varying extent 26

26. Antennal scape strongly inflated above, extending hoodlike over pedicel
     and basal part of flagellum _____ 27
—   Antennal scape not strongly inflated above _____ 28
27. Antennae black; areas of large and small facets on eyes well differen-
     tiated _____ *abditus* Philip
—   Antennal scape, pedicel and extreme base of flagellum reddish to reddish-
     orange; areas of large and small facets not well differentiated _____
     _____ *erythraeus* (Bigot)
28. Basal plate of flagellum short, rather stout, much shorter than annulate
     portion, entire plate orange, annuli black _____ *eurycerus* Philip
—   Basal plate of flagellum not much shorter than annulate portion, black
     beyond dorsal angle _____ 29
29. Frontal triangle mostly denuded, shining dark brown or black, denuded
     area crescentic _____ *caenosus* Burger
—   Frontal triangle pollinose _____ 30
30. Thorax black dorsally, densely clothed with erect black hairs _____
     _____ *gilanus* Townsend
—   Thorax grayish pollinose to pruinose dorsally, densely clothed with erect
     white hair _____ 31
31. Eyes moderately pilose, areas of large and small facets very strongly
     differentiated; thorax grayish pruinose dorsally _____ *boharti* Philip
—   Eyes very densely pilose, areas of large and small facets scarcely dif-
     ferentiated; thorax blackish dorsally with conspicuous grayish pollinose
     lines _____ 32
32. Basal plate slender, elongate, noticeably longer than annulate portion,
     dorsal angle very weak; frontal triangle not noticeably inflated; thorax
     clothed with erect white hairs dorsally _____ *stonei* Philip
—   Basal plate moderately stout basally, shorter than annulate portion,
     dorsal angle well-developed; frontal triangle inflated; thorax densely
     clothed with mixed black and white hairs dorsally ____ *mogollon* Burger

Tabanus abditus Philip

Tabanus abditus Philip, Canad. Entomol. 73:142, 1941.

Female: Length, 15–16 mm. Black and grayish; frons moderately wide, dis-
tinctly widened above, grayish pollinose; basal callosity dark brownish to black,
subquadrate, touching eyes laterally; median callosity black, drop-shaped, nar-
rowly joined to basal callosity; subcallus grayish pollinose, subshining yellowish
beneath pollinosity; antennal scape grayish pollinose, greatly enlarged dorsally,
extending hoodlike over pedicel and basal portion of flagellum, basal plate
of flagellum stout, with acute dorsal angle and shallow excision; flagellum
black; face whitish pollinose and white pilose; 2nd palpal segment creamy, very
stout basally, strongly tapered to an acute point apically, clothed with white and
a few black hairs; eyes with scattered microscopic hairs, in life unpatterned,
black; thorax blackish dorsally with grayish longitudinal lines, black erect and
pale yellowish appressed hairs; wings hyaline; hind tibial fringe mostly white
on basal ¾, remainder mostly black; abdomen black, with gray median triangles
and sublateral dashes on terga 2–5, the sublateral dashes usually reaching the
posterior margin of each tergum.

Male: Eyes with areas of large and small facets poorly differentiated, in life black, unpatterned; thorax rather densely clothed with erect, black hairs; otherwise similar to female except for usual sexual differences.

Comments: *Tabanus abditus* can be recognized by the black and grayish body and hoodlike antennal scapes. It has been collected infrequently in Arizona. I have seen specimens only from the type locality, Oak Creek Canyon, and from Young, in Gila County. Clark and Hibler (1973) collected 41 specimens from the Gila National Forest, New Mexico in 1970–71, so it is possibly more common in Arizona than indicated by past collections. Although *T. abditus* is not common enough to be considered a pest, Clark and Hibler (1973a) found 4 of 17 adults (23%) infected with larvae of *Elaeophora schneideri*, making *T. abditus* a potentially important vector of the parasite. Arizona specimens of *T. abditus* were collected in June and July, but based on collection records of Clark and Hibler (1973), it seems to be most common in June.

Tabanus boharti Philip

Tabanus boharti Philip, Ann. Entomol. Soc. Amer. 43:115, 1950.

Female: Length, 14.5–15.5 mm. Black and grayish pruinose; frons width moderate, slightly widened above, gray pollinose, with a brown spot on vertex and brownish markings laterally at level of median callosity; basal callosity brown to black, subquadrate, well separated from edge of eyes and with upward extensions at upper corners; median callosity black, often detached from basal callosity; subcallus yellowish-gray pollinose; antennae yellowish orange to dorsal angle, remainder black, basal plate of flagellum stout, dorsal angle acute, excision deep; palpi creamy, clothed with mixed black and white hairs; eyes very sparsely pilose, in life dark green to brown above, dark purple below, with 2 diagonal light green bands; thorax blackish dorsally, with grayish pruinose longitudinal lines, black erect and yellowish-golden appressed hairs; pleurae pruinose, clothed with white hairs; wings hyaline; hind tibial fringe mostly white on basal half, remainder black; abdomen grayish pruinose and black, with white median triangles and sublateral dashes on terga 2–6, the median triangles sometimes reduced on posterior segments and sublateral dashes either attaining the posterior margin of each tergum or isolated from margin.

Male: Eyes moderately pilose, areas of large and small facets well-differentiated, in life with 2 green stripes on a brownish-purple ground; 2nd palpal segment clothed with white hairs; front grayish pollinose; thorax densely clothed with erect white hair dorsally; white median triangles and sublateral dashes on abdomen large and conspicuous, dashes extending the length of terga; otherwise similar to female except for usual sexual differences.

Comments: In Arizona, *T. boharti* has been collected only from the type-locality in the Santa Rita Mountains, south of Tucson and from the Santa Catalina Mountains north of Tucson. I have collected immature stages from both ranges and also from Sonora, Mexico

(Burger, 1974), but not elsewhere in Arizona. I have collected adults in June and July in the Santa Rita Mountains.

Tabanus caenosus Burger

Tabanus caenosus Burger, Proc. Entomol. Soc. Wash. 76:3, 1974.

Female: Length, 15.5–17.5 mm. Dark grayish; frons width moderate, gradually widened above, grayish pollinose with a brown spot on the vertex and laterally on either side of median callosity; basal callosity yellowish brown to black, rounded above or with extensions at upper corners directed toward median callosity; median callosity drop-shaped, narrowly joined to basal callosity; subcallus denuded, shiny mahogany brown to black (very rarely yellowish), denuded area crescentic; antenna yellowish orange to dorsal angle, remainder black; palpi creamy, 2nd segment stout basally, abruptly tapered to an acute point apically, clothed with mixed black and white hairs; eyes with microscopic scattered hairs, in life with 2 light green bands on a brownish-purple ground; thorax grayish black dorsally, with grayish longitudinal lines, sparse black erect and coppery appressed hairs; pleurae grayish-white pollinose, clothed with white hair; wings hyaline; hind tibial fringe with mixed white and black hairs, mostly white on basal half; abdomen grayish black, with white median triangles and sublateral spots on terga 2–5, triangle largest on tergum 2, sublateral spots isolated from tergal margins.

Male: Length, 13–16 mm. Eyes sparsely pilose, areas of large and small facets sharply differentiated, in life brown above and below, purple between 2 light green bands; frontal triangle denuded, shining black, crescentic; thorax grayish pollinose dorsally, densely clothed with erect white hairs; abdomen dark grayish, terga 1–2 mostly grayish pollinose and clothed with white hairs except for 2 narrow, submedian black figures, sublateral black spots on tergum 2 and a faint median black spot beneath scutellum on tergum 1; white median triangles and sublateral spots on terga 3–5 large, conspicuous, sometimes obscuring grayish-black ground color.

Comments: The markings of *T. caenosus* can be variable; this is discussed in a previous paper (Burger, 1974). *Tabanus caenosus* is related to *T. pruinosus* Bigot; I have seen occasional specimens of *caenosus* approaching the reddish pruinose color of *pruinosus*, but *caenosus* can be separated easily by the denuded subcallus of the female and frontal triangle of the male, and black markings on the 2nd abdominal tergum of the male that are absent in *pruinosus*. Some specimens previously identified as *T. pruinosus* from the United States have proven to be *T. caenosus*. It is rather widely distributed in the eastern half of Arizona as far north as Oak Creek Canyon (Coconino County) and east to southeastern Navajo County. Although adults are not commonly collected, I found the larvae to be one of the most commonly encountered species in southeastern Arizona, where it is more common than farther north. Adults have been collected from May through September but most commonly in July and August.

Tabanus dietrichi Pechuman

Tabanus dietrichi Pechuman, Pan-Pac. Entomol. 32:39, 1956.

Female: Length, 15–16 mm. Stout, dark brownish species with some black markings; frons, subcallus and face light brown to dull ochre pollinose; basal callosity small, subquadrate, emarginate below by invasion of pollinosity from subcallus, black, finely wrinkled; median callosity narrow, narrowly joined to basal callosity or separated from it; antennae black, basal portion of flagellum with dorsal angle very blunt, excision absent; 2nd palpal segment pinkish yellow, clothed with short, stiff black hairs; eye in life dark green with a single diagonal purple band not retained in dried specimens, sparsely pilose; thorax blackish dorsally, with yellowish-brown longitudinal lines and appressed golden and black hairs; pleurae with a tuft of orange hair just beneath wing base; costal cell of wing light brownish, crossveins and bifurcation of veins R_4 and R_5 very lightly infuscated; abdomen yellowish brown, with some greenish tints; large, submedian black paired dashes present on terga 2–6 and joined to a large sublateral black spot by a narrow dark band along the anterior margin of each tergum, golden haired median triangles and sublateral patches present on terga 2–6.

Male: Eyes distinctly pilose; 2nd palpal segment chocolate brown, clothed with long black hairs; thorax dorsally densely clothed with erect and appressed black hairs, golden hairs restricted to anterior parts of paler longitudinal stripes; abdomen predominantly dark brown to black, black markings much more extensive than in female, lighter markings reduced to narrow median triangles on terga 2–3 and narrow sublateral dashes with some yellowish suffusion; otherwise similar to female except for usual sexual differences.

Comments: I did not have adequate material to determine the limits of variation in size and color for *T. dietrichi*; for discussion of variation, see Pechuman (1956). This unusual fly is unlike any other *Tabanus* in Arizona. Its small, emarginate, wrinkled basal callosity, single diagonal stripe on the eye, peculiar coloration and stout body immediately distinguish it from other species. Pechuman (1956) discussed the difficulty of generic placement for *T. dietrichi*. Certain features such as the antennae and eye pattern resemble *Atylotus*. In addition, the pupal aster resembles that of *Atylotus* species and those in the *Tabanus lineola* group. However, the larva has all features in common with those of other known *Tabanus* larvae and I believe Pechuman correctly placed *dietrichi* in *Tabanus*.

To date, *T. dietrichi* has been collected only from the type-locality (Phelps Botanical Area) in the White Mountains of eastern Arizona, but since it appears to occur in extremely local habitats, it may be found eventually elsewhere in the White Mountains. I collected larvae of *T. dietrichi* from the type-locality with those of *Atylotus incisuralis* (Macquart) in hummocks of wet moss in a large, boggy subalpine meadow, an unusual place to find *Tabanus* larvae in Arizona, *Atylotus* and *Hybomitra* larvae being the usual residents of such habitats. The type-series was collected on 7–8 July.

Tabanus dorsifer Walker

Tabanus dorsifer Walker, Trans. Entomol. Soc. Lond. 5: 273, 1860.

Female: Length, 14–14.5 mm. Black and grayish; frons width moderate, slightly widened above, grayish pollinose; basal callosity subquadrate, touching eyes laterally; median callosity drop-shaped; subcallus grayish pollinose; antennae black, scape noticeably enlarged dorsally, basal plate of flagellum with strong dorsal angle, excision shallow; eyes with microscopic scattered hairs, in life unpatterned, black; thorax black dorsally, with grayish longitudinal lines, black erect and black and yellowish appressed hairs; wings hyaline; abdomen black, tergum 1 with white rounded spot medianly beneath scutellum, terga 2–4 with sublateral pale dashes attaining posterior margins, most conspicuous on tergum 2, very obscure on tergum 4, tergum 3–5 with whitish median triangles, on tergum 3 extending half way to anterior margin, entire length of tergum 4 and ¼ length of tergum 5.

Male: Length, 13 mm. Eyes very sparsely pilose, areas of large and small facets sharply differentiated; pale triangles absent on tergum 5, except very rarely present as a small pale spot; otherwise similar to female except for usual sexual differences.

Comments: *Tabanus dorsifer* is found throughout the eastern half of Arizona. I have records of it from the Chiricahua Mountains north to the Grand Canyon. Color and markings of *T. dorsifer* vary throughout its range, and, particularly in Texas specimens, one finds the abdomen sometimes brownish, the abdominal triangles much enlarged and the antennal scapes much enlarged dorsally. In Arizona, most specimens have a blackish abdomen with only occasionally some brownish tints; the degree of enlargement of the scapes is also variable. *Tabanus dorsifer* has been collected from May through October but most commonly from June through September. Although larvae can be collected from streams rather commonly, adults are not often collected in Arizona.

Philip (1968) described *Tabanus monilus* Philip from Madera Canyon in the Santa Rita Mountains, based on a single male specimen. This specimen is an aberrant male of *T. dorsifer* with deformed palpi and front legs (Burger, 1973).

Tabanus erythraeus (Bigot)

Atylotus erythraeus Bigot, Soc. Zool. de France, Mem. 5:661, 1892.

Female: Length, 13–15.5 mm. Yellowish brown and black; frons grayish pollinose, width moderate, scarcely widened above; basal callosity orange to orange-brown, narrowed above and rather broadly joined to narrow median callosity; subcallus grayish pollinose; antennal scape greatly enlarged dorsally, extending hoodlike over pedicel and basal plate of flagellum; scape, pedicel and extreme base of flagellum orange to orange-brown, remainder black, dorsal angle prominent; 2nd palpal segment creamy, clothed with mixed black and white hairs; eyes sparsely pilose; thorax dark grayish dorsally, with lighter

longitudinal lines and mixed black and whitish appressed hairs; wings hyaline, with a trace of infuscation at bifurcation of veins R_4 and R_5; mid- and hind femora and tibiae orange-brown; abdomen orange-brown and black dorsally, with large white median triangles and sublateral dashes on terga 2–6, tergum 1 pale yellowish gray except for 2 submedian dark patches and small sublateral spots.

Male: Eyes sparsely pilose, areas of large and small facets poorly differentiated; thorax densely clothed with mixed black and white erect hairs dorsally; mid- and hind femora dark; otherwise similar to female except for usual sexual differences.

Comments: *Tabanus erythraeus*, one of the commonest horse flies in southeastern Arizona, occurs in mountain ranges as far north as the Pinaleño Mountains in Graham County. I have seen 1 specimen (USNM) collected by C. H. T. Townsend from "Horse Camp Can.," apparently a locality in northern Gila County, but far from the known range of *T. erythraeus*. Possibly, there is more than 1 locality with that name. I also have seen 1 specimen from the San Carlos Indian Reservation in northern Graham County. Adults of *T. erythraeus* are active from June through August, but are most abundant from late June through late July.

Tabanus eurycerus Philip

Tabanus eurycerus Philip, Pan-Pac. Entomol. 13:66, 1937.

Female: Length, 14.5–17.5 mm. Grayish and black; frons and subcallus dark grayish pollinose, width of frons moderate, noticeably widened above; basal callosity dark brown to black, subquadrate, not quite touching eyes laterally, connected to the rather large, spindle-shaped median callosity; antennal scape, pedicel and basal plate orange-brown, annulate portion black, scape slightly enlarged above, basal plate short, stout, with conspicuous dorsal angle and scarcely any excision; palpi creamy, clothed with white and a few black hairs; eyes sparsely pilose; thorax dark grayish dorsally, with pale longitudinal lines, black and white erect and black and coppery appressed hairs; wings hyaline; abdomen dark grayish dorsally, with pale median triangles and rather narrow sublateral diagonal dashes usually reaching hind margins of terga 2–5, occasionally yellowish-brown suffusion present laterally on terga 1–2.

Male: Eyes sparsely pilose, areas of large and small facets sharply differentiated; otherwise similar to female except for usual sexual differences.

Comments: *Tabanus eurycerus* occurs in southeastern Arizona as far north as the Santa Catalina Mountains, north of Tucson. It is not common in Arizona but is collected most frequently in the Chiricahua Mountains. Specimens have been taken in June and July, but most often from mid-June to early July. I have collected males and females while they were drinking from pools of water in a small creek. In Arizona, *T. eurycerus* is usually found in mountain woodlands from

5000 to 9000 ft., but it may be more common in New Mexico; Clark and Hibler (1973) collected 316 specimens during 1970–71 from the Gila National Forest, New Mexico. Clark and Hibler (1973a) found 17 of 76 *T. eurycerus* (23.6%) to be infected with larvae of *Elaeophora schneideri* in 1970–71, so it may be a vector of the parasite in Arizona.

Tabanus gilanus Townsend

Tabanus gilanus Townsend, Psyche. 8:92, 1897.

Female: Length, 12.5–15.5 mm. Blackish, with gray markings; frons dark grayish pollinose, width moderate, slightly widened above; basal callosity shining black, subquadrate, not quite touching eyes laterally, narrowly joined to narrow, rectangular median callosity; subcallus either dark yellowish-gray pollinose or partially and irregularly rubbed, revealing a shiny yellowish to black integument; antennae yellowish orange to dorsal angle, remainder black, ventral hairs on scape mostly black, dorsal angle acute, excision moderate; 2nd palpal segment pale yellowish orange, clothed with mixed black and white hairs; eyes sparsely pilose, in life brown above, purple below with 2 light green bands; thorax blackish dorsally, with grayish longitudinal lines, black erect and black and straw-colored appressed hairs; wings hyaline; hind tibial fringe mostly black, with some white hairs mixed basally; abdomen black, with grayish narrow median triangles and sublateral diagonal dashes on terga 2–6, the dashes reaching posterior margins of terga and extended laterally to edge of segments, terga 2–3 sometimes with yellowish-brown suffusion laterally; abdominal sterna 2–4 with black hairs medianly, pale hairs laterally.

Male: Length, 13–16 mm. Areas of large and small facets on eyes sharply differentiated, in life dark green above, brownish purple below, with 2 narrow light green bands, large faceted area moderately pilose, small faceted area sparsely pilose; frontal triangle grayish pollinose; thorax dorsally densely clothed with erect white hairs anteriorly behind head, remainder with erect black hairs; otherwise similar to female except for usual sexual differences.

Comments: *Tabanus gilanus* occurs in most or all of the higher mountain ranges in eastern Arizona, from the Chiricahua Mountains north to Oak Creek Canyon and the White Mountains, records being scattered throughout that area. I have never found it in large numbers. Adults are collected most commonly in forested areas from 6000 to 9000 ft. Females of a closely related species, *T. mogollon* (misidentified as *T. gilanus*), may account for some past records of *gilanus*. Adults in northern Arizona are most active in June; those in southern Arizona in July and August. Clark and Hibler (1973a) found 7 of 161 *T. gilanus* (4.3%) in the Gila National Forest, New Mexico infected with larvae of *Elaeophora schneideri*, however some of their specimens may have been *T. mogollon*. The low infection rate of *T. gilanus* indicates that this species plays only a minor role in the transmission of *E. schneideri* to wildlife.

Tabanus mogollon Burger

Tabanus mogollon Burger, Proc. Entomol. Soc. Wash. 76:8, 1974.

Female: Length, 13–14 mm. Grayish and black; frons grayish pollinose, with prominent brown spots laterally near median callosity; width of frons moderate, slightly widened above; basal callosity shining black, subquadrate, narrowly joined to spindle-shaped median callosity; subcallus grayish pollinose, occasionally partially rubbed and noticeably inflated; scape and pedicel of antenna grayish to yellowish-gray pollinose, scape with predominantly white hair ventrally, flagellum yellowish to orange brown basally to dorsal angle, black beyond, basal plate rather stout, dorsal angle blunt, excision very shallow; 2nd palpal segment creamy, stout basally, abruptly tapered to a point apically, clothed with white and a few black hairs; eyes distinctly pilose, in life greenish brown above, dark purple below, with 2 broad light green bands; thorax blackish dorsally, with light gray longitudinal lines, black erect and black and light yellowish appressed hairs; wings hyaline; hind tibial fringe mostly white, with some mixed black hairs on the apical ¼; abdomen blackish, with white median triangles and sublateral diagonal dashes on terga 2–6, the dashes extending entire length of terga, abdominal sterna 2–4 white pilose.

Male: Eyes densely pilose, areas of large and small facets scarcely differentiated, in life dark brown above, dark purple below and brownish purple between 2 light green narrow bands; ocellar tubercle very large, clothed with white and stiff black hairs; frontal triangle grayish pollinose, conspicuously inflated below; thorax dorsally densely clothed with mixed black and white erect hairs; abdomen dark grayish, sublateral diagonal dashes large on tergum 2, coalescing with an extensive white area laterally, tergum 1 mostly whitish, except for 2 submedian dark grayish spots; otherwise similar to female except for usual sexual differences.

Comments: Females of *T. mogollon* are very similar to *T. gilanus* but can be separated readily by the white hair ventrally on the antennal scape, the more densely pilose eyes, and absence of black hairs medially on abdominal sterna 2–4. *Tabanus gilanus* has black hairs ventrally on the scape, sparsely pilose eyes and black hairs medially on sterna 2–4. Males of *T. mogollon* have been confused with *Tabanus stonei* Philip, but the former can be recognized by the stouter basal plate, more strongly inflated frontal triangle, and more extensive dark areas on the abdominal terga. *Tabanus stonei* is more grayish, lacking the blackish marking of *T. mogollon*. *Tabanus mogollon* occurs from southeastern to north-central Arizona, being most common in forested areas from 4000 to 7000 ft. Possibly most old records of *T. stonei* and some of *T. gilanus* from southern Arizona are *T. mogollon*. Because of this confusion, the true distribution of *T. mogollon* is yet uncertain; I have used only records personally verified as being *T. mogollon*, and based on these, it occurs in Cochise, Santa Cruz and Pima Counties in southern Arizona, and along the Mogollon Rim in Gila, Coconino and Yavapai Counties. It probably also occurs in mountain ranges throughout central and east-central

Arizona since it is not uncommon in the Gila National Forest, New Mexico.

Tabanus morbosus Stone

Tabanus morbosus Stone, U.S. Dept. Agr. Misc. Pub. 305:89, 1938.

Female: Length, 17–21 mm. Brownish black; frons narrow; slightly widened above, brownish; vertex with shiny black denuded area; basal callosity narrow, black, raised above surface of integument where joined by narrow, ridged median callosity; subcallus concolorous with frons; antennae black, dorsal angle of flagellum acute, excision deep; 2nd palpal segment black, clothed with black hairs; eyes with microscopic scattered hairs, lacking pattern in life; thorax dark brown to black dorsally, clothed with black hairs; wings subhyaline, costal cell dark smoky brown, wing veins basad to bifurcation of R_4 and R_5 heavily margined with dusky brown; legs black, empodium and pulvilli yellowish white; abdomen black, clothed with black hairs.
Male.—Unknown.

Comments: *Tabanus morbosus* was considered extremely uncommon, being recorded only from the type-locality, Ramsey Canyon, in the Huachuca Mountains of Cochise County (Stone, 1938). I have collected larvae of it from the Santa Catalina Mountains in Pima County, Workman Creek and Horton Creek in Gila County and from Wet Canyon in the Pinaleño Mountains as well as from the type-locality. Reasons for scarcity of adults remain unknown. I have collected many larvae of *T. morbosus* from the stream in Ramsey Canyon but, to date, have been unable to rear a male specimen, so the male remains undescribed. Two specimens collected from the type-locality, 1 an adult, the other reared, both agree with the holotype in the U.S. National Museum, except the thorax is black dorsally, concolorous with the abdomen.

Tabanus oldroydi Philip

Tabanus oldroydi Philip, Canad. Entomol. 73:143, 1941.

Female: Length, 14–15 mm. Pale yellowish gray; frons grayish-white pollinose, width moderate, not noticeably widened above; vertex denuded; basal callosity yellowish brown, with upper corners extended above; median callosity yellowish brown, separated from basal callosity; antenna pale reddish to dorsal angle, remainder black, dorsal angle of flagellum acute, excision moderate, basal plate elongate, slender, longer than annulate portion; 2nd palpal segment light yellowish, clothed with white hairs; eyes rather densely pilose; thorax blackish dorsally, grayish pollinose and clothed with erect whitish gray and pale yellowish appressed hairs; wings hyaline; hind tibial fringe with mixed light and dark hairs, mostly black apically; abdomen grayish red with extensive yellowish-brown suffusion sublaterally, dark grayish black submedian paired spots present on terga 2–5, those on tergum 2 coalescing into a large median spot.

Male: Unavailable for examination; taxonomic characters adapted from Philip (1941) for the allotype male. Eyes densely pilose, areas of large and small facets but slightly differentiated; vestiture of abdomen dorsally entirely yellow, abdominal pattern indistinct, except dark shadows on terga 2–4; otherwise similar to female except for usual sexual differences.

Comments: *Tabanus oldroydi*, a striking pallid species, has been reported previously from Sonora, Mexico, and Baja California, along the Gulf of California, and is apparently restricted to hot, dry arid regions. Philip (1971) first reported it from Arizona, near Yuma, an expected extension of its known range. Possibly *T. oldroydi* will spread through the Yuma area and northward along the Colorado River, if it has not already done so. It is an early spring species, active in April and May.

Tabanus pruinosus Bigot

Tabanus pruinosus Bigot, Soc. Zool. France, Mem. 5:683, 1892.

Female: Length, 17–18 mm. Reddish pruinose; frons width moderate, slightly widened above, dark grayish pollinose, with paired brown spots on vertex and laterally at level of median callosity; basal callosity subquadrate, with pollinose spots laterally below and upward extensions at the upper corners, dark brownish to black, narrowly connected to spindle-shaped median callosity; subcallus yellowish-gray pollinose; antennae reddish to dorsal angle, black beyond; 2nd palpal segment pale beige, clothed with mixed black and white hairs; eyes microscopically pilose, in life with 2 light green bands on a brown ground; thorax reddish-gray pruinose dorsally, with indistinct, narrow light grayish longitudinal lines, clothed with rusty reddish and black appressed hairs; wings hyaline; hind tibial fringe white except some black hairs at apex; abdomen reddish-gray, with pale median triangles and small, isolated spots on terga 2–5.

Male: Length, 17–23 mm. Eyes sparsely pilose, areas of large and small facets noticeably differentiated, in life 2 narrow light green bands on a dark brown ground; 2nd palpal segment pale yellowish, white pilose; thorax dorsally densely clothed with erect white and golden appressed hairs; hind tibial fringe black on apical ¼, remainder white; abdominal terga 1–3 entirely pale, except 2 small, submedian black spots anteriorly on tergum 3; sublateral pale spots on terga 4–6 large, extending posteriorly to and along posterior margin of each tergum to tufts of whitish hairs laterally.

Comments: Stone (1938) listed *T. pruinosus* occurring in the United States as far north as Utah. Philip (1950), in his discussion of a new species, *T. boharti*, considered Stone's "*T. pruinosus*" to be possibly *T. boharti*. Stone's figure of the stout flagellar basal plate resembles that of *T. boharti* as do parts of the adult description. However, since I have found *T. boharti* only as far north as Tucson in Arizona, Stone may have included specimens of *T. caenosus* as records of *T. pruinosus*.

I have discussed the distribution of *T. pruinosus* in a previous paper

(Burger, 1974a). I know of no specimens collected as adults north of Mexico, but I reared adults from larvae collected in southern and central Santa Cruz County. I have not found it farther north.

Tabanus pruinosus specimens from Mexico and Central America tend to have the basal and median callosities yellowish orange, and the abdomen darker reddish brown than Arizona specimens, but at present too few adults from Arizona are available to determine variability of adult characters.

Tabanus punctifer Osten Sacken

Tabanus punctifer Osten Sacken, Boston Soc. Nat. Hist. Mem. 2:453, 1876.

Female: Length, 17–22 mm. Cream-colored and black; frons width moderate, not noticeably widened above, brownish pollinose; basal callosity large, subquadrate, brown to black, broadly joined to large median callosity; subcallus subshiny dark brown, with thin brownish pollinosity; antenna black; palpi black, clothed with black hairs; eyes essentially bare, in life brown above, purple below, with 2 broad dark green bands; thorax and scutellum reddish brown dorsally, densely clothed with creamy appressed hairs; fore-tibiae bicolored, basal ⅓ creamy, remainder black; wings brownish, crossveins margined with brown and bifurcation of veins R_1 and R_5 with a dark brown spot; abdomen black, clothed with black hairs.

Male: Eyes with areas of large and small facets sharply differentiated; thorax dorsally with broad lateral border and entire scutellum clothed with creamy appressed hairs on a reddish-brown ground, central part of mesonotum black, clothed with black hairs; otherwise similar to female except for usual sexual differences.

Comments: *Tabanus punctifer* is the most ubiquitous horse fly in Arizona. It is most abundant along major streams and lakes and in extensively irrigated farmlands where soil moisture persists throughout the year. The immature stages are highly adaptable to a wide variety of habitats; I have found them beneath cattle droppings in a wet field where water had seeped through a dam. Webb and Wells (1924) present an exhaustive study of the biology and economic importance of *T. punctifer* in the western United States. This species is less common at higher elevations in the mountains (above 7000 ft.) and probably does not occur in the highest parts of the White Mountains. I have collection records for *T. punctifer* from mid-April to mid-November, with most records being from June through September.

Tabanus similis Macquart

Tabanus similis Macquart, Soc. des Sci., de l'Agr., et des Arts, Lille, Mem. 1849:335, 1850.

Female: Length, 13–13.5 mm. Blackish, with pale median abdominal stripe and yellowish sublateral markings; frons grayish pollinose, slightly tinged with

brown and distinctly widened above; basal callosity subquadrate, black, taller than wide, narrowly separated laterally from eyes; median callosity black, spindle-shaped, narrowly joined to basal callosity; subcallus grayish pollinose; antenna reddish, annuli reddish brown; 2nd palpal segment creamy, stout basally but not strongly attenuated apically, clothed with mixed white and black hairs; eyes essentially bare, in life with a bluish-black border, a complete, narrow bluish-black band below and an incomplete, broad, concolorous band above on a light green ground; thorax blackish dorsally, clothed with short, erect black and appressed grayish hairs; scutellum concolorous with thorax basally, reddish apically; wings hyaline; abdomen reddish brown to black, whitish median stripe present on terga 1–6, not noticeably widened posteriorly on each tergum, yellowish sublateral patches present on terga 2–5, indistinct on tergum 6, outer margin slightly irregular but not conspicuously jagged.

Male: Eyes lacking noticeable pilosity, at most only microscopic scattered hairs present, in life with a large central pale green area above surrounded by a black border, 2 narrow iridescent green bands on a dark purple ground below, area of large facets brown, that of small facets black in dried specimens; 2nd palpal segment creamy to very pale yellowish, clothed with long, white and some short black hairs; abdomen reddish brown, median stripe narrow, yellowish, concolorous with sublateral patches; otherwise similar to female except for usual sexual differences.

Comments: *Tabanus similis* is apparently an uncommon species in Arizona, occurring only in the northern half of the state. I have seen 2 specimens, both reared from larvae collected at Mormon Lake (Coconino County). *Tabanus similis* could be confused with *T. subsimilis* in northeastern Arizona, but the former can be separated readily by the slightly narrower median stripe and the sublateral patches on the abdomen not noticeably jagged and irregular along the outer margin; males can be separated by the lack of noticeable pilosity on the eyes (distinctly pilose in *T. subsimilis*). There are too few records of *T. similis* in Arizona to provide a seasonal distribution pattern.

Tabanus stonei Philip

Tabanus stonei Philip, Canad. Entomol. 73:144, 1941.

Female: Length, 14–15 mm. Grayish; frons grayish pollinose, with brown spots laterally at level of median callosity, widened above; vertex with shiny brown spot; basal callosity reddish brown to black, rounded above or subquadrate, narrowly joined to or separated from irregularly spindle-shaped median callosity; subcallus yellowish-gray pollinose; scape and pedicel of antenna light to dark reddish-gray pollinose, not enlarged, flagellum brownish gray to dorsal angle, black beyond, basal plate narrow, elongate, excision shallow; 2nd palpal segment creamy, stout basally, attenuated apically, clothed with white and a few black hairs; eyes sparsely pilose, in life brown above, dark purple to brownish purple below, with 2 light green bands; thorax grayish pollinose dorsally, with indistinct darker lines and mixed white and black erect and straw-colored appressed hairs; wings hyaline; hind tibial fringe white, with a few mixed black hairs; abdomen dark grayish pollinose, with pale median triangles and oblique sub-

lateral dashes on terga 2–5, the dashes expanded posteriorly along posterior margin of each tergum to lateral margin.

Male: Ocellar tubercle moderately to conspicuously raised above eyes, clothed with stiff black hairs; eyes densely pilose, areas of large and small facets only slightly differentiated, in life dark green above, purple to brownish purple below with 2 narrow light green bands; frontal triangle grayish pollinose, not conspicuously inflated; scape and pedicel of antenna grayish pollinose, basal plate of flagellum very slender and elongate, dorsal angle scarcely developed; 2nd palpal segment creamy, white pilose; thorax dorsally densely clothed with erect, grayish hairs; median triangles and sublateral dashes on abdomen more extensive than in female, obscuring dark grayish submedian and sublateral markings; otherwise similar to female except for usual sexual differences.

Comments: *Tabanus stonei* is uncommon in Arizona. Males have been confused in the past with those of *T. mogollon*, especially in southern Arizona. I have seen 2 males of *stonei* from Arizona, 1 from Greer (Apache County) and 1 from Oak Creek Canyon (Coconino County). Males of *stonei* can be separated from those of *mogollon* by the more elongate, slender basal plate of the flagellum, scarcely inflated frontal triangle, and little or no erect, black hair on the thorax dorsally. There are too few records of *T. stonei* in Arizona to give a useful seasonal distribution pattern.

Tabanus subsimilis Bellardi

Tabanus subsimilis Bellardi, Saggio. di ditterol. messicana 1859:66.

Female: Length, 13–14 mm. Buff and brownish, with conspicuous mid-dorsal abdominal stripe; frons light grayish-brown pollinose, with some black tones near vertex, distinctly widened above; basal callosity dark brown to black, subquadrate, taller than broad, not touching eyes laterally; median callosity black, spindle-shaped, narrowly joined to basal callosity; subcallus gray pollinose, subshining reddish beneath pollinosity; antenna reddish, annuli black, scape moderately enlarged above, basal plate of flagellum stout, excision shallow; 2nd palpal segment creamy, stout basally, strongly attenuated apically, clothed with mixed black and white hairs; eyes essentially bare, only microscopic scattered hairs visible, in life light green, surrounded by a bluish-black border and interrupted by a bluish-black complete band below and a concolorous incomplete band above; thorax black dorsally, with thin dark grayish pollinosity, sparse black erect and abundant buff-colored appressed hairs, longitudinal lines indistinct; posterior half of scutellar disc reddish above; wings hyaline; abdomen reddish brown, with broad buff pollinose median stripe and sublateral patches, median stripe slightly widened posteriorly on each tergum, sublateral patches narrow basally, expanded laterally, outer margin jagged.

Male: Eyes with area of large facets dark brown, that of small facets black, strongly differentiated, moderately pilose, in life a pale green central area surrounded by black border above, 2 narrow irridescent green bands on a black ground below; basal plate of flagellum narrower and more elongate than female, annuli dark reddish brown to black; 2nd palpal segment creamy, white pilose, with occasional black hairs; thorax grayish pollinose dorsally, with sublateral

dark brown stripes and dense, erect black and buff and appressed grayish buff hairs; abdomen similar to female except median stripe and sublateral patches more extensive, giving abdomen a frosted appearance; otherwise similar to female except for usual sexual differences.

Comments: Philip (1942) described this species as *T. vittiger schwardti* Philip, but subsequently used the older name for this species (Philip, 1965a). *Tabanus subsimilis* is separated from a related variety, *T. subsimilis* var. *nippontucki*, by the more extensive black color on the thorax and extensive reddish-brown color on the abdominal terga, and from *T. similis* by the broader median stripe on the abdomen. *T. subsimilis* occurs throughout Arizona, and, with *T. punctifer*, is one of the most common desert species. It is active from May through September, but I have observed adults to be most annoying in July and August in the desert around Tucson, where I collected both *T. subsimilis* and the paler *nippontucki* variant. It is most common below 5000 ft.

Tabanus subsimilis var. *nippontucki* Philip

Tabanus vittiger nippontucki Philip, Psyche. 49:32, 1942.

Female: Length, 13–14 mm. Grayish; similar to *T. subsimilis* except grayish pollinosity dorsally on thorax sometimes obscuring blackish color; reddish-brown color of abdomen dorsally faded, approaching pale yellowish orange.

Male: Similar to *T. subsimilis* except 2nd palpal segment entirely white pilose; thorax clothed with whitish erect and grayish appressed hairs dorsally; hind tibial fringe with mixed pale and black hairs; abdomen dorsally with dark areas variable from light reddish brown to very pale yellowish, sometimes hardly contrasting with median stripe.

Comments: *Tabanus subsimilis* var. *nippontucki*, orginally described as a subspecies of *T. vittiger* by Philip (1942), is best recognized by its pallid, faded appearance, particularly the faded abdominal pattern. Although extreme pallid variants, usually collected in very arid deserts in California and Arizona, can be separated readily from typical *T. subsimilis* in Arizona, I have seen intermediate forms difficult to assign to 1 form or the other. Males tend to show the extreme pallid tones more than females. In a series of specimens I reared from larvae collected near Agua Prieta, Sonora, Mexico, some males had the dark abdominal pattern of *T. subsimilis*; others approached the *nippontucki* variant in the fading of the reddish-brown abdominal pattern to light brown; females did not exhibit such variation. Until more definitive evidence for subspecific differentiation is available, I consider *nippontucki* a pallid color variant of *subsimilis*, characteristic of arid desert environments.

In Arizona, *T. subsimilis* var. *nippontucki* occurs from March to November, being most common from June through August; it is found

throughout southern Arizona, but is collected most commonly in the more arid parts. I have collected males at lights in the desert and both males and females by sweeping crops such as alfalfa.

CHANGES IN RECORDS OF ARIZONA TABANIDAE

Based on all collections known to me, the following additions and deletions are given for the tabanid fauna of Arizona:

Additions: *Stenotabanus guttatulus* (Townsend)
Tabanus caenosus Burger
T. mogollon Burger
T. pruinosus Bigot
Hybomitra opaca (Coquillett)

Stenotabanus guttatulus was collected by C. B. Philip and L. L. Pechuman in 1969 near Patagonia, Arizona. Burger (1974) recently described *T. caenosus* and *T. mogollon* as new from Arizona. *Tabanus pruinosus*, authors, not Bigot, was reported by Stone (1938), but probably was, in part, another species subsequently described as *T. boharti* by Philip (1950). I reared specimens of *T. pruinosus* Bigot from Santa Cruz County, Arizona, the first record of it from Arizona and the first north of Mexico. I reared specimens of *H. opaca* from near Greer, Arizona in 1970. Subsequently, I have seen specimens, also from the White Mountains, in the U.S. National Museum.

Deletions: *Chrysops brunneus* Hine
Chlorotabanus crepuscularis (Bequaert)
Tabanus monilus Philip, syn. of *T. dorsifer* Walker

Philip (1965) lists both *C. brunneus* and *Chl. crepuscularis* from Arizona. Since both species would be far from their known ranges, their occurrence in Arizona was highly doubtful. Pechuman (personal communication) provided me an explanation for these old records. In 1917, an expedition from Cornell University traveled across the country collecting insects and visiting many states, including Arizona. Specimens collected were labelled after their return to Cornell. Specimens of *C. brunneus* and *Chl. crepuscularis*, probably collected in the southeastern United States, were mislabelled as collected in Arizona. Pechuman states that other tabanid species occurring only in the southeastern United States also were given similar Arizona labels, but only the 2 species above were subsequently listed in the literature as occurring in Arizona. Thus, it is certain that these 2 species were mislabelled and are excluded from the list of Arizona Tabanidae. *Tabanus monilus* Philip was synonymized with *T. dorsifer* by Burger (1973).

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OBSERVATIONS ON THE BIOLOGY OF TRICORYTHODES
ATRATUS MCDUNNOUGH (EPHEMEROPTERA: TRICORYTHIDAE)[1]

Ronald J. Hall,[2] Lewis Berner,[3] and Edwin F. Cook[4]

ABSTRACT—As the ecology of the nymphal stages, the behavior of the adults, and the life history of the mayfly genus *Tricorythodes* are poorly known, an intensive study of *T. atratus* was undertaken in northern Minnesota during the summers of 1969 and 1971. Analyses were made of populations of nymphs by dividing them into age groups to determine where each occurs in the streams studied. Stomach contents revealed that nymphs feed primarily on plant materials. Drift-net collections for 24-hour periods were made to provide information about growth, emergence, and oviposition. Frequent observations of emergence and swarming were made. Subimagoes were seen emerging from the nymphal stage underwater, swimming to some emergent object, climbing from the water, and expanding their wings. Emergence of subimagoes appears to be correlated with low light intensity. Swarming of adults occurs soon after daybreak and may continue until mid-morning. Eggs begin hatching in early June, nymphs develop in about five weeks and adults emerge in mid-July. A second peak emergence occurs in late August with occasional individuals appearing as adults into November. The species probably overwinters in the egg stage as mid-winter collections from the streams studied have never produced nymphs.

The mayfly genus *Tricorythodes* has been studied mainly from a taxonomic viewpoint and consequently little is known about the ecology of the nymphal stage, the behavior of the adult, or its life history (Allen, 1967; Berner, 1950). During the summers of the 1969 and 1971 an opportunity to carry out intensive observations made it possible for us to add significant details to our understanding of one species, *T. atratus* McDunnough.

Our study was conducted in Minnesota at the Headwaters of the Mississippi River, Itasca State Park, Clearwater County, and at Birch Creek, near Lake George, Hubbard County, from June through August in each of the two years. We had intended that the entire study be carried out at the "Headwaters" but, after the project was well under way, the nymphal population dropped to a very low level and, concurrently, an accident occurred in which a truck was driven into the stream and gasoline and oil were spilled, damaging the stream environment. After some exploration, we found that Birch Creek had

a high *Tricorythodes* population and was easily accessible for study. As all of the adults reared or captured at both streams were *T. atratus* and as the two streams are separated by only a few miles, we are considering jointly many of the observations made at both areas.

Description of Study Areas

The two sites chosen for this study were conveniently located near the University of Minnesota's Biological Station, which served as our headquarters. The first study area, the Headwaters of the Mississippi River, arises as an overflow of Lake Itasca. At its point of origin and in the areas where the study was done, the river is small, only 12–20 feet wide, and shallow with a depth generally ranging up to a maximum of three feet. Birch Creek, the second site, is likewise small and shallow and in the area studied resembles the Mississippi River Headwaters.

In both streams the beds were composed of sand, silt, gravel, and small stones, although in Birch Creek there were large rocks and small boulders scattered throughout the riffle areas studied. Both streams were well shaded with poplar and willow trees as well as spruce and pine. The aquatic plants that dominated in the Mississippi were *Heterantheria dubia* (Jacq.) MacM., *Ranunculus longirostris* Godr., and *Elodea canadensis* Michx., while a fine film of precipitated organic material covered the rocks. The aquatic plants in Birch Creek consisted chiefly of *Cladophora* sp., fully enveloping the rocks, and the aquatic moss *Fontinalis*. The algae growing along the marginal areas of the stream were predominantly *Spirogyra* sp.

Water in both streams was clear, cool, and generally slightly alkaline to neutral.

Methods

Nymphal specimens for study were collected with a six-inch diameter coffee strainer. At the time that specimens were taken, water temperature was also recorded. In addition, nymphs were removed from water-soaked logs by hand picking and brought back to the laboratory for observation. Owing to their large number of molts, it is difficult to distinguish with certainty any particular instar of a mayfly nymph except the last. A system of categorizing the specimens into size groups was established (Table 1) following the method of Lehmkuhl (1969). Large samples from each of the collecting sites were sorted and classified according to the categories below.

To investigate the phenomenon of drift in *T. atratus*, two stationary drift nets were positioned in midstream near the downstream end of riffles. In both streams the widths were approximately 5 m, depths 0.25 m, and surface velocities 0.38 m/s.

The drift nets measured 15 cm by 30 cm at the mouth and were one meter long. They were constructed of Nitex netting with a mesh size of 471 μ and were supported side by side in the streams by means of iron rods. Detailed descriptions of the nets used are given by Waters (1962) and Holt and Waters (1967).

At hourly intervals the nets were removed and replaced by two identical ones. The debris and organisms caught in the nets were rinsed into an enameled pan, concentrated with a sieve, and stored in individual plastic bags (Nasco Whirl-pac) in a 10% formalin solution. Water temperature, air temperature, and light

Table 1. Characteristics used to separate age groups of *T. atratus* nymphs
(after Lehmkuhl, 1969)

Group	Characteristics	Stage
I	Gills poorly developed, thread-like or absent	Newly hatched
II	No wingpads; gills more fully developed than nymphs of Group I	Young nymphs
III	Mesothoracic wingpads present but small	Half-grown nymphs
IV	Mesothoracic wingpads fully developed	Mature nymphs
V	Wingpads swollen or blackened	Nymphs ready to transform

intensity (Weston Illumination Meter—model 156 Quartz Filter) were measured and recorded each hour before the nets were replaced. After the collections were made, the organisms and debris were manually separated in the laboratory. Only eggs, nymphs, subimagoes, and adults of *T. atratus* were retained for study.

Ten bottom samples were collected at random every two weeks above the drift nets using a modified Hess bottom sampler (Waters and Knapp, 1961). The substrate and organisms therein were processed as described above for the drift investigations. In addition, during the winter substrate cores were taken to determine whether nymphs could penetrate to much greater depths beneath the water-substrate interface. Immediately after removing the substrate from the sample, a galvanized circular core sampler (diameter of 34.2 cm) with a serrated edge was placed inside the Hess apparatus (diameter of 34.4 cm) and forced down approximately 15 cm into the substrate. Subsequently, the material was removed and also processed as described above.

DISCUSSION

Habitat selection: It is obvious from repeated observations that protection afforded *T. atratus* nymphs by plants is significant and that plants growing in more slowly flowing water provide more effective protection than those in fast moving water. The aquatic plants *Elodea*, *Ranunculus*, and *Cladophora* appear equally attractive to the nymphs. Generally, older nymphs are found in more slowly flowing water in vegetation or sometimes attached to logs in protected places, while the smaller forms occur in more swiftly moving water. Intermediate-sized nymphs seem to be associated more frequently with faster currents. All age groups were represented in the various habitats examined, although minimally in some, such as submerged, water-soaked logs.

Nymphal food: The nymphs of *T. atratus* are primarily herbivorous, as our examination of stomach contents of freshly killed nymphs pro-

Table 2. Analysis of stomach contents of 50 nymphs collected during June and July

Miscellaneous plant tissues: stem, leaf, and epidermis; pine pollen
Filamentous blue-green algae (Cyanophyta): *Oedogonium* sp., *Oscillatoria* sp.
Desmids (Chlorophyta): *Scenedesmus* sp., *Staurastrum* sp.
Diatoms (Chrysophyta): *Cocconeis* sp.,* *Hantzschia* sp., *Navicula* sp., *Pennularia* sp., *Fragilaria* sp., *Nitzschia* sp., *Cymbella* sp., *Gomphonema* sp.*

* Most abundant food material

duced only fragments of plant tissue, filamentous algae, desmids, and diatoms. The results of the analyses are listed in Table 2.

In addition, we attempted to ascertain whether nymphs would develop more rapidly on *Elodea* or *Ranunculus* covered with epiphytes (predominantly diatoms). The nymphs were kept in water which was not aerated but was changed at frequent intervals. Ten partially grown nymphs were placed in each of two jars with the respective plants and after two weeks we found that the nymphs in both situations were of equal size. The epidermis of the *Elodea* had been entirely eaten and all diatoms had been cleaned from the surface of the *Ranunculus*. Apparently the nymphs do equally well on both foods.

Drift: The phenomenon of drift of stream invertebrates has been known for some time but has been investigated intensively only within recent years. Periodicity, reflected in drift rate, has been studied by Tanaka (1960), Waters (1962, 1965), Müller (1963a, b), Elliott (1967a, b), and others. Additionally, Dendy (1944) and other workers have noted that the drift of stream organisms is a constant factor and has considerable ecological significance.

Variations in drift rate have been attributed to natural events, such as increased rate of water flow (Anderson and Lehmkuhl, 1968; Lehmkuhl and Anderson, 1972), and to manipulation of flow by investigators (Minshall and Winger, 1968), both resulting in an increased drift rate. Furthermore, Elliott (1967a) reported that the tenacity of insects could be correlated with stream velocity. He found that thigmotactic response was greatest in faster flowing water, while in slower moving water, the taxis was reversed, with the organisms swimming about freely. Elliott also observed that these freely-moving organisms may exhibit the phenomenon of jostling, a behavioral competition among a number of organisms for a limited area as well as a limited food supply. Weninger (1968) concluded that along with flow velocity the substrate is of great importance in drift activity.

To determine the influence of forces other than stream flow, Holt and Waters (1967) tried artificial lighting during the night hours. Under these conditions, the night-time drift rate decreased indicating that these circadian rhythms appear to be controlled to some extent by exogenous factors. Chaston (1968) has postulated that under normal light illumination the variation in drift-bound organisms is under both exogenous and endogenous controls.

With the exception of Weninger's (1968), Anderson's (1967), Elliott's (1967a, 1968, 1969, and 1971), Lehmkuhl's (1969), and Lehmkuhl and Anderson's (1972) studies, few others have investigated life histories using drift techniques to determine the cycle of a single species from its early stages through the adult. This part of the study of *T. atratus* was undertaken to try to establish a relationship between what is known about the phenomenon of drift and the major phases in the insect's development.

To enable us to recognize eggs of *T. atratus* in drift samples, eggs were taken from females in the act of ovipositing. They were formed in a spherical, greenish cluster under the abdomen and were obtained by touching the females to water in small dishes. The eggs immediately dissociated, settled to the bottom, and adhered. They also attached to any foreign objects in the water.

The eggs are ovate with scales or plates around the outer edge and with numerous small whitish filaments at one end. They measure 0.20 mm. in width and 0.25 mm. in length and range in color from light to dark green. A detailed description and figures of the eggs of this genus are given by Koss (1968).

Eggs were often found in the drift debris (Tables 3 and 4). They never occurred individually but always in clusters ranging in size from 25 to 100 eggs. They adhered to each other by means of the whitish terminal filaments. Bundles of egg masses in the nets were found clinging to filamentous algae or to small pieces of plant epidermis, while many eggs were located inside the remains of the female *T. atratus* thoraxes. Eggs were caught in the nets at various hours of the day and night, a reasonable finding since eggs tend to attach to the aquatic plants and the plants in turn were found in the drift at all hours.

While the eggs were collected at various times throughout the 24-hour period, nymphs of *T. atratus* living in the Mississippi River, however, showed a very distinct periodicity in drift rate, with the peak drift occurring within two hours after sunset (Fig. 1). With the coming of dawn and a consequent increase in light intensity, drift decreased until a minimum rate was reached and remained at that level for the remainder of the daylight hours. A similar pattern of drift was shown by the nymphs of Birch Creek, although fewer organisms were taken.

Table 3. Results of hourly collections of drift-net samples of *Tricorythodes atratus* from the Mississippi River Headwaters. Temperatures given in degrees Centigrade. Collections made on August 16, 1969.

Hour	Temperature Water	Air	Light intensity foot candles	Eggs Present	Nymphs	Subimagoes ♂	♀	Imagoes ♂	♀	Exuviae
800	22	17	520	—	1	—	—	2	—	—
900	22	19	620	—	—	—	—	2	17	—
1000	22.5	24.5	820	—	1	—	—	—	3	—
1100	23	28	7400	x	1	—	—	—	—	—
1200	24	29	7800	x	2	—	—	—	—	—
1300	24.5	29.5	8400	—	—	—	—	—	—	—
1400	25	29.5	8400	—	1	—	—	—	—	—
1500	26	33	9250	—	1	—	—	—	—	—
1600	26	29	5600	—	—	—	—	—	—	1
1700	26	29	4000	—	1	—	—	—	—	—
1800	24.5	26	3000	x	2	—	—	—	—	—
1900	26	24	1000	x	2	—	—	—	—	—
2000	25	23	280	x	5	—	—	—	—	—
2100	26	20	2	x	10	—	—	—	—	—
2200	26	19	0	x	100	8	8	—	—	1
2300	26	17	0	—	115	5	—	—	—	2
2400	25.5	18	0	x	94	4	—	—	—	—
100	25	20.5	0	x	84	1	—	—	—	3
200	25	20	0	x	71	—	—	—	—	—
300	25	20	0	—	45	—	1	—	—	—
400	25	19.5	0	—	42	—	1	—	—	—
500	24.5	19.5	0	x	31	—	—	1	—	—
600	24.5	20	0.5	—	5	—	24	—	6	5
700	24.5	23	400	—	1	—	—	2	11	1

To determine whether nocturnal activity is associated with stage of development, categories established by Lehmkuhl (1969) were used to separate the nymphs into various size-class/age groups (Table 1). All nymphs collected were categorized according to these criteria. Nymphs fitting the characterizations of Group II were those most frequently taken from the Mississippi River drift, while those from Birch Creek were generally older, falling into Groups III, IV, and V (Fig. 2). Anderson and Lehmkuhl (1968) concluded that mature nymphs could avoid downstream displacement better than smaller ones because of their better swimming abilities. If this is a correct conclusion, one would expect to obtain more of the Group II nymphs in the drift. The Mississippi collection, but not that from Birch Creek corroborated this point.

Table 4. Results of hourly collections of drift-net samples of *Tricorythodes atratus* from Birch Creek. Temperatures given in degrees Centigrade. Collections made on August 22, 1969.

Hour	Temperature		Light intensity foot candles	Total hourly catch						
	Water	Air		Eggs Present	Nymphs	Subimagoes		Imagoes		Exuviae
						♂	♀	♂	♀	
800	20	15.5	720	—	—	—	—	1	3	—
900	20.5	20	2600	x	1	—	—	3	43	3
1000	21.5	26	4200	x	1	—	—	21	11	—
1100	22	24	6800	—	1	—	—	2	3	—
1200	23.5	25	7300	x	1	—	—	4	1	—
1300	24.5	26.5	8000	—	1	—	—	—	—	—
1400	25	29	8400	—	—	—	—	2	—	1
1500	26	26	7400	x	1	—	—	—	—	—
1600	25	31.5	6000	—	—	—	—	—	—	—
1700	26	27	4400	—	—	—	—	—	—	—
1800	26	26.5	2700	—	—	—	—	—	—	—
1900	25	25.5	700	—	1	—	—	—	—	—
2000	24	19.5	0	—	—	—	—	—	—	—
2100	23	15.5	0	—	1	1	—	—	—	—
2200	22	15	0	—	8	1	—	—	—	—
2300	22	14.5	0	—	11	1	—	—	—	—
2400	21.5	13	0	—	3	1	—	—	—	1
100	20.5	11.5	0	—	8	2	—	—	—	—
200	20.5	11.5	0	—	7	—	—	—	—	1
300	20	10	0	—	4	—	—	—	—	—
400	20	10	0	—	2	—	—	—	—	—
500	20	9	0	—	3	1	—	—	—	—
600	19	9	0.2	—	—	—	2	—	—	1
700	19	9	220	—	—	—	—	—	—	—

Waters (1965) suggested that organisms leave the benthic regions and appear in the drift for only a short time before returning to the bottom. The differential positioning of the nets in the streams, then, could account for some of the differences in the total numbers of nymphs and their size classes represented in the samples from each stream. Müller's (1954) "Colonization Cycle" (i.e., migration of adults upstream, oviposition at the limits of their habitat range, and subsequent downstream drift of larvae) might also help explain the discrepancies in collections from the two streams, for it again involves the positioning of the nets. If the nets were placed close to the area of oviposition, eggs and young nymphs might be expected to be predominant in the drift, as well as a large number of female imagoes, for generally they do not return to flight after egg deposition. If the
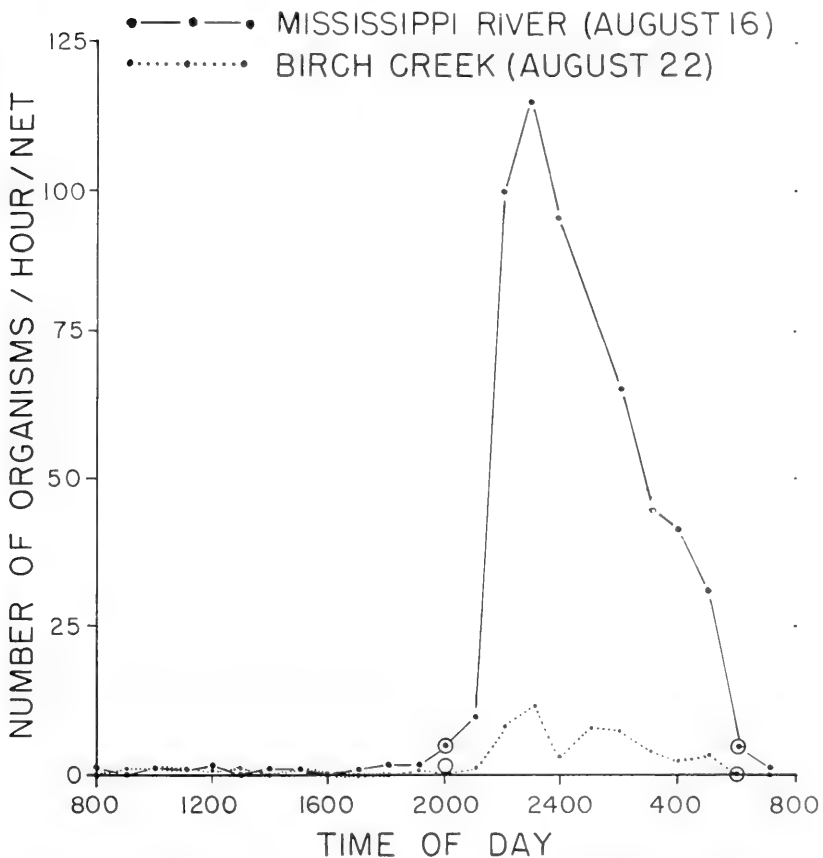
Fig. 1. Drift rate of *T. atratus* nymphs based on number of organisms collected per hour per net over a 24-hour period. Closed circles indicate sunrise and sunset.

nets were relatively distant from the oviposition area, the older age groups of nymphs could be more prevalent in the drift collections.

Another factor that should be considered in explaining differences in numbers of nymphs collected at the two sites is the amount of brush hanging over the water, often with many branches extending below the water surface. When such submerged branches were lifted from the water, we observed that many nymphs of *T. atratus* were present on the branches and leaves. Preferential placement of drift nets near such over-hanging vegetation could be a factor that would affect the results when comparing drift samples from different areas.

Data in Tables 3 and 4 support our observations that the female

MISSISSIPPI RIVER (AUGUST 16)
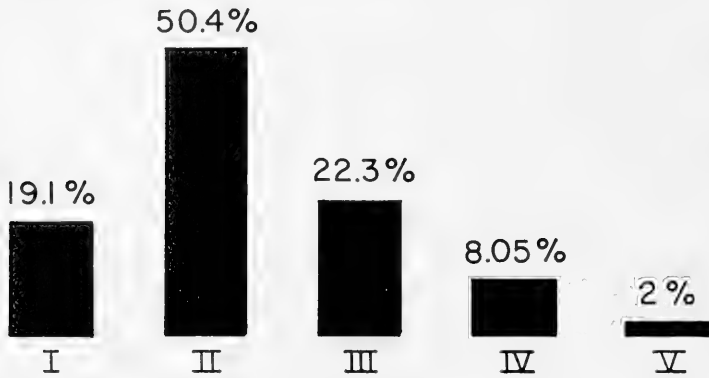
BIRCH CREEK (AUGUST 22)
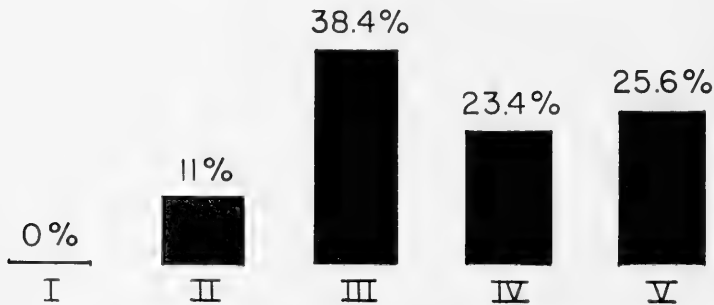
AGE GROUP / SIZE CLASS

Fig. 2. Size class of *T. atratus* nymphs based on 24-hour drift collections. Bars indicate the percentage of total collection in each size class.

subimagoes emerge in the evening when there is a significant drop in light intensity and begin emerging again in the early hours of the morning when the light intensity just begins to increase (Fig. 3). There is apparently a positive correlation between a low level of light and emergence time of the female subimago. The conclusion that low light intensity and emergence of the female are correlated was con-
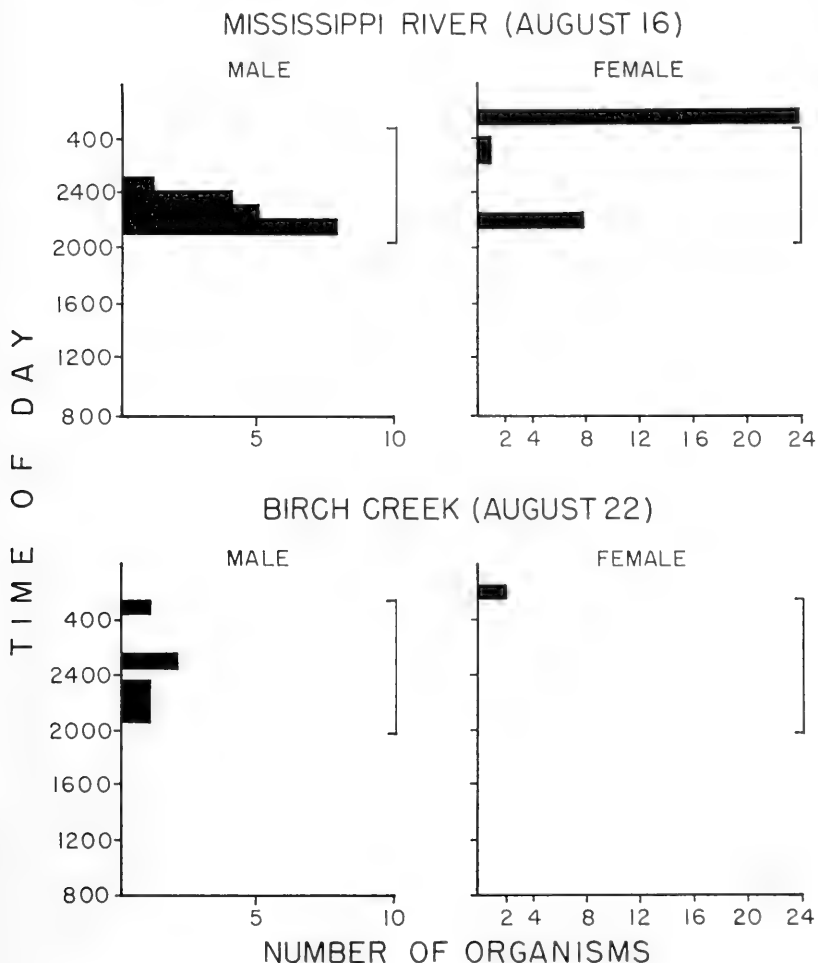
Fig. 3. Number of *T. atratus* subimagoes collected at the time of emergence over a 24-hour period. Bracket to the right of each graph indicates hours when light-meter readings were too low to record.

firmed by our laboratory observations and by field experiments with a light trap. We noted that the females never emerged at times other than when the light intensity was at a low level, and we never observed emergence of this sex after dark.

Our observations that most females oviposited about 9:00 a.m. are confirmed by the data given in Tables 3 and 4; however, it is apparent that the process must have begun as early as 8:00 a.m. and continued to 10:00 a.m. on the dates that 24-hour drift samples were
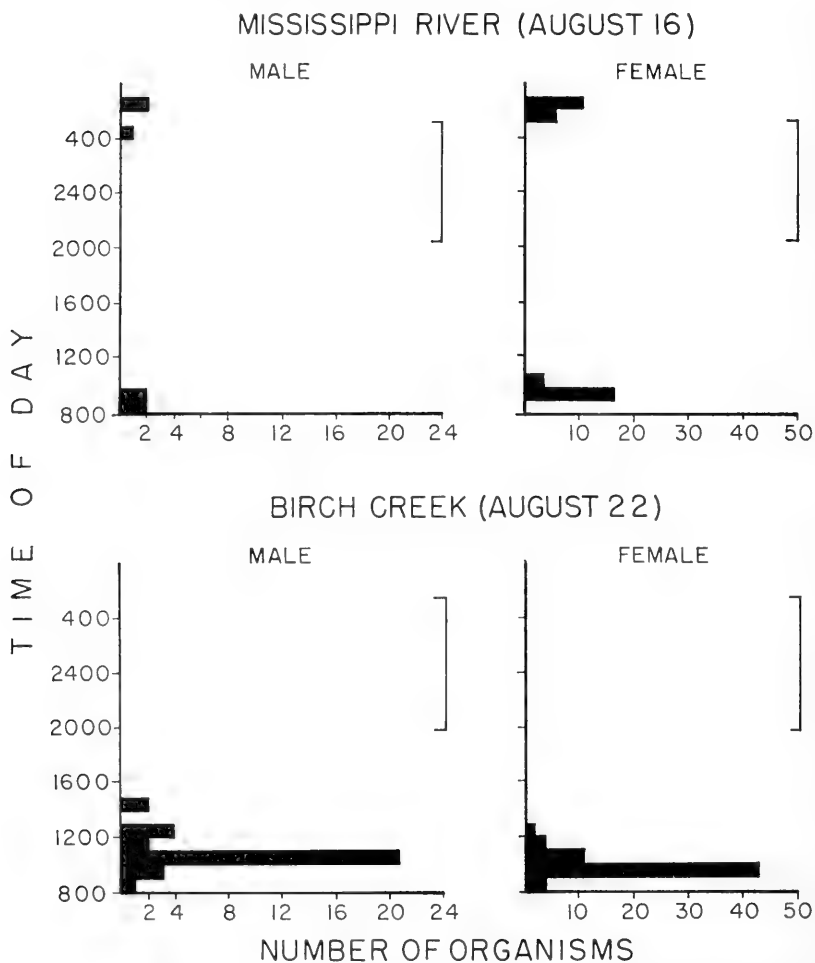
Fig. 4. Number of *T. atratus* imagoes collected in the drift after they returned to the water. Collections were made over a 24-hour period. Bracket to the right of each graph indicates hours when light-meter readings were too low to record.

taken (Fig. 4). We believe, further, that these data are substantiated by the fact that females do not usually return to flight after egg deposition but simply drop onto the water surface, an observation which we have made repeatedly in the field.

Male adults began falling to the water surface at 8:00 a.m. and continued to do so as late in the afternoon as 2:00 p.m., as reflected in the 24-hour drift samples (Fig. 4). The male longevity has also been confirmed by field observations.

Emergence of the subimago and transformation to the adult: Several factors appear to affect the emergence patterns of the females. When the current velocity was high, the subimagoes emerged directly from the stream; however, in the more slowly flowing water, or in the absence of current, the females were seen to climb from the stream and fly to the overhanging branches. When the humidity was high, the subimagoes remained on the trees until rays of sunlight struck them, at which time molting occurred, and the adults would then fly to a height of about 35–50 feet. When the humidity was low, however, they would molt faster, usually within two or three minutes.

The pattern of male emergence observed was similar to that of the female except that the event did not occur until light intensity was so low that our meter gave a zero reading. Males began to appear on the wing at 9:00 p.m. and continued to emerge until 1:00 a.m. A few additional subimagoes emerged between 4:00 and 5:00 a.m. (Fig. 3). With the first signs of dawn, emergence ceased.

Because the molt from nymph to subimago occurs so late in the evening, or in the early hours of the morning, it was difficult to make detailed observations of this event in the field. Consequently, large numbers of Group IV (mature) nymphs were brought to rearing cages in the laboratory. They were kept in white-enameled pans to which small sprigs of *Ranunculus* and blades of grass were added as resting places. The rearing cages were placed in an area where they were exposed to fluctuating outside temperatures.

In mid-July at 9:55 p.m., just at dark, one *Tricorythodes* nymph was observed molting to the subimaginal stage underwater. Rather than being expanded vertically or horizontally, the wings remained folded against the thorax and the subimaginal insect then swam underwater to an emergent blade of grass, crawled up on it until it was free of the water, and remained quiescent. Soon thereafter it opened its wings into the normal position of the subimago. At 10:05 p.m. of the same evening three other nymphs behaved in an identical manner. The four subimagoes were transferred to pint jars and placed on blades of grass. At 4:20 a.m. one subimago transformed, the process taking approximately two minutes. Within 15 minutes the three other mayflies had molted but the time required of exuviation varied slightly. Three of the four imagoes retained the subimaginal exuviae on the caudal filaments for an additional two or three minutes. Subsequent observations, including those conducted in an artificial stream with a sand and gravel substrate, have confirmed the underwater emergence pattern of *Tricorythodes*. Final corroboration of our observations will require intense field study of this phenomenon.

Many additional observations of subimagoes show that exuviation generally requires about one minute. Mississippi River males collected between 10:30 p.m. and 2:00 a.m. molted to the imaginal stage be-

tween 4:30 and 5:30 a.m.; those from Birch Creek taken between
9:00 and 10:00 p.m. reached the adult stage between 2:00 and 3:00
a.m. Females, regardless of time of emergence, apparently molt to
the imago stage shortly before mating, with some females molting im-
mediately after emerging and others waiting as long as two hours.
Molting was observed to occur between 7:45 and 8:30 a.m. in early
to mid-August. Although we have no data to support the hypothesis,
we believe that molting is controlled in part by humidity, temperature,
and time of emergence under natural conditions. That molting does
occur at an earlier hour is obvious for we have seen ovipositing fe-
males as early as 5:00 a.m., just at dawn, in mid-July.

Mating flights: Male and female *Tricorythodes* show differential
flight patterns. Individual females flying over a stream displayed the
usual mayfly behavior, progressing in an up-and-down movement as
diagramed in Fig. 5. We observed single males flying with a rather
different movement—producing more of a gliding up-and-down effect
(Fig. 6). As the males assembled into swarms, the flight pattern
changed to resemble that of the individual female, perhaps the change
serving in part as an attractant to the female.

As the sun rose on July 8 and July 13, we saw large swarms of
male *Tricorythodes* 25–30 feet above the Mississippi River. Later, in
early to mid-August, we observed males patrolling over the stream
at a height of 30–50 feet. At times, we noted thousands of males
flying at this height in the jerky, up-and-down pattern described
above. The insects seemed to favor tree-top level for their flight, where
light was somewhat greater than at lower elevations. The swarms of
males moved in unison as though there were a cloud of black spots
suspended in the air. Occasionally the swarm would descend suf-
ficiently so that we were able to collect a large number of the males
by sweeping a net through it. We took very few females in these
sweeps.

We observed females in small groups of three of four flying up-
stream and directly into the large swarm of males, and while there
appeared to be a constant flow of females into the male assemblage,
we never observed the actual mating of *T. atratus* with certainty.
After the entry of a large number of females into the swarm, the flight
continued for another 20–30 minutes after which the individuals began
to disperse so that there was no longer a single large swarm. Still the
males continued their up-and-down flight at a height of 25–30 feet.
After leaving the swarm, the females dropped to stream level to begin
oviposition.

On July 8 at 5:00 a.m., just at dawn, and on July 13 at 5:30 a.m.,
we saw females flying approximately 6–8 feet above the water's
surface, patrolling up and down over a limited section of the stream.
The flight up- and downstream occurred from one to four times,
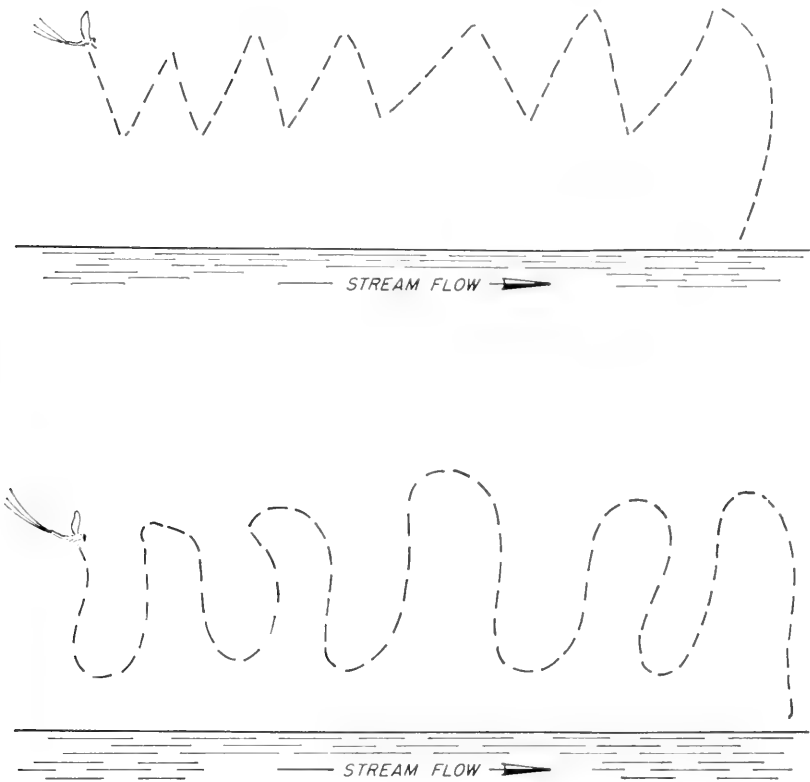
Fig. 5–6.   Diagrammatic representation of flight of individual female *T. atratus* imagoes, terminated by dropping onto the water surface. 6, Diagrammatic representation of flight of lone males of *T. atratus* prior to swarming. Following swarming, males drop to the water surface.

suggesting that the females may have been searching for a suitable oviposition site. Once committed, the female descended swiftly to the water, broke through the water surface over clumps of submerged vegetation, apparently oviposited, and then either remained on the water or rarely returned to the air. We observed flights of females only over water, with oviposition generally taking place at the upstream end of a riffle area.

The flights in early to mid-August seemed to begin as early as 6:15–6:30 a.m., with the females leaving the swarming males around 9:30 a.m. After 10:00 a.m. few additional females were seen (Figures 2 and 3; Tables 3 and 4). Our observations of times of swarming are consistent with those of Leonard and Leonard (1962) who reported seeing *T. stygiatus* flying from 4:30–10:00 a.m.

The adult life of *T. atratus* clearly shows that it is but a brief part of the species' entire life history, lasting only nine to ten hours, beginning at dusk and terminating soon after the sun is well above the horizon.

Life cycle: From our study of numerous bottom samples we have observed that the eggs hatch early in June, the nymphs develop for approximately five weeks, and the adults start to emerge in mid-July. There appears to be a second peak emergence in late August with some adults emerging continuously from mid-July to November.

Our study of winter samples leads us to believe that this species overwinters in the egg stage because no nymphs have ever been taken during that time period in drift, bottom, or core samples. Continued emergence from mid-July until November, plus the fact that small nymphs were collected in late summer and fall bottom samples, indicates that this species is multivoltine. Subsequent detailed analysis of extensive benthic and drift sampling should clarify the above observations and will be reported at a later date.

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THE GALL MIDGES OF RAGWEED, AMBROSIA, WITH DESCRIPTIONS OF TWO NEW SPECIES (DIPTERA: CECIDOMYIIDAE)

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ABSTRACT—Four species of Cecidomyiidae, all from North America, occur on ragweed, *Ambrosia* spp.: *Asphondylia* **ambrosiae** Gagné, new species, *Contarinia partheniicola* (Cockerell), *Rhopalomyia* **ambrosiae** Gagné, new species, and *Neolasioptera ambrosiae* Felt. The first 3 species form bud galls; the last lives in the stems. The poorly known *C. partheniicola* is redescribed on the basis of new specimens.

It will be small comfort to hayfever sufferers in North America to know that four species of Cecidomyiidae feed on ragweed and indirectly reduce pollen production. The work of these species is ineffective, in large part, presumably, because parasites reduce gall midge populations considerably. But in Europe and Asia, where *Ambrosia artemisiifolia* L. has become naturalized, these midges, minus their parasites, can be regarded as possible biological controls. The gallforming cecidomyiids, in general, are assumed to be good risks for introduction because of evidence or, in some cases, belief that they are closely host specific. Dr. O. V. Kovalev of the All-Union Plant Protection Institute in Leningrad intends to test for host specificity the Nearctic species of gall midges treated below. If the species prove specific enough, they presumably will be introduced into Russia.

Two of the four cecidomyiids from *Ambrosia*, the *Asphondylia* and the *Rhopalomyia*, are new to science. Another species, *Contarinia partheniicola* (Cockerell) is poorly known and so odd compared with its congeners that I have redescribed it.

I am describing the two new species only because of their immediate importance in biological control work. Ideally, descriptions of new species in such large genera as *Asphondylia* and *Rhopalomyia* should await a thorough generic revision. Even though I have reviewed (unpub.) the Nearctic species of *Asphondylia* and *Rhopalomyia*, the immature stages of many species are still unknown, and because of this, I am unable to distinguish satisfactorily among many species known only from adults or from one sex. The probable result of the existence of many indistinguishable "species" is that one will be led to conclusions that are not necessarily correct concerning host specificity.

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Asphondylia ambrosiae Gagné, new species

Adult: Wing length: ♂, 2.7–2.9 mm; ♀, 3.2–3.4 mm. Palpus of 3 cylindrical segments of uniform diameter; segment I slightly longer than wide, II about 2× as long as I, III about 3× as long as long as I. Tarsal claws as in fig. 14. Distal half of ovipositor (needle-shaped portion) 1.7–2.1 as long as sternum VII.

Pupa: Antennal horns and frontal crests as in fig. 15, 16.

Larva: Spatula as in fig. 13. A pair of terminal papillae apparent on each side of anus.

Holotype: Pupal exuvium, Miami, Fla., XI-4-1971, C. E. Stegmaier, Jr., USNM Type No. 72836. A pupal exuvium was chosen as holotype because pupal characters are the most diagnostic in *Asphondylia*; there was no adult specimen associated with the holotype exuvium. Paratypes (all in USNM): ♂ ♂, ♀ ♀, pupal exuvia, and larvae, ex galls on *Ambrosia artemisiifolia*, Hialeah, Fla. (C. E. Stegmaier, Jr.) and ex *Ambrosia monophylla* (Walt.) Rydb., Lake Placid, Fla. (S. W. Frost), and ♂ ♂, ♀ ♀, and pupal exuvia from *Ambrosia dumosa* (Gray) Payne, San Diego Co., Calif. (R. D. Goeden and D. W. Ricker).

A. ambrosiae forms fuzzy, globose bud galls on *Ambrosia* spp. Pupation takes place within the galls.

The pupae and larvae are similar to those of *Asphondylia helianthiglobulus* Osten Sacken. The only difference I can find between these two species is the length of the ovipositor with respect to that of sternum VII. The ovipositor of *helianthiglobulus* is somewhat longer than that of *ambrosiae* at 2.6–2.8 times the length of sternum VII. Comparison of *ambrosiae* with *Asphondylia xanthii* Felt, reared in Texas from *Xanthium*, a plant with a close affinity to *Ambrosia*, is not possible: the ovipositor of the lone female type of *xanthii* is broken off, and the immature stages are unknown.

Contarinia partheniicola (Cockerell)

Diplosis partheniicola Cockerell, 1900:201.

Male: Wing length, 2.3–2.6 mm. Postvertical peak absent. Eye facets hexagonoid ventrolaterally, rounded elsewhere, not appreciably farther apart laterally than dorsally. Antennal flagellomere III (fig. 8): loops of circumfila short, the bases not evenly aligned on a horizontal plane; internode and neck shorter than preceding nodes. Frontoclypeus with 9–18 setae. Palpus short, one-segmented. Anepisternum with 7–12 setae. Claws and empodia of equal length. Abdominal terga without scales and with few lateral setae: terga I–V (all setal counts made on one-half of terga) with 0–4 lateral setae; VI with 11–14 caudal setae, 3–7 laterals; VII with 9–18 caudals and 7–12 laterals; caudal setal rows unbroken
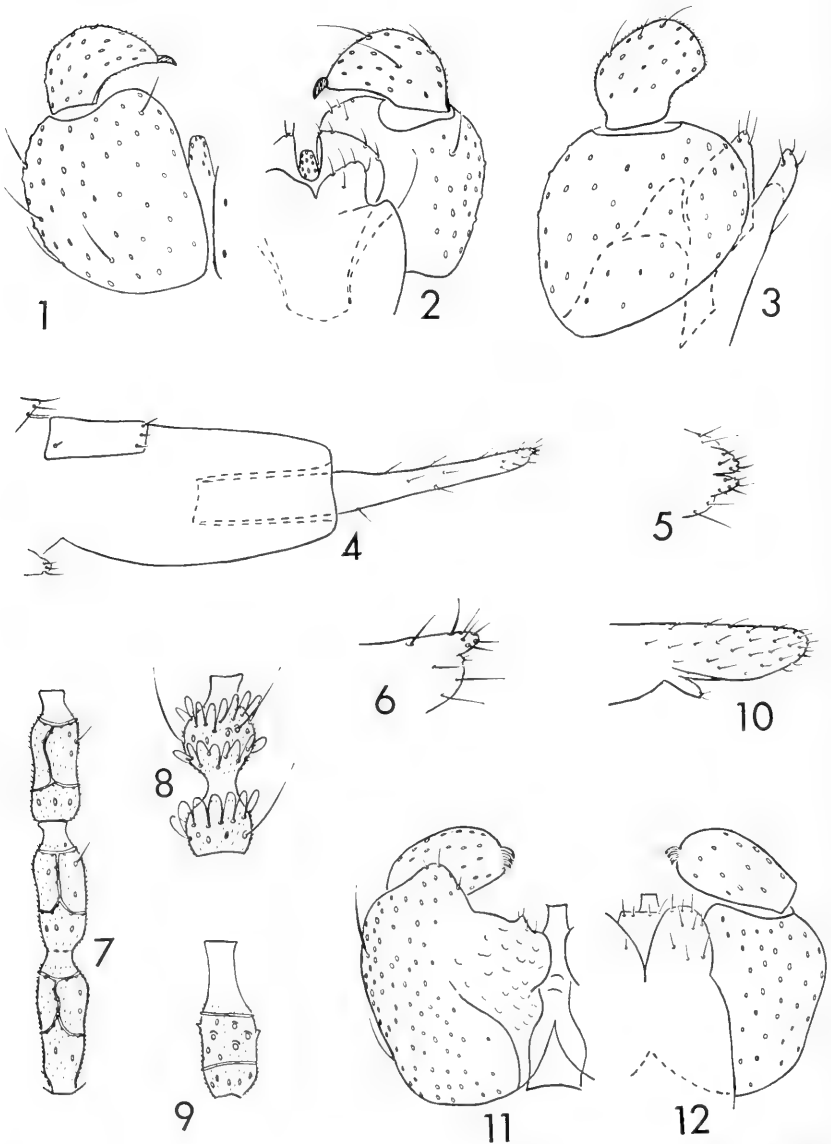
Fig. 1–8. *Contarinia partheniicola.* 1, ♂ genitalia (ventral view). 2, same (dorsal). 3, same (lateral). 4, ♀ postabdomen (lateral). 5, ♀ cerci (dorsal). 6, same (lateral). 7, ♀ flagellomeres I–III. 8, ♂ flagellomere III. Fig. 9–12. *Rhopalomyia ambrosiae.* 9, ♂ flagellomere III. 10, ♀ cerci (lateral). 11, ♂ genitalia (ventral). 12, same (dorsal).
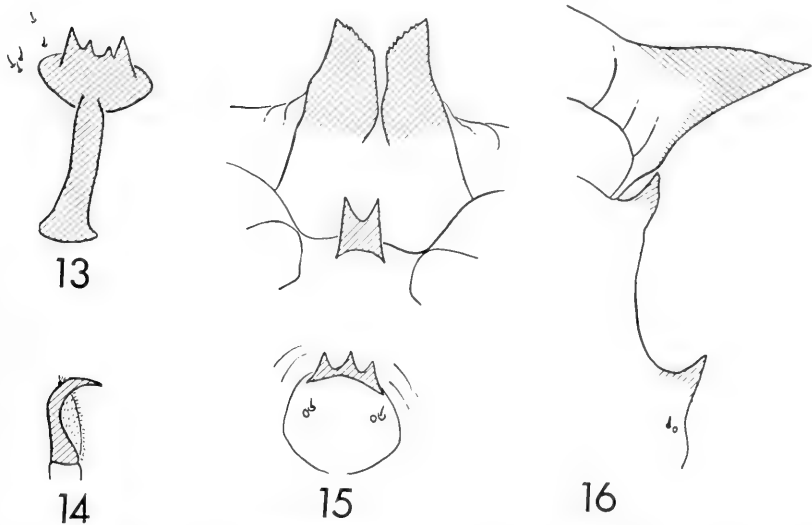
Fig. 13–16. *Asphondylia ambrosiae*. 13, larval spatula. 14, adult tarsal claw. 15, pupal cephalic armature (ventral). 16, same (lateral).

or with slight interruption mesally. Genitalia (fig. 1–3): cerci triangular; lobes of sternum X short, wide, obtuse apically; aedeagus short, wide, punctate; basimere very stout; telomere setulose throughout, very wide basally, tapering to apical tooth.

Female: Wing length, 1.7–1.9 mm. Antennal flagellomeres I–III (fig. 7) with proportions about as 1.00:0.86:0.81 (average of 4 spns.). Other cephalic and thoracic characters as in male. Abdominal terga without scales and with few lateral setae (all setal counts made on one-half of terga): terga I–V with 2–4 lateral setae and a single complete row of caudal setae; VI with 0–10 laterals and 15–17 caudals mainly in single row; VII with 2–8 laterals and 15–16 caudals in double row; VIII with 1–4 short caudals. Tergum VII (measured from basal trichoid sensillae to caudal edge) about 0.4 length distal half of ovipositor (fig. 4); cerci (fig. 5, 6) short, about as wide as long, broadly rounded apically.

Larva and pupa unknown.

Lectotype, here designated, male, emerged III-26-1900, ex galls on *Parthenium incanum* H.B.K., near foot of Picacho Mt., Mesilla Valley, N. Mex., in Felt Collection [sent to Felt by Cockerell] on indefinite loan to Systematic Entomology Laboratory, U.S.D.A., from New York State Museum in Albany. Paralectotypes: 3 ♂ ♂, same data as lectotype, in Felt Collection; pupa[e], larva[e], gall[s] either not saved or lost. Additional adults (all on *Ambrosia* in California collected by R. D. Goeden and D. W. Ricker): ex galls on *Ambrosia chamissonis* (Less.) Payne, II-12-1970, San Clemente, Orange Co.; *A. confertiflora* D.C., XI-9-1970, Otay, San Diego Co.; *A. dumosa*

(Gray) Payne, III-4 to 8-1971, Desert Center, Riverside Co.; *A. eriocentra* (Gray) Payne, Cedar Canyon, San Bernardino Co.; *A. psilostachya* DC, I-28-1970, Alpine, San Diego Co., and I-28-1969, Oceanside, San Diego Co.

Contarinia partheniicola forms whitish, woolly, cupulate galls 5–8 mm long and 4–5 mm wide. Previously reported only from *Parthenium incanum*, the type host, it is now known to occur on *Ambrosia* spp. *Parthenium* and *Ambrosia* are closely related genera. R. D. Goeden writes (pers. comm.) that the galls on *Ambrosia* are formed singly or in small groups on various parts of the shoots, e.g., on axillary buds along the stems, on the young leaves, on the staminate florets, and along the rachis of the inflorescence.

This unusual species nearly bridges the gap between *Contarinia* and *Halodiplosis*; the latter now seems only an offshoot of *Contarinia* stock that is adapted to the Chenopodiaceae. As species of *Contarinia* become better known, they only broaden the generic definition. Although *C. partheniicola* resembles *Halodiplosis* in the foreshortened, broad, male genitalia and female cerci, the one-segmented palpus, and the tricircumfilar male flagellomeres, the two taxa are not necessarily monophyletic. The last two characters occur elsewhere in *Contarinia*, and the first two may be merely adaptive. The larva of neither taxon is known but might clarify the matter. In my key (Gagné, 1973) *C. partheniicola* will run to *Halodiplosis*, but, unlike *Halodiplosis*, *C. partheniicola* has only a few scattered setae on the distal half of the ovipositor, the empodia and tarsal claws are of equal length, and the telomere of the male genitalia is widest basally, and its tooth is very narrow.

Neolasioptera ambrosiae Felt

Neolasioptera ambrosiae Felt, 1909:288.

This species was originally and subsequently reared from stems of *Ambrosia trifida* L. in New York. In addition I have found it in Maryland in stems of *A. artemisiifolia* L. *N. ambrosiae* is hard to find because there is usually no apparent gall or only the slightest swelling; occasionally, it causes a noticeable fusiform swelling on the small side branchlets. One to several larvae occur in a stem where they crawl up and down silken tubes where the pith would normally be. Before pupation, the larva cuts a hole almost all the way through the twig and retracts into the pith, where it overwinters. In spring the larva pupates, and the adult emerges a short time later.

Rhopalomyia ambrosiae Gagné, new species

Adult: Wing length: ♂, 1.8–1.9 mm; ♀, 1.7–1.9 mm. Male antenna broken; flagellomere III as in fig. 9. Female antenna with 18–19 flagellomeres; flagel-

lomere III without definite neck, gradually tapering from end of node to apex. Eyes broadly joined at vertex. Palpus 1-segmented, the apex blunt or pointed. Claws simple, slightly shorter than empodia. Terga with lateral setae; caudal setal rows not interrupted mesally. Male genitalia as in fig. 11–12. Ovipositor elongate, the fused cerci as in fig. 10.

Pupa: Antennal horns not produced, the ventrocephalic corner barely acute. Frons without projections.

Larva: Unknown.

Holotype, male, ex terminal galls on *Ambrosia artemisiifolia*, VI-7-1966, Hialeah, Fla., C. E. Stegmaier, Jr., USNM type number 72837. Paratypes, 6 ♂ ♂, 4 ♀ ♀, pupa, same data as for holotype.

C. E. Stegmaier, Jr., writes (pers. comm.) that *R. ambrosiae* forms a bud gall on the terminal tips of *A. artemisiifolia*. In my manuscript key to *Rhopalomyia*, *R. ambrosiae* runs closest to *R. bulbula* (Felt), a species that forms galls on the crowns of goldenrod (*Solidago*). The male genitalia of the two species are similar except that those of *bulbula* appear more robust. Comparison of abdominal sclerites of the two species is not possible because all the specimens I have of *ambrosiae* were killed too soon after eclosion. Also, the pupa of *bulbula* is unknown. There are so many different species of *Rhopalomyia* on goldenrod, each species making a different kind of gall, that I think it is safe to consider *R. ambrosiae*, found on a different host and forming a distinct gall from *R. bulbula*, a separate species.

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A NEW NORTH AMERICAN GENUS OF EUMENIDAE
(HYMENOPTERA: VESPOIDEA)

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ABSTRACT—A new genus, **Smeringodynerus,** is described for *Odynerus morelios* de Saussure, previously placed in the genus *Euodynerus.* Pertinent illustrations, including a habitus figure of the male, are included.

While engaged in a routine study of some species currently assigned to the genus *Euodynerus,* I discovered that one species, at least, should not be placed there. Further investigation revealed that this species cannot be placed in any of the existing genera. The higher classification of the New World eumenids has not received much attention. Parker (1966) has provided the first adequate key to the North American genera. Much work remains to be done, especially in the fauna of the tropical areas.

Smeringodynerus Snelling, new genus

Diagnosis: First discoidal cell acutely pointed apically; summit of postscutellum rounded; lower propodeal lamella free on 3 sides; male antenna rolled apically; abdomen sessile; mandible 5-toothed in both sexes; head about as broad as long.

Description: Body stoutly cylindrical; head about as broad as long, antennal sockets slightly below midpoint in full-face view; mandibles 5-toothed in both sexes; mouthparts short, not extending beyond fore coxa, maxillary and labial palpi, respectively, 4- and 6-segmented (fig. 4); labrum elongate, slender, narrowly rounded apically, extending about ½ length of mandible; vertex bituberculate in both sexes; female without mite chambers on vertex, but with a pair of dense clusters of short, golden hairs, clusters separated by about their own length; front face of pronotum without median pits, but with scattered coarse punctures laterally; without raised pronotal lamella, humeral angles sharp; postscutellum rounded in profile, propodeal enclosure bounded anteriorly by arcuate lamella-like carina and laterally by low carina; lower propodeal lamella free on 3 sides, almost square; first tergite ventrally not overlapping first sternite anteriorly; second sternite without median basal suture, with strongly raised transverse tubercule; wings elongate, narrow, first discoidal cell acute apically; male genitalia stout (fig. 5); aedeagus blunt, short, simple; digitus with many sensillae basally, membranous apically, inner face with dense, long, simple hairs (fig. 7).

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Fig. 1–7. *Smeringodynerus morelios* (de Saussure). 1, male, lateral view. 2, male, frontal view of head. 3, female, same. 4, mouthparts, glossal hairs not shown. 5, genitalia, dorsal (left) and ventral views. 6, aedeagus in profile. 7, volsella, pubescence removed. Figures by Ruth Ann DeNicola.
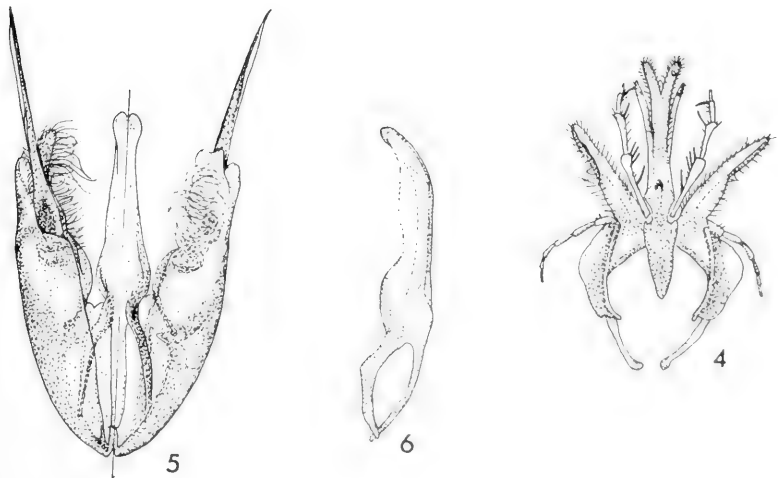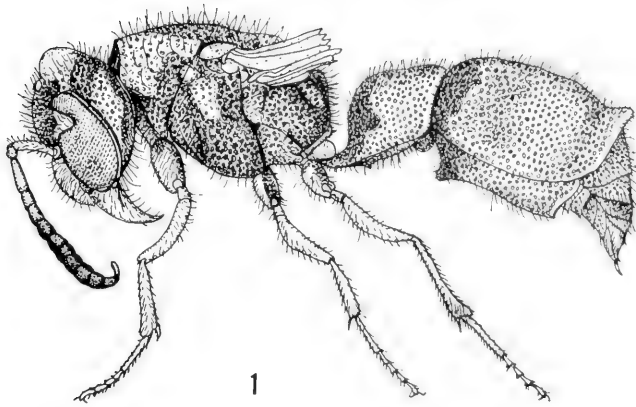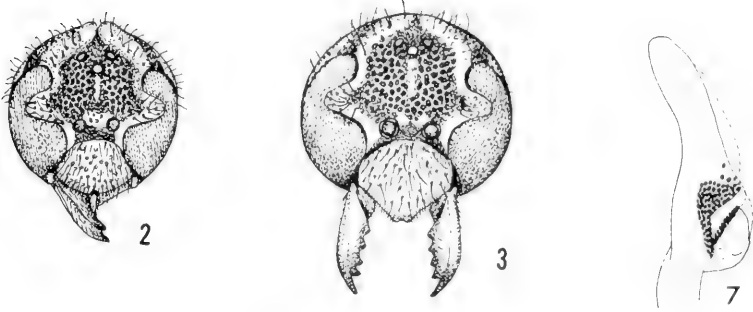
Type-species: *Odynerus morelios* H. de Saussure, 1857.

Etymology: Greek, *smerinx* (bristle) + generic root, *Odynerus*, because of the peculiar long, black bristles on the body.

Discussion: *Smeringodynerus* is presently known to include only the type-species, which ranges from western Texas to southern Arizona, south into temperate portions of Mexico.

In the key to North American genera by Parker (1966), *Smeringodynerus* will go to *Cephalodynerus* from which it differs in the broader head, five-toothed mandible and lack of a median suture at the base of the second sternite. As noted above, *S. morelios* has previously been placed in *Euodynerus*; it must be excluded from that genus because of the free lower propodeal lamella, the absence of a median suture at the base of the second sternite, the narrower labrum and the triangular three apical mandibular teeth.

This genus is probably most closely related to *Cephalodynerus*, possibly derived from a similar primitive stock. Unlike this and many other other eumenine genera, the three apical teeth of the mandible are all triangular and of approximately equal size.

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NOTE ON THE USE OF THE SUFFIXES *-FER* AND *-GER* IN NOMENCLATURE

It is a common misconception that words formed with the suffixes *-fer* and *-ger*, both meaning 'bearing,' should have the ending *-us* in the masculine. These suffixes are both Latin and are derived from the verbs *fero* and *gero*. They form words that are considered to be basically adjectives. However, a number of them are used also as nouns (substantives), a property of adjectives generally in Latin and many other languages. Whatever their use, as adjective or as noun, the suffixes have the following three gender forms: *-fer* and *-ger*, masculine; *-fera* and *-gera*, feminine; and *-ferum* and *-gerum*, neuter. See Latin dictionaries under such words as *lucifer, signifer, armiger, setiger* (*saetiger*).

Therefore, the statements by De Jong (1974, Zool. Meded. 48, no. 1, p. 4) in reference to the correct form of the name *Carcharodus flocciferus* (Zeller) are wrong. The suffix *-fer* is not Greek, although the Greek verb *pherō* is cognate with the Latin *fero*. The original combination used by Zeller, *Hesperia floccifera*, is correct, but the later combination should be *Carcharodus floccifer*. Many other similar examples could be cited.

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THE FAMILY-GROUP NAMES BASED ON THE NAME OF THE GENUS ELMIS LATREILLE (COLEOPTERA)

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ABSTRACT—The names Elminthidae, Helminthidae, etc. are considered unjustified, and the proper stem for family-group names is Elm-, forming Elmidae, Eliminae, etc.

Several authors, some as recent as Delève (1973), have referred to a family of water-beetles by the name Elminthidae or Helminthidae, although based upon the genus-name *Elmis* Laterille, cited in the Agassiz, Schulze, and Neave nomenclators as of 1802, but by some authors as of 1798. Steffan (1961) gives a lengthy synonymy of the family name, under the form Elminthidae, beginning with Elmidae Shuckard and Spry, 1840, and going through Elmissiens Mulsant and Rey, Helmides Grouvelle, Helminthinae Ganglbauer, etc. to Elmidae Sanderson, 1959.

There seems substantial agreement that the name proposed by Latreille was *Elmis*, and that he referred to it as derived from Greek *helmis* (classical Latin transcription by me). Inasmuch as the International Code of Zoological Nomenclature (Art. 32.a.ii) does not consider incorrect transliteration or improper latinization as a justified basis for emendation, it is clear that the name upon which family-group names should be based is *Elmis* and not *Helmis* or *Helmins*.

I have been able to find the word *helmis*, from which the name *Elmis* is derived by transcription without the "rough breathing" indicated by the letter *h*, only in the Liddell and Scott unabridged Greek-English lexicon (Jones, 1940) under *helmins*, where it is cited as a variant: . . . "also nom. *helmis* Arist HA602^{b}26; acc. *helmitha* IG4.952.10, 18; nom. pl. *helmeis* Dsc. *Eup*.2. 67; dat. *helmisi* Opp. H.3.180; also gen. *helmingos* Hp. *Epid*.1.26.ib`: - worm." (my literal transcription). This variant is thus declined differently from the usual *helmins*, the genitive of which is *helminthos* in literal transcription and *helminthis* in classical Latin transcription. The only clues to the stem of the word are in other cases than the genitive (except for the wholly irregular or erroneous *helmingos*), and in none of the recorded usages does a stem *helminth-* occur. Perhaps, from the evidence of the accusative *helmitha*, the word had the genitive stem *helmith-* (or *elmith-*), one that apparently has never been used to form family-group names based on *Elmis*.

There is, therefore, no good basis for treating the word otherwise

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than as a regular 3rd declension Latin word in the same way the Romans treated *basis*, also a word of Greek origin; that it, to consider its genitive as *helmis* or *elmis* (stem *helm-* or *elm-*), the same as the nominative. This results in the family-group names Elmidae, Elminae, Elmini, etc., those used certainly by far most often and including the first family-group name proposed.

I am grateful to Paul J. Spangler, U.S. National Museum, for literature references.

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NEW SYNONYMIES AND COMBINATIONS IN NORTH AMERICA BRUCHIDAE (COLEOPTERA)

To provide correct names for biological and ecological studies currently underway in North American Bruchidae, the following changes in status are necessary:

Acanthoscelides flavescens (Fahraeus), *In* Schönh. Gen. Curc. 5, 1839, p. 36 (*Bruchus*).
Bruchus ochraceicolor Pic, Echange 29, 1913, p. 10. NEW SYNONYMY.
Bruchus ochraceus Schaeffer, Bull. Brooklyn Mus. 1, 1907, p. 303 (not Baudi, 1886).

Acanthoscelides argillaceus (Sharp), Biol. Centr.-Amer., Coleop. 5, 1885, p. 452 (*Bruchus*).
Bruchus armitagei Pic, Mel. Exot.-Entom. 58, 1931, p. 35. NEW SYNONYMY.
Acanthoscelides obreptus Bridwell, Rev. Chileña Hist. Nat. 44 (1940) 1942, p. 256.

Mimosestes immunis (Sharp), loc. cit., p. 474 (*Bruchus*). NEW COMBINATION.

Merobruchus columbinus (Sharp), loc. cit., p. 474 (*Bruchus*). NEW COMBINATION.

Merobruchus solitarius (Sharp), loc. cit., p. 456 (*Bruchus*). NEW COMBINATION.

Stator championi (Sharp), loc. cit., p. 477 (*Bruchus*). NEW COMBINATION.

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THE GEOMYDOECUS (MALLOPHAGA: TRICHODECTIDAE) OF THE SOUTHEASTERN USA POCKET GOPHERS (RODENTIA: GEOMYIDAE)[1]

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ABSTRACT—Descriptions, illustrations, and distributions are given for *Geomydoecus scleritus* (McGregor) and the new species, G. **mobilensis** (type-host: *Geomys pinetis mobilensis*). These represent the only lice known to occur on the *Geomys* of the southeastern USA.

Price and Emerson (1971), in a revision of the genus *Geomydoecus* Ewing, 1929, recognized the single louse species, G. *scleritus* (Mc-Gregor, 1917), as occurring on all 8 species and subspecies of the southeastern USA pocket gophers. Since then I have studied additional material from these hosts and have concluded that a new species is represented by those lice from *Geomys pinetis mobilensis* Merriam. It is my intent here to redescribe and illustrate G. *scleritus* and then to describe the closely-related new species.

In the following descriptions, measured or counted characters are followed by the minimum and maximum observed values, and, in parentheses, the sample size, mean, and standard deviation. All measurements are in millimeters.

I would like to thank Mr. Ronald A. Hellenthal, Department of Entomology, Fisheries, and Wildlife, for making his computer programs available to me and for aiding in the statistical analysis of my material; the University of Minnesota University Computer Center for a computer time grant and the use of its facilities; and Dr. K. C. Emerson, Arlington, Virginia, for the loan of pertinent specimens.

Geomydoecus scleritus (McGregor)
Fig. 1–5

Male: Unknown.

Female: As in fig. 1. Head width, 0.40–0.45 (37:0.432 ± 0.0113); head length, 0.28–0.32 (36:0.303 ± 0.0095); submarginal and marginal temple setae (STS, MTS: fig. 2) each 0.025–0.035 long, with STS variably anterior to somewhat lateral of MTS. Prothorax width, 0.29–0.34 (37:0.315 ± 0.0118). Metanotum with from 2 + 2 very long setae each side, as shown in fig. 1, to 2 + 1, 1 + 2, or 1 + 1. Tergal setae: I, 2; II, 10–14 (37:12.3 ± 0.87); III, 16–20 (37:17.8 ± 1.04); IV, 17–25 (38:20.0 ± 1.46); V, 15–21 (37:18.3 ± 1.40); VI, 13–18 (38:15.6 ± 1.48); tergal and pleural setae on VII, 19–26 (37: 22.4 ± 1.57). Longest seta of medial 10 on tergite VI, 0.065–0.090 (38: 0.083 ± 0.0054) long; on tergite VII, 0.115–0.140 (37:0.124 ± 0.0059), with 5–8 (82:7.2 ± 0.88) of these longer than 0.10 (fig. 5) (41 specimens with 8,
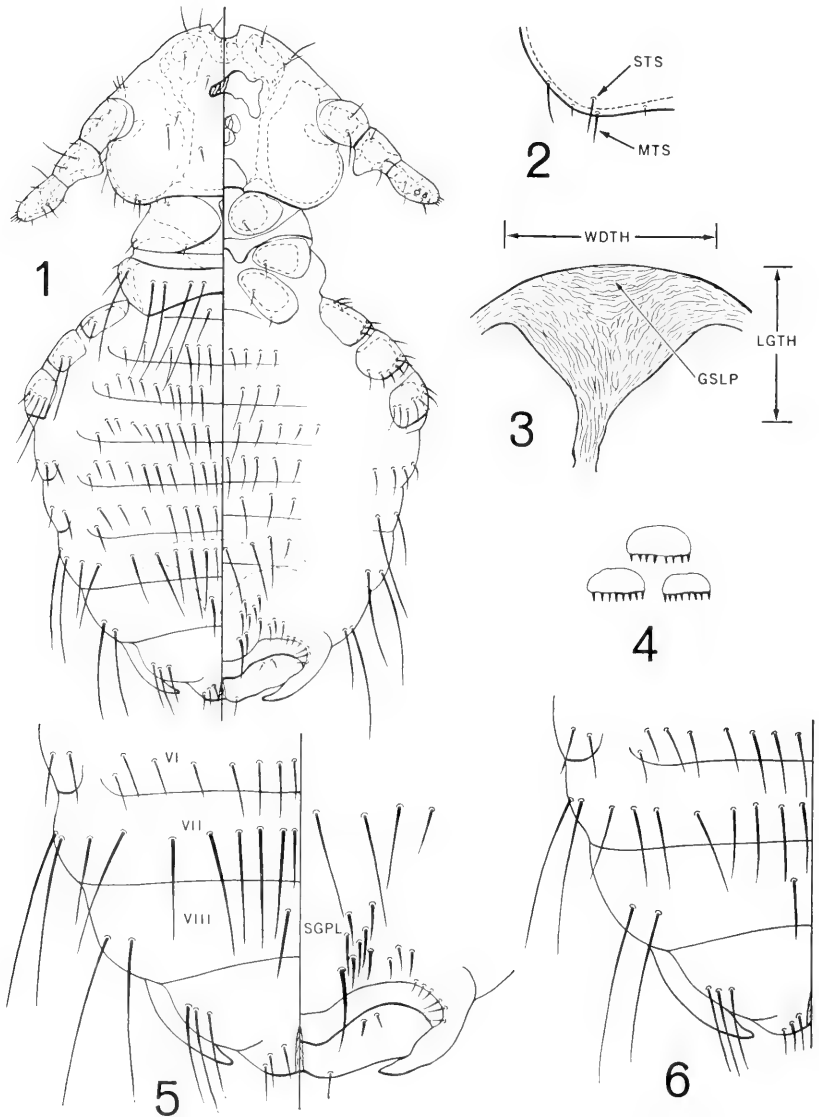
Fig. 1–5. Female *Geomydoecus scleritus* (McGregor). 1, dorsal ventral view (without legs). 2, temple margin. 3, genital chamber sac. 4, genital chamber particles. 5, dorsal ventral view of terminalia.
Fig. 6. Female *G. mobilensis*, n. sp., dorsal terminalia.
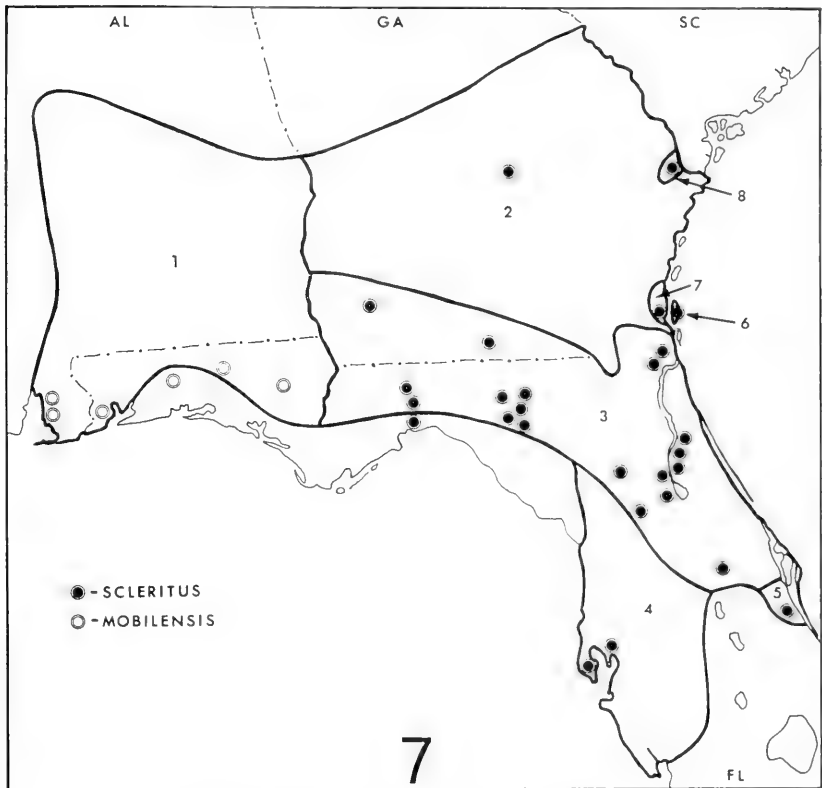
Fig. 7. Collections of *Geomydoecus scleritus* and *G. mobilensis* from the 8 taxa of southeastern USA pocket gophers—1) *Geomys pinetis mobilensis*, 2) *G. p. pinetis*, 3) *G. p. floridanus*, 4) *G. p. austrinus*, 5) *G. p. goffi*, 6) *G. cumberlandius*, 7) *G. colonus*, 8) *G. fontanelus*. Gopher ranges from Hall and Kelson (1959).

23 with 7, 15 with 6, 3 with 5). Longest seta of medial pair on tergite VIII, 0.065–0.100 (34:0.084 ± 0.0100). Last tergite with 3 setae close together each lateroposterior corner (fig. 5), subequal in length, outer seta 0.075–0.105 long, middle 0.075–0.120, inner 0.080–0.110. Sternal setae: II, 8–11 (38:8.7 ± 0.77); III, 6–11 (36:7.9 ± 1.18); IV, 7–13 (34:9.9 ± 1.28); V, 5–9 (31:7.7 ± 0.94); VI, 5–8 (33:6.9 ± 0.97); VII, 5–9 (35:6.4 ± 1.01). Subgenital plate (SGPL: fig. 5) with 16–24 (37:20.6 ± 2.06) total setae, with distribution and lengths as shown. Total body length, 1.09–1.27 (36:1.173 ± 0.0481). Genital sac (fig. 3) 0.18–0.23 wide, 0.11–0.18 long, with 7–14 weak posteriorly directed loops (GSLP: fig. 3); genital chamber particles indistinct, shaped much as in fig. 4.

Material examined (all females, with number of collections in parentheses following each locality): 6, *Geomys colonus* Bangs, Georgia—St. Marys (2); 25, *G. cumberlandius* Bangs, Georgia—Cumberland Island (3); 5, *G. fontanelus*

Sherman, Georgia—Savannah (1); 22, *G. pinetis austrinus* Bangs, Florida—
Tampa (1), Belleair (4); 235, *G. p. floridanus*, Florida—Orlando (1), Satsuma
(1), San Mateo (1), Welaka (3), Silver Springs (2), Ocala National Forest (1),
Jacksonville (1), Oceanway (1), Day (1), Mayo (3), Ellaville (1), Tallahassee
(7), Gainesville (2), Falmouth (5), Dowling Park (2), St. Marks (1), Wakulla
(2), and Georgia—near Naylor (1), Newton (1); 23, *G. p. goffi* Sherman,
Florida—Eau Gallie (6); 4, *G. p. pinetis* Rafinesque, Georgia—McRae (1).

<center>

Geomydoecus mobilensis Price, new species

Fig. 6

</center>

Male: Unknown.

Female: Much as for *G. scleritus*, except as follows. Head width, 0.40–0.44
(34:0.420 ± 0.0099); head length, 0.28–0.31 (34:0.292 ± 0.0076). Prothorax
width, 0.28–0.33 (33:0.307 ± 0.0104). Tergal setae on VI, 15–21 (34:
17.8 ± 1.75); tergal and pleural setae on VII, 22–27 (34:24.1 ± 1.47). Longest
seta of medial 10 on tergite VII, 0.085–0.115 (35:0.099 ± 0.0077), with only 0–5
(82:0.5 ± 0.93) of these longer than 0.10 (fig. 6) (53 specimens with 0, 22 with 1,
3 with 2, 2 with 3, 1 each with 4 or 5). Longest seta of medial pair on tergite
VIII, 0.050–0.075 (33:0.063 ± 0.0064). Sternal setae: II, 7–10 (35:8.0 ± 0.64);
III, 6–8 (34:7.0 ± 0.63); IV, 8–11 (31:9.1 ± 0.85); V, 7–10 (33:8.1 ± 0.68);
VI, 7–9 (34:7.9 ± 0.55).

Discussion: Even though *G. mobilensis* is similar in most respects
to *G. scleritus*, it has differences in setal lengths on tergites VII–VIII
(fig. 6 vs fig. 5). The principal feature for separation is associated
with the lengths of the medial 10 setae on tergite VII. With *G.
mobilensis*, usually (75 of 82 specimens) 0–1 of these setae are longer
than 0.10, but with *G. scleritus* (79 of 82 specimens) 6–8 are longer
than 0.10. The longest seta of this group is also longer for *G. scleritus*.
Since the 2 medial setae in this row are invariably less than 0.10, *G.
scleritus* has the majority of all remaining setae over 0.10, and *G.
mobilensis* has few, if any, setae this length. A comparison of character
means by single classification analysis of variance indicates that, for
most measurements, *G. scleritus* is somewhat larger than *G. mobilensis*.
G. scleritus also has fewer setae on tergites VI–VII and sternite VI
and more on sternites II–III than does *G. mobilensis*. A map (fig. 7)
gives the locations of the known collections of these 2 species of lice.

Of almost 500 adult lice of these species which have been examined,
none are males. This supports my belief that these species are
parthenogenetic with males rare or absent.

Type-host: *Geomys pinetis mobilensis* Merriam.

Type-material (all females from type-host): Holotype, Point Clear,
Baldwin Co., Alabama, 7 Jan. 1934, E. V. Komarek; in collection of
National Museum of Natural History. Paratypes: 21, same data as
holotype; 35, Fairhope, Baldwin Co., Alabama, 27 May 1948 (KU-
27160) and 28 May 1948 (KU-27161), W. K. Clark; 22, Crestview,
Walton Co., Florida, 2 June 1970, C. Jones (4423, 4424); 76, East

Pensacola Heights, Escambia Co., Florida, 22 Mar. 1928 (SD-7126) and 23 Mar. 1928 (SD-7128), F. F. Gander; 12, 6 mi. south Wausau, Washington Co., Florida, 3 May 1948, W. K. Clark (KU-27149); 16, De Funiak Springs, Walton Co., Florida, 26 June 1972 (USNM-348387, 348388).

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BOOK REVIEWS

AN INDEX TO BIOGRAPHICAL FRAGMENTS IN UNSPECIALIZED SCIENTIFIC JOURNALS. By E. Scott Barr. 1973. University of Alabama Press, University, Alabama. 294 pp. $12.50

This book is a new source-work in searching literature for references to persons active in or otherwise associated with the sciences, chiefly prior to 1920. The compiler, while a physicist at the University of Alabama, sought to assemble biographical data by scanning English language journals of a general nature rather than those specializing in individual sciences. The literature search was based on the following: American journals—American Journal of Science, 200 volumes, 1819–1920; Popular Science Monthly, 87 volumes, 1872–1915; Science, First series, 24 volumes, 1883–1894; Science, New series, 50 volumes, 1895–1919. British journals—Proceedings of the Edinburgh Royal Society, 40 volumes, 1832–1920; Proceedings of the Royal Society (London), 172 volumes, 1800–1905, Series A. 1905–1931–32, Series B. 1905–1932–33; Nature, 100 volumes, 1869–1918; Philosophical Magazine, 210 volumes, 1798–1902.

This survey yielded about 15,000 citations, covering some 7,700 individuals. The book lists the scientists alphabetically, together with the fields of scientific activity, years of birth and death (if known), countries of birth, and abbreviated references to the literature citations. In some cases supporting information was obtained from American Men of Science or similar source-works, though those references are not cited for individuals.

Inspection of the first 100 pages shows that 30 persons are listed as having entomology as a major field. It is clear that many others with biology, zoology or similar fields were also involved in entomology. There is no index to the individuals in particular specialties. Readers searching for biographical references to past entomologists may find this book useful as a supplement to more specialized sources such as Mathilde M. Carpenter's 2 parts of "Bibliography of biographies of entomologists" (Amer. Midl. Nat. 33(1):1–116, 1945; 50(2):257–346, 1953) and the several volumes comprising histories of entomology.

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TWO NEW SPECIES OF BAGWORM MOTHS FROM VENEZUELA WITH SPECIAL REMARKS ON REPRODUCTIVE MORPHOLOGY IN PSYCHIDAE (LEPIDOPTERA: PSYCHIDAE)

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ABSTRACT—The adults and immature stages of *Dendropsyche* venezuelae, n. sp. and the adult male of *Lumacra* leucobasilaris, n. sp., are described from Venezuela and are illustrated. A brief discussion of possible correlations between certain elements in the male and female reproductive systems in Psychidae is also presented.

Intensive collecting within the last few years by Dr. Fernandez-Yepez and his students has resulted in a fine representation of Micro-lepidoptera from Venezuela, including the two new species of bagworm moths described below. Dr. Fernandez-Yepez has requested a name for one of these to facilitate reporting on certain aspects of its biology. I wish to thank Dr. Fernandez-Yepez and Mr. L. Rodriquez for allowing me to examine this material as well as for their patient efforts in securing more material at my request.

In addition, I have devoted some discussion to the possible correlation of the length of the vesica in the male reproductive system to that of the ductus seminalis in the female. This is discussed under *Dendropsyche venezuelae* because the reproductive morphology of that species apparently contradicts the correlation observed in several other species of Psychidae.

Dendropsyche venezuelae Davis, new species

MALE (fig. 1): Body slender, moderately hairy, uniform brownish color. Antennae with 22–24 segments, broadly bipectinate with terminal 5 or 6 segments strongly serrate to simple; lateral rami (fig. 4) arising from base of each segment; sensory setae very fine, elongate, length approximately 2–4 × the diameter of lateral rami. Legs with epiphysis and tibial spurs absent, light brownish fuscous in color.

Wings uniformly fuscous and rather heavily scaled; wing scales very slender with acute apices. Venation similar to that described for genus (Davis, 1964); forewings 11-veined, hindwings 7-veined; all veins typically separate. Wing expanse 12–15 mm.

Genitalia (fig. 8–9): Elongate and slender. Apex of tegumen evenly rounded. Vinculum elongate, approximately equalling length and width of tegumen. Saccus relatively stout, subequal to vinculum in length. Valvae broad, breadth approximately 0.5 total length of valvae; pulvilli slender, digitate, with 8–10 minute setae at apex; sacculus with 3–4 small, apical spines. Aedeagus slender, long, approximately equalling entire genitalia in length. Furcal arms of eighth sternite (fig. 10) long, approximately 2.5 × length of undivided base. Eighth tergite (fig. 11) relatively large, elongate, similar to *Dendropsyche burrowsi* in form.

Fig. 1. Adult male of *Dendropsyche venezuelae* n. sp., paratype, wing expanse 14.5 mm. Fig. 2. Adult male of *Lumacra leucobasilaris* n. sp., holotype, wing expanse 28 mm.

Fig. 3. Antenna of *Dendropsyche burrowsi*, holotype. Fig. 4. Antenna of *Dendropsyche venezuelae* n. sp., paratype. Fig. 5. Antenna of *Lumacra leucobasilaris* n. sp., holotype. Fig. 6. Larval case of *Dendropsyche venezuelae* n. sp., length of case (exclusive of pupal exuvium) 13 mm.

FEMALE: Length 7–8 mm. Vermiform. All body appendages vestigial, reduced to minute tubercules, or completely absent. Dorsum of head and thorax lightly sclerotized, brownish; remainder of body naked, whitish except for encirclement of dark brownish hair around seventh segment of abdomen.

Genitalia (fig. 7): External genitalia largely membranous; a single pair of

Figs. 7–11. *Dendropsyche venezuelae* n. sp. 7, female genitalia, scale = 0.5 mm. 8, male genitalia. 9, aedeagus of male. 10, eighth abdominal sternite of male. 11, eighth abdominal tergite of male. Scale of figs. 8–11 = 0.5 mm.
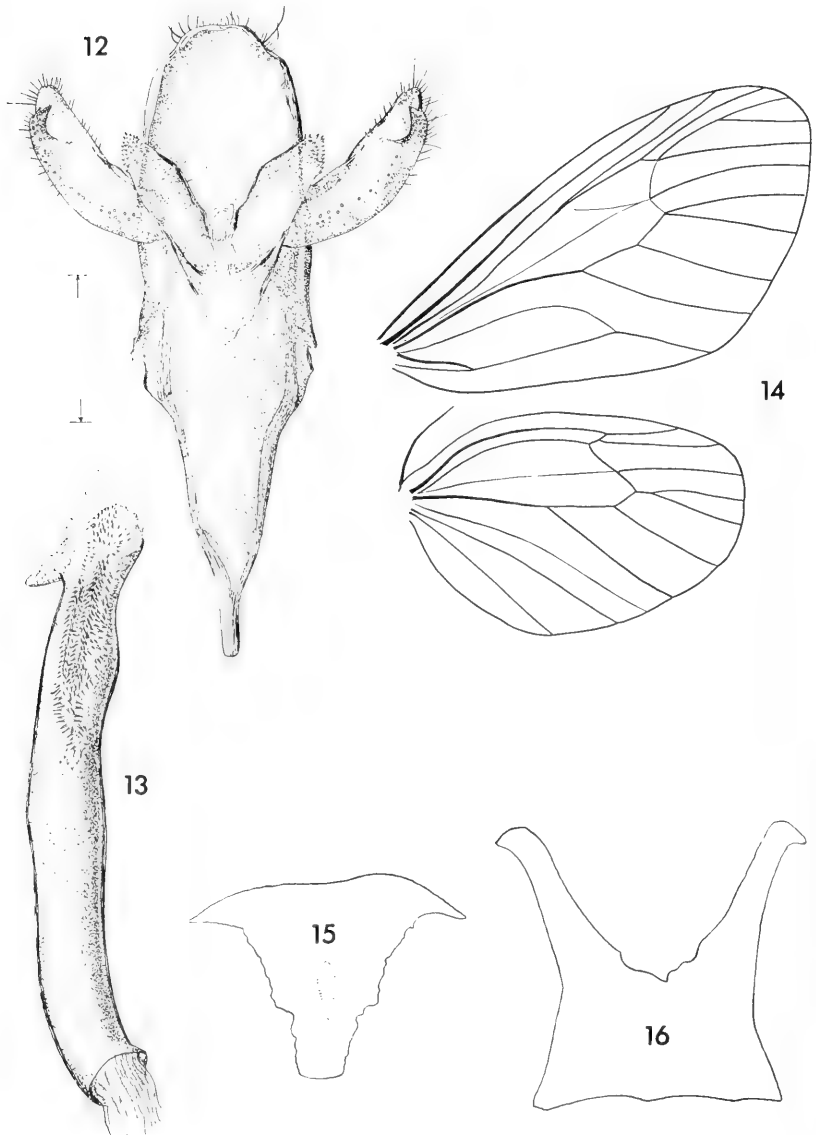
Fig. 12–16. *Lumacra leucobasilaris* n. sp. 12, male genitalia. 13, aedeagus of male. 14, wing venation. 15, eighth abdominal tergite of male. 16, eighth abdominal sternite of male. Scale of Figs. 12–13, 15–16 = 0.5 mm.

short, posterior apophyses extending from about level of ostium and gradually coalescing with walls of terminal (9 & 10) segment; anterior apophyses of eighth segment indistinct. Internal genitalia with extremely long, convoluted ductus seminalis extending to junction of spermatheca; bursa copulatrix reduced, smaller in size than relatively elongate spermatheca.

LARVA (fig. 17–23): Length of largest larva 11 mm.

Head: Light tan with four irregular, fuscous, longitudinal bands along each side of head; subdorsal band the most irregular, typically broken into a series of variable spots; a slightly paler, inverted V-shaped band extending down over adfrontal and frontal sclerites. Six ocelli present, arranged in an inverted L-shaped series. O2 situated between fifth and sixth ocelli; O3 arising more posterior and ventral and situated caudad of sixth ocellus. P2 absent. AFa situated somewhat intermediate between AF1 and AF2 but closer to latter. Labrum with M1 and M3 well separated from outer margin; all other setae closely bordering margin.

Thorax: Pronotum light tan with dark brown V-shaped bands on either side of dorsal median and two pairs of irregular dark brown bands situated laterally; maculation of meso- and metanota similar except bands usually shorter and broader. L1, L2, and L3 situated with spiracle on pronotal shield; L series situated on a separate pinnaculum on meso- and metathorax. SV1 and SV2 on a separate, partially darkened pinnaculum.

Abdomen: Dorsum of first and second abdominal segments dark brown, becoming somewhat paler caudally. Pinnacula no darker or frequently lighter than remainder of integument, especially along dorsal half. Integument without microtrichia, smooth, except for minute, squamoid thickenings in pigmented areas. D1 and D2 usually on separate pinnacula with D2 situated slightly forward of D1. SD2 minute, separated from pinnacula bearing SD1 except on VII and VIII. Abdominal prolegs III to VI with 20–22 crochets in a uniordinal, lateral penellipse (fig. 22); anal prolegs similar except with 22–24 crochets. SV1, 2 and 3 on same pinnaculum bearing crochets and separated from VI. SV2 absent on segment 1 but present on II and situated on same pinnaculum as VI (fig. 20). Ninth segment with D2 and SD1 on same pinnaculum. Dorsal anal shield (fig. 21) with cephalic margin deeply excavate at midline.

LARVAL CASE (fig. 6): Dimensions: male, 9–12 mm in length; 2–3 mm in diameter; female, 13–15 mm in length; 3–4 mm in diameter. Exterior of case densely covered with a mat of tiny fragments of plant material; overlying this are usually attached a few large fragments of the same material arranged lengthwise.

MALE PUPA (fig. 24–28): Length 5–6 mm. Dark reddish brown. Frontal area raised slightly to form a low median ridge, or cocoon-cutter (fig. 28). Antennal sheaths extending almost to apices of mesothoracic legs; wings extending to caudal margin of third abdominal segment. Abdominal segments I–II without transverse rows of spines; III–VI each with a dorsal anterior row of stout spines (fig 24) directed caudad and a posterior row of slender spines (fig. 25) directed cephalad; segments VII and VIII with a single anterior row of stout spines. Tabulation of spines as in Table I.

Cremaster of segment X consisting of a single pair of large, stout hooks (fig. 27) curved cephalad.

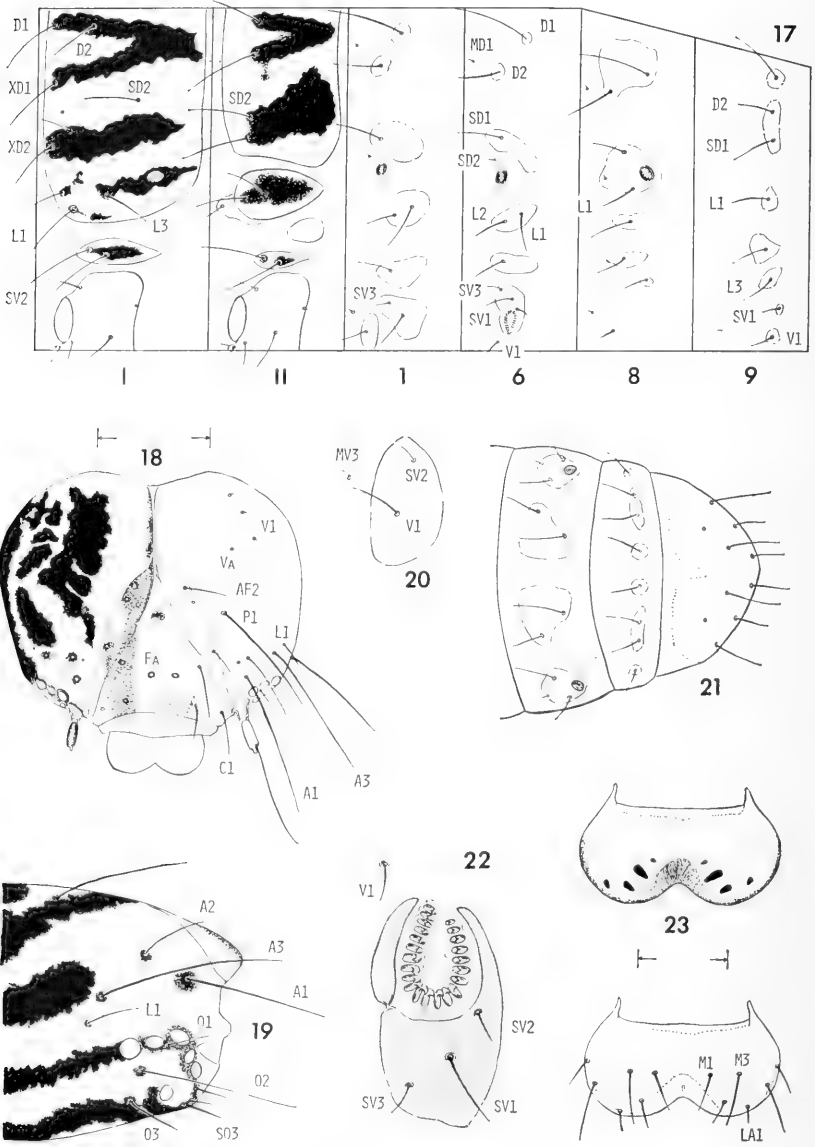Fig. 17–23. Larvae of *Dendropsyche venezuelae* n. sp. 17, chaetotaxy of prothorax, mesothorax, and abdominal segments 1, 6, 8 and 9. 18, frontal view of head, scale = 0.5 mm. 19, lateral view of head. 20, chaetotaxy of venter of second abdominal segment. 21, dorsal view of abdominal segments 8, 9 and 10. 22, sixth abdominal proleg. 23, ventral (top) and dorsal (bottom) view of labrum, scale = 0.2 mm.

Table 1. Distribution of dorsal abdominal spines of male pupa.

Segment	I	II	III	IV	V	VI	VII	VIII
Anterior row	0	0	8–10	10–13	16–18	16–19	12–14	5–8
Posterior row	0	0	21–25	21–24	20–25	15–17	0	0

FEMALE PUPA (fig. 29): Length 10 mm. Light reddish brown. Pupal antennae, eyes, and maxillae vestigial; wings absent. Legs vestigial, represented by small tubercules. Dorsal row of spines usually smaller than in male, completely absent on first segment; second segment with a single row of stout spines at extreme posterior margin; anterior row of segment III greatly reduced, spines barely discernible. Tabulation of spines summarized in table 2 (1 pupa examined).

Cremaster reduced, consisting of two small stout spines. Anal groove (fig. 29) prominent, Y-shaped with two minute tubercules near anterior end.

HOLOTYPE: El Limon, Aragua, Venezuela, 450 m., ♂, Jan. 20, 1967, adult emerged Jan. 26, 1967, coll. L. Rodriguez, Holotype no. USNM 72078; in the National Museum of Natural History, Washington, D.C.

PARATYPES: Same locality as holotype, adults emerging Jan. 20–May 9: 45 ♂, 6 ♀ (NMNH); 42 ♂, 2 ♀ (UCV). Described from a total of 88 ♂ and 8 ♀ (most with associated pupal exuviae and larval cases) and 10 larvae.

HOST: "Acanthaceae: *Ruellia tuberosa* Linn.; Amaranthaceae: *Amaranthus* sp.", F. Fernandez-Yepez, *in litt.*

PARASITES: Chalcididae: *Spilochalcis* sp., (det. B. Burks). Ichneumonidae: *Chirotica* sp., *Pristomerus* sp., (det. R. Carlson). Tachinidae: *Stomatomyia* sp., near *floridensis* Townsend, (det. C. Sabrosky).

DISTRIBUTION: Known only from the type locality near Maracay in the Cordillera de la Costa of Northern Venezuela.

DISCUSSION: Prior to the discovery of this moth, the only known member of *Dendropsychyche* was *D. burrowsi* Jones, which was described from three imperfect males and a very limited amount of immature material. Thus, the large series of reared and associated material which Dr. Fernandez-Yepez and his associates have acquired recently are of great value in gaining more information on this particular genus. The discovery of *D. venezuelae* also suggests the existence of more undescribed neotropical members of this genus.

Table 2. Distribution of dorsal abdominal spines of female pupa.

Segment	I	II	III	IV	V	VI	VII	VIII
Anterior row	0	0	4	8	12	15	20	4
Posterior row	0	23	27	31	23	0	0	0
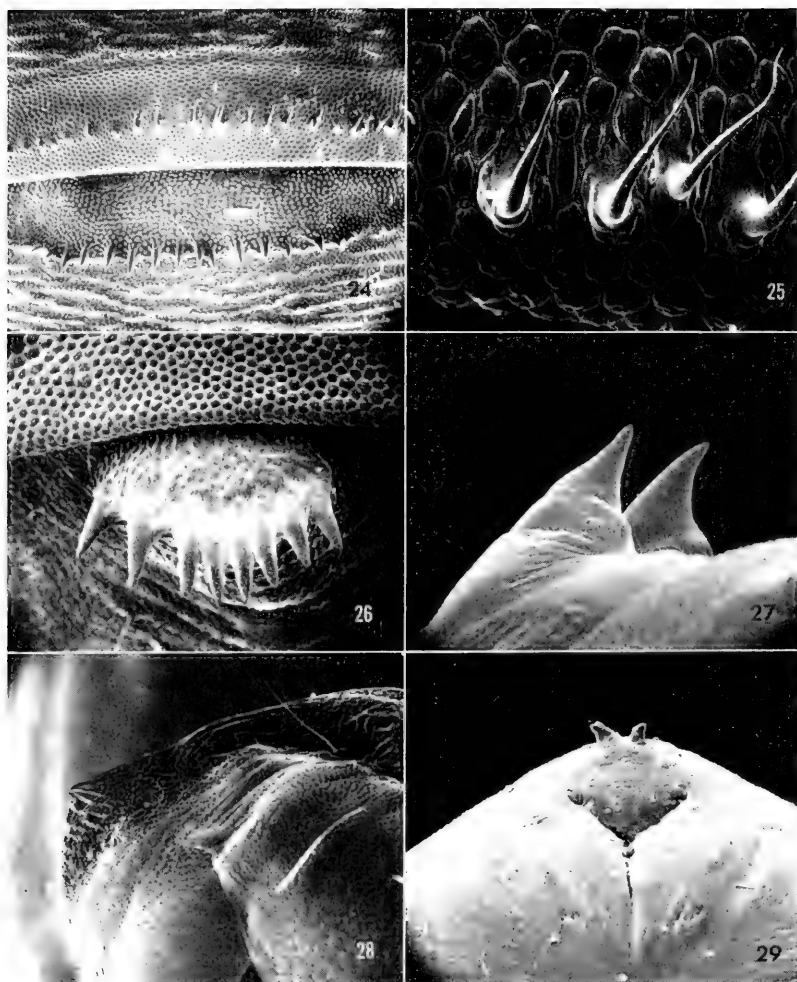
Fig. 24–29. Male and female pupal characters of *Dendropsyche venezuelae*, n. sp. 24, dorsal view of fifth and sixth abdominal segments showing posterior and anterior rows (respectively) of transverse spines (male). 25, detail of posterior row of spines of fifth abdominal segment (male). 26, dorso-caudal view of anterior row of spines on eighth abdominal segment (male). 27, lateral view of cremaster of tenth segment (male). 28, lateral view of cremaster of tenth segment (female).

Dendropsyche venezuelae may be distinguished from its only known relative, *D. burrowsi*, most easily by comparing the male genitalia. The vinculum of *D. venezuelae* is considerably longer and the saccus is correspondingly shorter than in *D. burrowsi*. The eighth sternites

also differ in outline, with that of *D. venezuelae* possessing a more truncated anterior margin. The antennal rami of this species also arise more basad than in *D. burrowsi* (Fig. 3).

The larva of *D. venezuelae* may be recognized by the deeply clefted cephalic margin of the anal shield and by the presence of SV2 on the same pinnaculum as VI on the second abdominal segment. The latter character is also a feature of the larva of *Oiketicus kirbyi* Guilding, and probably of other species of *Oiketicus*. However, in most species of Phychidae examined to date, seta SV2 is absent from the second abdominal segment.

The male pupa displays no outstanding feature useful for recognition and superficially resembles two undescribed species (not co-generic) from Trinidad. The female pupa is somewhat unusual in lacking the posterior row of dorsal spines from the sixth abdominal segment, thus agreeing with *Cryptothelea surinamensis* and *Oiketicus kirbyi* in this respect. However, the anterior row of spines is absent from the eighth abdominal segment in the latter two species but present in *D. venezuelae*.

The female reproductive system of this species is most unusual in possessing a greatly lengthened ductus seminalis. Prior to the discovery of *D. venezuelae*, such an extended ductus was known to occur in only two of the most specialized psychid genera, *Oiketicus* and *Thyridopterix*. Furthermore, I formerly believed that a definite correlation existed between the length of the male vesica (and relative enlargement of the base of the aedeagus) and the length of the ductus seminalis of the female. The reason for this belief being that dissections of two mating pairs of *Thyridopteryx ephemeraeformis*, killed *in copulo*, showed the vesica of the male to have been forced halfway through the greatly lengthened ductus seminalis of each female, thus bypassing the bursa copulatrix. It is not known how great an effect the manner of death may have had on the final position of the vesica. However, these two observations, although posing some intriguing questions as to the relative function of the bursa copulatrix and spermatheca, did seem to offer an explanation as to why males with the longest vesicae were only known to occur in species where the females possessed the longest ductus seminalis. In order to accommodate the extended vesica in these species, the base of the aedeagus has been correspondingly enlarged.

Thus, I hypothesized that the females of such genera as *Biopsyche* (in which the females are still undiscovered), would possess a greatly lengthened ductus seminalis. Conversely, in no species which the vesica of the male was relatively short (and the aedeagus base unswollen) would the female ductus be lengthened. However, as has been pointed out, the male and female reproductive systems of *D. venezuelae* present a significant and paradoxical exception to all pre-

vious correlations and observations. Because the female of *D. burrowsi* is unknown, no comparison of reproductive systems is possible with the only other member of this genus.

The females of many more species will have to be collected and studied before any clearer understanding concerning the significance in the relative length of the ductus seminalis can be established. Studies involving pairs *in copulo* are especially needed in order to better understand the entire rather peculiar reproductive morphology and copulatory behavior in this family.

Lumacra leucobasilaris Davis, new species

MALE (fig. 2): Body slender, moderately hairy, uniformly fuscous in color, Antennae with 23 segments, broadly bipectinate with only the terminal segment strongly serrate; lateral rami (fig. 5) arising subapically or apically from those segments on outer half of flagellum; sensory setae very fine, elongate, length approximately 3.0–4.0 the diameter of supporting rami. Legs brownish in color; meso- and metathoracic legs without tibial spurs (prothoracic legs missing but probably with a prominent epiphysis).

Forewings fuscous, uniformly scaled, 12-veined (fig. 14) with 8 and 9 (R3 and 4) stalked half their length; 4 and 5 (M2 and 3) connate in the right wing, slightly stalked in the left; base of medial vein not forked within cell; scales of discal cell relatively broad, oblanceolate, with simple, subacute to rounded apices. Hindwings unevenly scaled, outer three-fifths fuscous and covered with oblanceolate scales; basal two-fifths whitish, thinly covered with long, hairlike scales; 8-veined with 4 and 5 (M2 and 3) stalked about one-fifth their length; Sc + Rl and Rs connected by oblique crossvein beyond apex of discal cell. Wing expanse 28 mm.

Genitalia (fig. 12–13): Elongate with apex of tegumen broad and rounded. Vinculum elongate, roughly V-shaped, tapering to form a short, stout saccus; saccus less than one fourth the length of vinculum. Valvae relatively slender with large, prominent pulvilli; apex of pulvilli densely covered with approximately 30 small spines; apex of sacculus sharply bipid. Aedeagus elongate, equalling genitalia in length; base not swollen. Furcal arms of eighth sternite (fig. 16) divergent, slightly exceeding length of undivided base. Eighth tergite roughly triangular (fig. 15).

FEMALE: Unknown.

LARVA: Unknown.

HOLOTYPE: Rancho Grande, Aragua, Venezuela, 1100 m., ♂, May 1, 1966, coll. F. Fernandez-Yepez and J. Salcede, wing slide 16145, ♂ genitalia slide 16159, Holotype no. USNM 72079; in the National Museum of Natural History, Washington, D.C.

HOST: Unknown.

DISTRIBUTION: Known only from the type specimen which was collected near Maracay in the Cordillera de la Costa of northern Venzuela.

DISCUSSION: The large whitish area covering the base of the hindwings easily distinguishes *Lumacra leucobasilaris* from all other

Psychidae and has suggested its specific name, of Greek derivation: (leuco, white; basilaris, at the base). The species most resembling *L. leucobasilaris*, at least with regard to genitalia, appears to be *L. hyalinacra* Davis, which is known only from El Salvador. The two may be easily separated by the above hindwing character with that of *L. hyalinacra* being entirely fuscous. In addition, the vinculum of *L. leucobasilaris* is more attenuated than that of *L. hyalinacra*. The general similarity of the genitalia places *L. leucobasilaris* and *hyalinacra* in the same species group (the *quadridentata* group) along with *L. quadridentata* Davis, a species ranging from Venezuela to French Guiana.

The venational pattern within the genus *Lumacra* demonstrates minor variations among the various species. Usually these involve the relative position of the subcostal crossveins in the hindwing or the degree of separation of fusion of the major veins. Likewise, *L. leucobasilaris* exhibits minor differences from the type of the genus, *L. brasiliensis* (Heylaerts). For example, the base of the medial vein in *L. leucobasilaris* is undivided within the cell of both wings, and the position of the crossvein between 7 and 8 (Sc + Rl and Rs) of the hindwing is beyond the apex of the cell (as in *L. quadridentata*). Such variations appear to have no significance in most instances other than being specific in nature.

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STUDIES ON THE FUNCTION OF THE MEMBRACID
PRONOTUM (HOMOPTERA) II. HISTOLOGY

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ABSTRACT—The membracid pronotum historically has been considered an ornamental and protective structure with no physiological function. This paper demonstrates the pronotum of *Umbonia crassicornis* to be a complex cellular structure permeated with trachea suggesting a high metabolic rate. Two types of cells which may be secretory in function are present. Nerves in association with trichoid sensilla offer further evidence that the pronotum may have a sensory function.

Membracidae are characterized by an enlarged pronotum, which takes many bizarre forms. Poulton (1903) and Funkhouser (1951) discussed crypsis, mimicry, aposematic display and shape as possible functions of the pronotum, but these contentions lack experimental verification. Funkhouser (1951) stated that even the hairs and punctations (pits) on the pronotum were not functional since he found no evidence of nervous, tracheal or glandular connections. He concluded that pronotal structures were not involved in any physiological processes and were "merely hollow extensions of the chitinized wall." In contrast Wood and Morris (in press) demonstrated the general occurrence of trichoid sensilla and pits on the membracid pronotum, which implied a sensory function for the pronotum. These conflicting statements led me to reexamine the histology of the pronotum and demonstrate its cellular nature.

METHODS

The pronotum with head attached was removed from live *Umbonia crassicornis* (Amyot and Serville) and fixed in a modified Carnoy's fixative (Salthouse, 1958). Tetrahydrofuran was used for dehydration, the pronotum was then double embedded with paraloidin and paraffin. Paraffin infiltration was done under vacuum. Serial longitudinal, horizontal, and cross sections were made and stained with Delafield's hematoxylin and eosin Y. The Ramon y Cajal's

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Fig. 1–13, illustrations and photomicrographs of the pronotum of *Umbonia crassicornis* Amyot and Serville. Symbols: E = exterior cuticle, I = interior cuticle, d = dorsal horn, m = metopidium, h = humeral horn, p = posterior process, c.s. = cross section, l.s. = longitudinal section. 1, relationship between (c.s.) cuticular layers and pits. 2, scanning electron micrograph of conical projections on interior cuticular surface. 3, secretory cells (c.s.) below exterior and interior cuticle. 4, trichoid sensilla with elongate cells (c.s.) at base of hair. 5, squamous epithelial cells (c.s.) lining exterior cuticle. 6, two adjacent pits
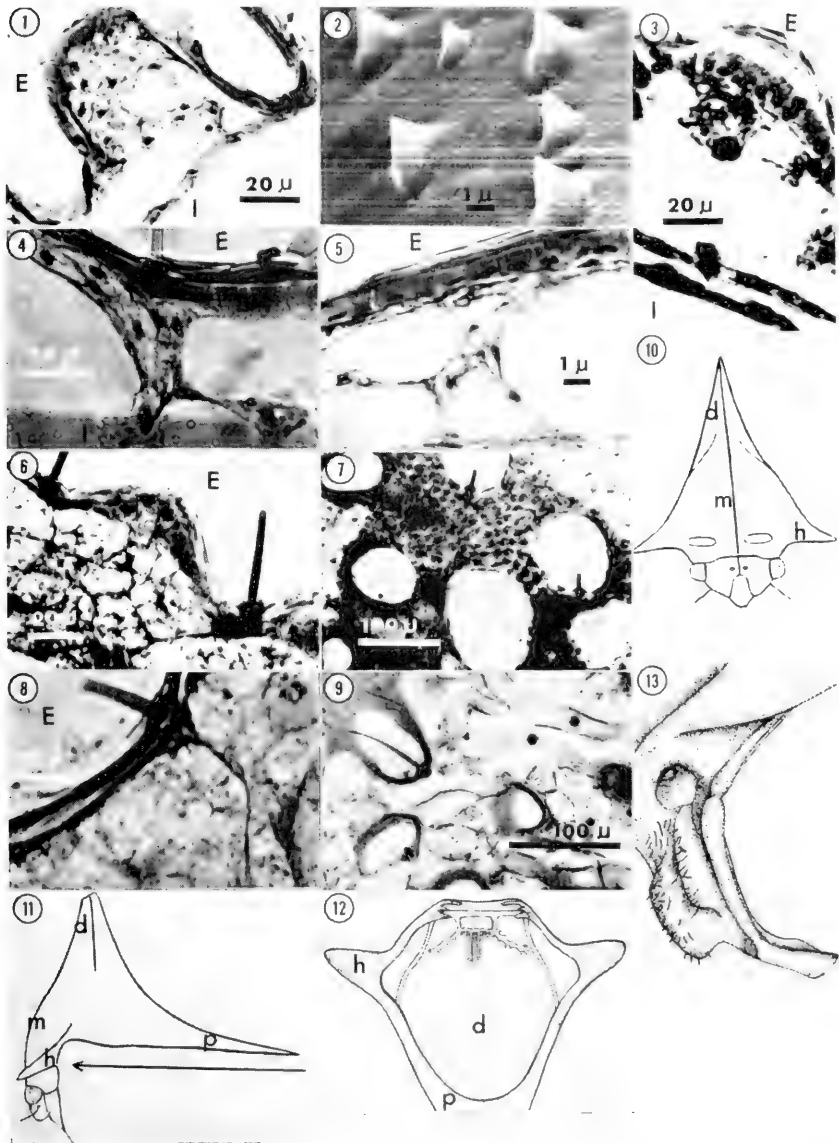
(c.s.) demonstrating secretory cells below exterior cuticle. The relationship between trichoid sensilla and the nerve at base of hair is also shown. 7, dorsal horn (l.s.) with exterior cuticle removed. 8, nerve along pit (c.s) with a peripheral fiber to interior cuticular surface. 9, humeral horn (c.s.) demonstrating trachea. 10, frontal view of head and pronotum. 11, lateral view of head and pronotum, the arrow indicates view of Fig. 12. 12, a posterior-ventral view of metopidial surface showing the transverse and lateral ridges. 13, frontal view of eye fossa showing position of exterior opening to transverse and lateral ridges.

pyridine silver method (Humason, 1962) was used for silver impregnation then double embedded and sectioned (15 to 20μ). The detached pronotum was examined for main tracheal trunks under 70% ethyl alcohol with the dissecting microscope. Glycerin mounts were made by spreading the pronota of adults (3 to 4 days old) out on microscope slides. Glycerin mounts were studied with a bright field microscope.

<center>RESULTS</center>

A matrix of cells between two cuticular layers characterize the wall of the expanded pronotum. The exterior[1] surface is marked by punctures (pits) and associated trichoid sensilla (Wood and Morris, in press). Surface punctures are invaginations which terminate above the interior cuticular wall (Fig. 1). On the interior cuticular layer are conical projections (Fig. 2) uniformly distributed and not associated with the pits.

Large cuboidal cells (Fig. 1) surround the pits. Adjacent to these cells are large elongate cells (Fig. 4) which extend from the base of the trichoid sensilla to the interior cuticular layer. A layer of squamous epithelial cells with elongate nuclei (Fig. 5) are found below the exterior cuticula. Hematoxylin stains these cells in a similar fashion as the neurosecretory cells of the brain. The large cuboidal cells lining the pits also have similar staining properties indicating a probable secretory function.

The silver nitrate procedure stains neurofibrils black; nerve cells stain yellow-brown. At the bottom of the pit and running along the clear cuticula is a single layer of yellow-brown cells (Fig. 3). Between and surrounding the pits below the exterior cuticula are clusters of large cuboidal cells which stain yellow with black nuclei. The relationship of these cells to the pits are shown in cross section (Fig. 6) and longitudinal section (Fig. 7). The stain affinities of these cells suggest a secretory function. A large nerve fiber which runs from these secretory cells to the base of the trichoid sensilla can be seen in cross sections through adjacent pits and sensilla (Fig. 6). Below the base of the trichoid sensilla the nerve fiber is enlarged (Fig. 8) with a peripheral fiber running toward the interior cuticular surface. Sections through the dorsal horn show nerve fibers run parallel to the trachea with peripheral fibers to the cells surrounding the pits. The interior contents of some trichoid sensilla stain black.

The relationship between the head and pronotum is shown in Fig. 10, 11. The pronotum is an enlargement of the prothoracic tergum which is expanded dorsally into the humeral and dorsal horns (Fig. 10, 11) and into a posterior process (Fig. 11).

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[1] Exterior and interior refer to the cuticular layers of the pronotum and not to the relationship of the pronotum with the thorax.

The interior surface of the metopidial wall (Fig. 12) has two chitinized lateral ridges and one transverse ridge which contain tracheae. Branches from the tracheae in the lateral ridges permeate both dorsal and humeral horns, and the posterior process. Two tracheal trunks from the transverse ridge supply the metopidium. Silver nitrate sections through the humeral (Fig. 9) and dorsal horns substantiate the general presence of trachea.

The large numbers of anastomosing tracheae in the expanded pronotum suggest either a tracheal connection with the mesothorax or an external opening. The only spiracles mentioned by Funkhouser (1917) were on the mesothorax and metathorax. I found no tracheal connection to the mesothorax but did find an external opening. Examination of the eye fossa reveals a lateral depression with an external opening at the bottom (Fig. 13). The lateral and transverse ridges with their tracheae originate at this opening.

Discussion

The pronotum has been considered an ornamental structure and discussion of its function has centered on possible protective roles. Probable secretory and/or neurosecretory cells between and surrounding the pits suggests the possibility the pits function as chemoreceptors or perhaps as dispersal sites for pheromones. Behavioral studies (Wood, in press) indicate that pheromones may be involved in mating and aggregation in *U. crassicornis*. The function of the conical projections on the cuticle below the pit is unknown.

The presence of nerves and their association with trichoid sensilla gives credence to the suggestion by Wood and Morris (in press) that the pronotum has a significant sensory function. The trichoid sensilla may act as mechano- or chemoreceptors. The pronotum's complex tracheal system supplying the cellular matrix indicates it has a high oxygen requirement and metabolism.

The demonstration of the complex nature of the pronotum demands that functional roles in addition to possible protection be further investigated.

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AN INVALID LECTOTYPE DESIGNATION FOR GREENOIDEA PHYLLANTHI (GREEN) IS DISCUSSED AND CORRECTED

Gerson and Davidson (1974, Proc. Entomol. Soc. Wash. 76(2):156–162) designated a lectotype and 3 paralectotypes for *Greenoidea phyllanthi* (Green) from 2 slides deposited in the U.S. National Museum. These designations are invalid according to rule 74 (A) (i) of the International Code of Zoological Nomenclature because the specimens are apparently not part of the syntypical series used by Green (1905, J. Bombay Nat. Hist. Soc. 16:344–345) in the original description of *Aspidiotus* (*Targionia*) *phyllanthi*. The type-data in the original description reads "On *Phyllanthus myrtifolius*. Peradeniya. February." The slide designated by Gerson and Davidson as lectotype reads "*Aspidiotus phyllanthi* Green n.s. *Phyllanthus myrtifolius* Peradenija [misspelled] Ceylon E. E. Green Coll. June 1900." Thus Green's (type) material was apparently collected 5 months earlier than the U.S.N.M. material cited by Gerson and Davidson.

I thank Dr. D. J. Williams for calling attention to this error and for providing a slide from the British Museum (Nat. Hist.) for the following lectotype designation.

Type-data: The adult female left hand specimen (nearest locality label) of 3 specimens is here designated as the lectotype. The slide bears a label on the left side reading "*Aspidiotus phyllanthi* Green from *Phyllanthus myrtifolius* Peradeniya, Ceylon E. E. G. coll. Feb. 1900." A label on the right side bears the word "TYPE" in red. I placed a label on the back mapping the lectotype's position. The other 2 specimens are paralectotypes. The lectotype can be recognized by having normally developed pygidial lobes. Both paralectotypes have broken or malformed lobes.

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DESCRIPTION OF HISTIOSTOMA CONJUNCTA (NEW COMB.) (ACARI: ANOETIDAE), AN ASSOCIATE OF CENTRAL AMERICAN BARK BEETLES

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ABSTRACT—The adult female and male plus the tritonymph of *Histiostoma conjuncta* (Woodring and Moser, 1970) (new comb.) are described. The species is known to be associated with various pine bark beetles from Honduras, Guatemala, and Louisiana.

Woodring and Moser (1970) described 5 new species of *Anoetus* associated with North American Scolytidae. One of these was *A. conjuncta*, which was based however only on the deutonymph. Fresh material has revealed the adult stages of *conjuncta*, which are herein described. The species is placed in the genus *Histiostoma*, a new combination, based on a redefinition of the genera *Histiostoma* and *Anoetus* by Woodring (1973).

Histiostoma conjuncta Woodring & Moser, (1970) new combination

FEMALE (Fig. 1, 4, 6, 7): Length of single female 256 μ; probably a young female (based on the short opisthosoma and length being in range of male). Cuticular surface smooth with minute, dark conical projections as in retangular inset of Fig. 1. Propodosomal shield not heavily sclerotized, but boundaries clearly distinguishable. Anterior margin of histerosoma indistinct. All dorsal setae gently curved, evenly tapered, and of approximate equal length. Dorsal opisthosomal setae (do1–do7) arise from small mounds. Opening of opisthosomal gland (g1) heavily sclerotized, large, and cup shaped. All ventral leg apodemes except a8 present, thick and dark in color. Cuticular area around anterior ring (r1) dark. Apodemes A1 join in midline to form short sternum (St1). Seta vm1 minute. Leg I largest and thickest, legs II and IV near equal length (II slightly thicker), and legs III shortest and thinnest. Outer, anterior edge of each coxa with distinct, thickened lip. Tarsal I setae e and f short, thick and blunt (Fig. 4). Distal cheliceral digit flattened, strongly curved at tip with 2 subapical teeth (Fig. 7).

MALE (Fig. 2, 5, 6, 7): Length of 2 specimens 242 and 260 μ. Entire dorsum thick and heavily sclerotized. Irregular areas of slightly thinner cuticle forms an uneven, irregular pattern over entire dorsum except propodosomal shield (Fig. 2). Dorsal hysterosomal shield curves over posterior end of body and extends onto ventrum. Anterior edge of hysterosoma distinct. All dorsal setae slightly curved, evenly tapered, and all of approximate equal length. Only median areas of ventor with thin cuticle. All leg apodemes thick and very dark. Edges of all coxal cavities and of camerostome with very thick, dark cuticle; most of coxal
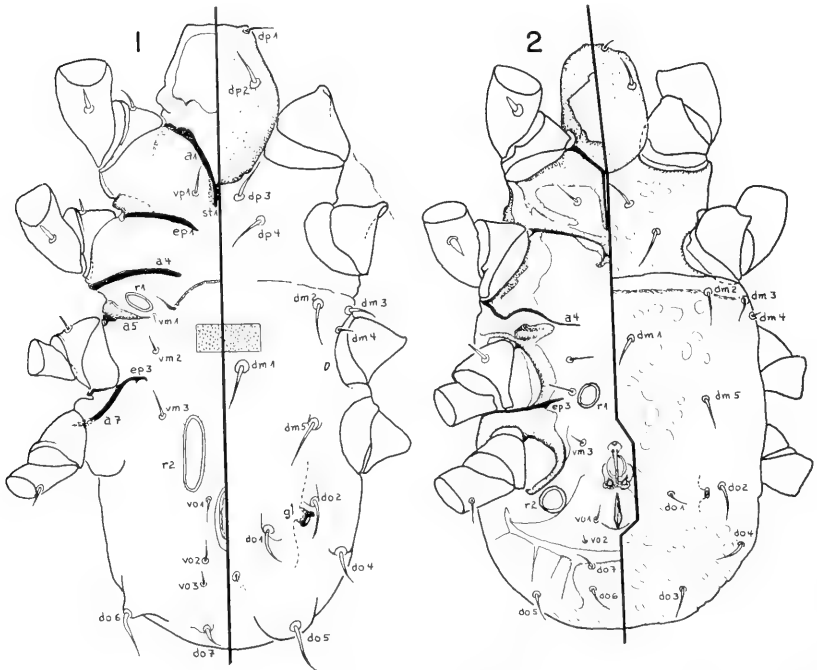
Fig. 1–2, *Histiostoma conjuncta*. 1, ventral-dorsal view of adult female. 2, ventral-dorsal view of adult male.

plate 1 so thickened. All vm setae of equal length and shape. Anterior and posterior rings of equal size and shape. Cuticular wall of all leg segments very thick (Fig. 5). Tarsal I seta e very fine, short and pointed; seta f as typical in this genus formed as a claw overhanging the true claw. Cheliceral digit and pedipalps as in female. Legs I and IV of equal length and slightly longer than II and III; legs I and II stouter than III and IV. Penis straight, thin and slightly longer than anal slit.

TRITONYMPH (Fig. 3, 6, 7): Average of 7 tritonymphs 222 μ (213 to 232 μ). Seven distinct plates on dorsal idiosoma, whose exact shape varies slightly among individuals. Plates thicker and darker (more sclerotized) than surrounding cuticle; and plates bear evenly distributed dense concentration of minute bright points (pores or at least thinner cuticle). Cuticle surrounding plates like that of female dorsum; smooth with minute, dark, conical, evenly spaced projections. All dorsal setae of approximate equal length, finely tapered and strongly curved. Ventrum smooth except for ill defined area of darker cuticle at posterior end. Leg apodemes reduced in number, length and thickness compared to adults; apodemes a2, a4, a6, and a8 lacking. Pedipalps and distal cheliceral digit as in female. Legs near equal length, though sequence of longest to shortest clearly I, IV, II, III; and legs I and II slightly heavier than III and IV.
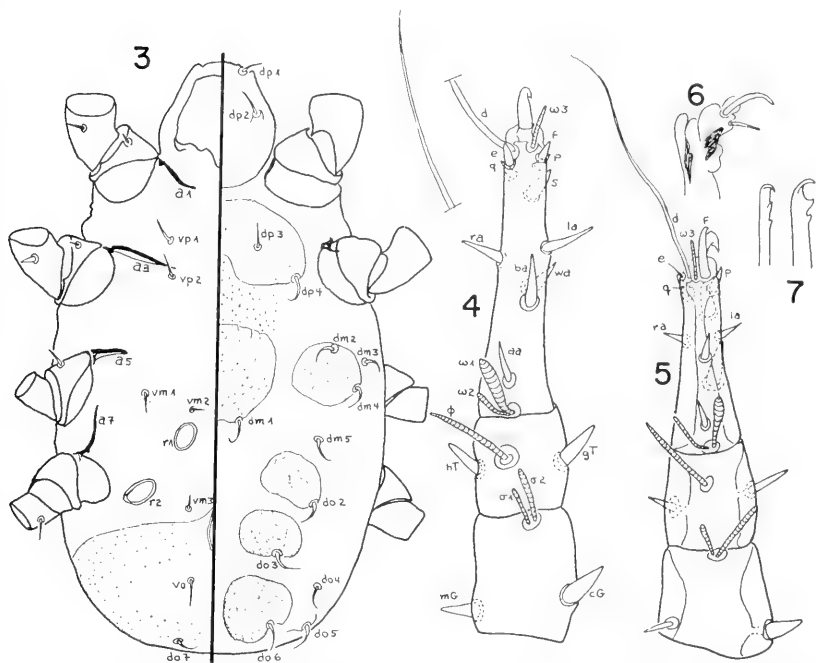
Fig. 3–7, *Histiostoma conjuncta.* 3, ventral-dorsal view of tritonymph. 4, dorsal view of female left leg I. 5, dorsal view of male left leg I. 6, pedipalps of male or female. 7, two views of distal cheliceral digit.

DEUTONYMPH: Described by Woodring and Moser, 1970, p. 1250–51.

DISTRIBUTION: The holotype and paratype deutonymphs from boring dust of *Dendroctonus frontalis* and *Ips cribricollis* in *Pinus oocarpa* from Tegucigalpa, Honduras; collected by R. C. Wilkinson. Additional deutonymphs were also collected from inner bark of *Pinus taeda* infested with *Ips avulsus, I. calligraphus,* and *D. frontalis* in Elizabeth, Louisiana; collected by J. C. Moser. New locality records: 1 ♀, 2 ♂ ♂, 1 tritonymph, 1 deutonymph and 1 larva from inner bark of *Pinus rudis* infested with *Ips* sp. (undetermined) from Department Totonicipan, Guatemala; collected by E. W. Clark. Also from the same locality 6 tritonymphs from galleries of *D. frontalis* in *P. rudis* and 1 deutonymph from inner bark of *Pinus montezuma* infested with *D. frontalis.* One deutonymph taken under elytra of an *Ips* sp. in galleries of *P. rudis* from Department Totonicipan, Guatemala.

TYPES: The holotype and paratype deutonymph was deposited in USNM in 1970. Plesiotypes of ♀, ♂, and tritonymph (3 slides total) are now also in USNM. These plesiotypes were taken from inner bark of *Pinus rudis* infested with *Ips* sp. from Totonicipan, Guatemala. Remaining specimens (1♂, 5 tritonymphs, and 8 deutonymphs) retained in first author's collection.

COMMENTS: Deutonymphs of *H. conjuncta* are now known from bark beetle galleries in Honduras, Guatemala, and Louisiana, USA. The species appears not to be restricted to an association with any single bark beetle on pine trees. The deutonymph and female are very typical of the genus and family, but the tritonymph and adult male are somewhat unusual. The adult male is as heavily armoured as many oribatid species, and such a degree of thickness and sclerotization of cuticle is very atypical of anoetids. Some of the tritonymphs were reared from deutonymphs, so it is certain the above described adults stages do belong to the previously described deutonymphs.

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RANGE EXTENSION OF TWO HETERANTHIDIUM, WITH DESCRIPTION OF H. CORDATICEPS MALE (HYMENOPTERA: MEGACHILIDAE)

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ABSTRACT—The previously undescribed male of *Heteranthidium cordaticeps* Michener is described and illustrated based on males from New Mexico and Arizona. The male possesses the deeply incised occiput described for the female. Other important features are: lack of spines on the fore coxae, sharp carina on pronotal lobes, third sternum without spines and hind basitarsus more than half as long as hind tibia. The existence of an eversible penis in this genus is noted and figured for *H. cordaticeps*. A male from Lower California extends the range of *H. autumnale* Snelling far to the south. Differences between this male and the type are briefly described.

Heteranthidium cordaticeps Michener was described from three female specimens, one from Austin, Texas, and two from Texas, without more definite locality. Since then, the species appears not to have been collected and at the time my key (Snelling, 1966) was published the male remained unknown.

The following description should permit the recognition of the male of this species.

Diagnosis: Occiput, in frontal view, deeply incised in middle; anterior coxa without spines; pronotal lobe with lamellalike carina; third sternum without spines; hind basitarsus more than $\frac{1}{2}$ as long as hind tibia.

Measurements: HW 4.5–4.6; HL (to middle of occiput) 3.5–3.6; wing length, 11; HL + thoracic length + T_1 + T_2 = 11.1–11.2 mm.

Head broader than long; facial breadth at level of clypeal base 0.85 times distance from anterior ocellus to apex of clypeus; first flagellar segment hardly longer than second; distance between posterior ocelli equal to distance between ocelli and eyes, 0.6 times distance between ocelli and posterior margin of vertex (measured in middle); occiput, in frontal view, deeply incised, the side strongly raised above top of eye (fig. 1A). Mandible tridentate. Apical clypeal margin nearly straight, with shallow median emargination, with a pair of denticles on either side. Punctures of clypeus and side of face coarse, deep, almost touching, interspaces shiny, those of frons and vertex finer, denser, with interspaces shiny; genal punctures as coarse and dense as those of clypeus, interspaces shiny.

Carina of pronotal lobe lamella-like, height equal to almost one-half an ocellar diameter. Mesoscutum, scutellum and axilla rugosopunctate; upper half of anterior face of mesepisternum coarsely, closely punctate, lower half shiny, largely impunctate; lateral face of mesepisternum contiguously punctate, punctures finer than those of frons, interspaces shiny. Tegula finely, densely punctate, interspaces lightly tesselate; lateral and discal areas shinier, more coarsely punctate.
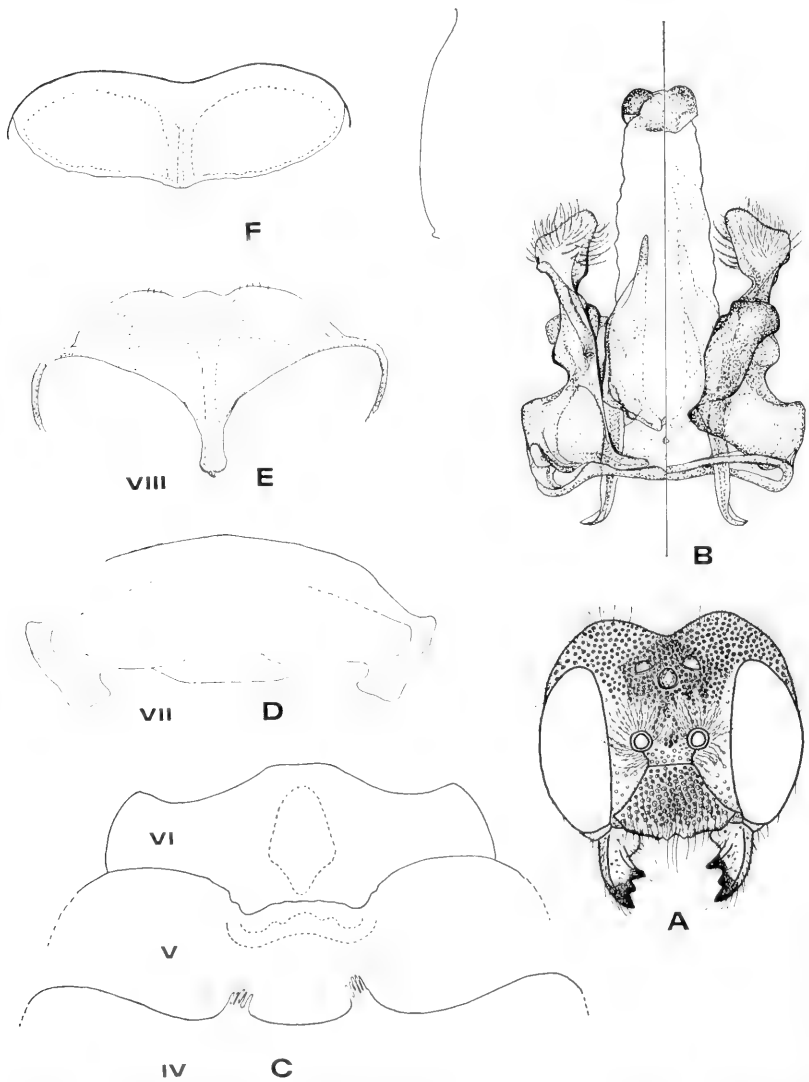
Fig. 1. *Heteranthidium cordaticeps*, male. A. Front of head. B. Genital capsule, left half ventral aspect, right half dorsal aspect. C. sterna IV–VI. D. sternum VII. E. sternum VIII. F. pygidium, dorsal view and lateral shape of median carina. Figures by Ruth A. DeNicola.

Anterior coxa without apical spine; middle tibia about twice longer than wide; middle basitarsus about one-fifth longer than hind, latter about two-thirds as long as hind tibia.

Abdominal tergites with a narrow apical band depressed, translucent, dis-

tinctly reflected; finely, closely punctate, interspaces lightly tesselate. Pygidial carina, in profile, straight; apical margin nearly straight, but slightly produced in middle. Sternite III without tubercules; sternite IV with an apically pectinate process on either side of median emargination (fig. 1C); outline of sternites V and VI as in fig. 1C. Genitalia (fig. 1B) much as in other species.

Color: The following light yellow: labrum, clypeus, lateral face mark, extending along inner orbits to summit of eye; quadrate supraclypeal mark; lower one-fourth of outer orbit; pronotal lobe, behind carina; tegula, except irregular ferruginous mark; most of axilla; posterior half of scutellum; metonotum; irregular apical third of fore coxa; apical half, or more, of hind coxa; narrow ventral stripe on apical three-fifths of fore femur; irregular, vague ventral stripe on mid femur; mid basitarsus. The following brighter yellow: underside of scape; mandibles, except black teeth; apical stripes on first three tergites, narrowed in middle; remaining tergites wholly yellow; second and third sternites with apico-lateral spots. The following black: large frontal spot; pronotum; middle two-thirds of scutum; meso- and meta-pleurae; propodeum mostly; basal third of fore coxa; tips of tarsal claws. Remainder of insect ferruginous.

The color features described above are based largely on the New Mexico specimen. The Arizona series exhibit some variation. The specimens collected by Zavortink, Snelling, and Rozen, *et al.*, all have the lower one-third of the outer orbits yellow; the remaining Arizona male (from Apache) has a broad yellow stripe extending nearly to the top of the eye. Two have the frontal and ocular areas black, one has the lower frons black and one has these areas ferruginous. In the Apache specimen collected by Snelling, the yellow on the pronotal lobe is reduced and the pronotum is otherwise black, the mesoscutum has only narrow lateral ferruginous stripes, the axillae, scutellum and metanotum are wholly ferruginous, the propodeum is entirely black, and the extreme bases of tergites II–VI are blackish (fading into ferruginous on II–IV). The Apache specimen with the long outer orbital stripe has yellow stripes laterally on the mesoscutum and the axillae and scutellum are mostly yellowish. In this specimen the outer faces of the fore and middle tibiae and basitarsi are largely yellowish.

The morphological agreement among these specimens is quite close. Of the Arizona specimens only the one collected near Douglas has a median clypeal emargination; the remaining three possess a median denticle flanked by a pair of larger denticles on each side. In two specimens the median tooth is minute, while in the third it is subequal to the outermost of the flanking denticles.

In my key to the males of *Heteranthidium* these males will go to the last couplet, where they agree best with *H. autumnale*. The diagnostic features noted above should be sufficient to separate the two. The deeply incised occiput of *H. cordaticeps* appears to be unique.

A previously unrecognized feature of *Heteranthidium* is the existence of an eversible penis, as illustrated in fig. 1B. I have briefly

examined other species of this genus and all possess an eversible penis. There are differences between the species in the shape of the apical sclerotized area which may prove useful as specific characters.

Specimens examined: NEW MEXICO: 1 ♂, Sitting Bull Falls Picnic Grounds, Eddy Co., 23 August 1970 (O. Shield and M. Toliver; LACM). ARIZONA (all Cochise Co.): 1 ♂, 16 mi. N.E. Douglas, 31 August 1962 (J. G. Rozen, M. Statham, S. J. Hessel; AMNH); 1 ♂, Apache, 26 August 1972 (Rozen, Favreau, McGinley; AMNH); 1 ♂, Apache, 24 August 1969 (T. J. Zavortink; TJZ), on either *Helianthus annuus* or *Heterotheca subaxillaris*, 10:20–10:50 AM, M.S.T.; 1 ♂, 0.5 mi. N. Apache, 4 September 1972 (R. R. Snelling; LACM), on *Helianthus annuus*.

Heteranthidium autumnale Snelling, 1966, was described from a a single pair collected near Desert Hot Springs, Riverside Co., Calif. One recently collected male is the third specimen known to me and extends the range into Lower California: Rancho Buena Vista, Territorio Sur de Baja Calif., Mexico, 16 Oct. 1972 (E. M. & J. L. Fisher; LACM). This individual is structurally very similar to the male holotype, but has a pair of low, rounded teeth on either side of the median denticle of the clypeal margin; in the type there is a single such tooth on either side.

The pale maculae are less extensive than in the type. On the head, the upper outer orbital line is absent and the lower line is about ¾ as long as in the type and the supraclypeal mark is entirely absent. The pronotal lobe is without any indication of a pale spot and the tegulae are blackish with a yellow median spot. The legs are blackish, rather than reddish as in the type, the mid and hind femora with reddish areas but no yellow; the external stripe broadly interrupted on all tibiae. The transverse fascia of the first tergite is broken into four maculae, rather than deeply invaginated medially and sublaterally; the fasciae of the second to fourth tergites are broken into three maculae; that of the fifth is complete but with deep incursions of black sublaterally, extending anteriorly from the apical margin; the sixth segment has a large median macula and the seventh is immaculate. The ventral segments are without lateral spots.

A NEW KOHLSIA FROM THE REPUBLIC OF
COLOMBIA (SIPHONAPTERA: CERATOPHYLLIDAE)

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ABSTRACT—Description and illustrations of *Kohlsia* falcata Méndez and Hanssen, n. sp. are given. This species is compared with *K. tiptoni* Méndez and Altman, its nearest known relative.

The new species of *Kohlsia* described in this paper represents the first record of the genus for the Republic of Colombia. Another South American species, *K. campaniger* (Jordan), was described from Ecuador. Presently, the known range of *Kohlsia* seems to extend from Mexico, throughout Central America and Panamá to areas of Colombia and Ecuador in northwestern South America. Tipton and Machado-Allison (1972) present no record of *Kohlsia* from Venezuela. However, it is possible that this genus is extant also in that country.

*Kohlsia falcata* Méndez and Hanssen, new species
Fig. 1–8

Type material: ♂ Holotype, ♀ allotype and 1 ♂ paratype, ex *Tamandua tetradactyla* Linnaeus, Hacienda "La Conquista" (humid tropical forest, elevation 642 m), 70 km North of Puerto López, Departmento del Meta, Colombia, July 1971, H. Hanssen, collector. Holotype and allotype deposited in the U.S. National Museum of Natural History. Paratype in the British Museum (Natural History).

Length of types (in mm): ♂ Holotype, 1.95, ♀ allotype, 2.00; ♂ paratype, 1.87.

Diagnosis: *Kohlsia falcata*, n. sp. is similar to *K. tiptoni* in several morphological features. Two of the most outstanding of these are the tibial comb, found on all legs, and the possession of a prominent bristle on the dorsal margin of the distal arm of the ninth sternum. It is readily separated from the latter species and from all other known *Kohlsia* by the peculiar primary dorsal lobe of the aedeagus, which is definitely sickle-shaped. A squamose area of the aedeagal alate lobe also seems to be peculiar to the present new species.

MALE: Head (fig. 1): Anterior margin provided with short frontal tubercle. Preantennal area with numerous micropores, 3 rows of prominent bristles and several scattered minute bristles. Postantennal area having few micropores and 3 rows of unequal bristles. Both pre- and postantennal areas showing typical
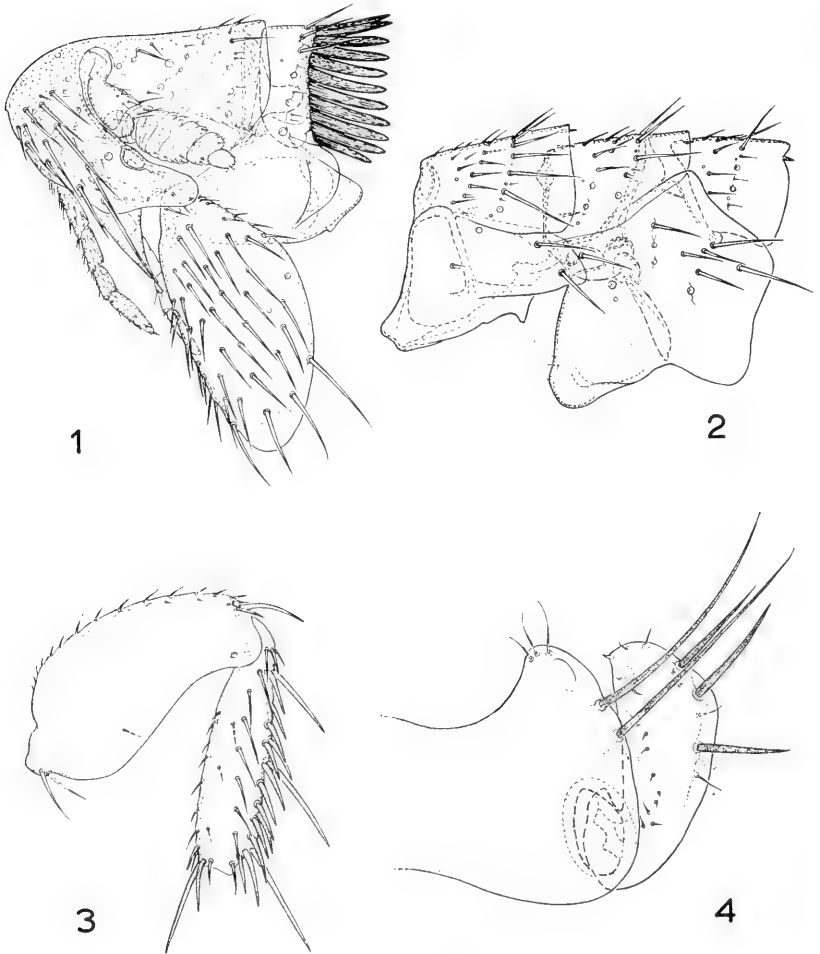
MENDEZ

Fig. 1–4, *Kohlsia falcata*, male. 1, head, prothorax and procoxa. 2, meso-
thorax, metathorax and first abdominal segment. 3, femur and tibia of hind leg.
4, process and movable finger of clasper.

striation. Antenna as illustrated. Trabecula centralis large, rounded. Eye sub-
oval and slightly pigmented. Genal process ending in subrounded apex. Maxillary
lobe subtriangular. Maxillary palpus reaching about ½ of fore coxa, clothed
with many bristles. Labial palpus exceeding length of maxillary palpus.

Thorax (fig. 1, 2): Pronotum relatively narrow, armed with one row of dis-
similar bristles and pronotal comb of about 22 semiblunt spines. Mesonotum with
several dorsal bristles and 3 lateral rows of bristles, the last row being the more
conspicuous. Mesonotal flange having 2 or 3 pseudosetae per side. Metanotum
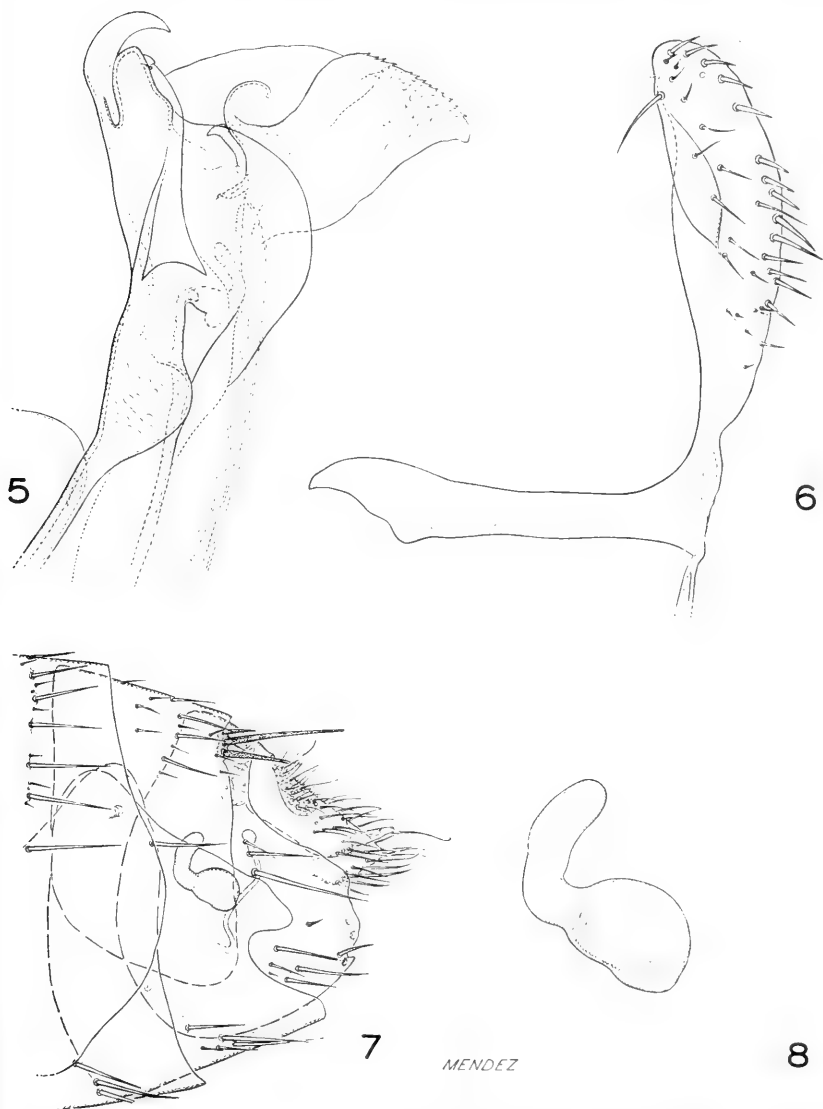
Fig. 5–6, *Kohlsia falcata*, male. 5, terminal portion of aedeagus. 6, ninth sternum.

Fig. 7–8, *K. falcata*, female. 7, modified abdominal segments. 8, spermatheca.

provided with 3 rows of bristles. Mesepisternum apparently with but 1 or 2 bristles, its antero-ventral portion being truncate. Mesepimeron with no more than 3 bristles: Metasternum exhibits 3 minute bristles on its most anterior section and single large bristle close to pleural ridge. Metepimeron with about 9 bristles, of which only the first 3 are arranged in a definite row.

Legs: Morphology and chaetotaxy very much as in *K. tiptoni*. The most conspicuous feature displayed by all legs is the presence of a tibial comb of thickened false spines.

Abdomen: Tergum I bearing several bristles, the majority arranged in 2 well defined rows. Terga II to VII with bristles arranged in 2 rows. Terga I–IV having 1 or 2 spinelets per side. Sternum I with 1 ventral bristle. Sterna II–VI with single row of ventral bristles.

Modified abdominal segments: Tergum VIII broad but scarcely ensheathing part of genitalia, with shallowly convex posterior margin. Sternum VIII apparently reduced to a semimembranous structure devoid of bristles. Distal arm of sternum IX (fig. 6) larger than proximal arm, resembling a club armed with a row of submarginal subspiniform bristles in combination with a number of thin bristles which are distributed irregularly.

In addition, this arm presents a prominent subapical bristle oriented cephalad. Fixed process of clasper (fig. 4) broad, having subangular apex exhibiting three subapical bristles and oval fovea. Acetabular bristles displaced towards upper half of immovable process (this peculiarity is also observed in *K. tiptoni* but not in other members of the genus where acetabular bristles are normally inserted on subcaudal border facing acetabulum). Movable process (fig. 4) about reaching level of apex of fixed process, slightly subtriangular, being narrower at its base and gradually dilated into subangular portion which bears small subrounded anterior fovea. This process is armed with three stout bristles restricted to its anterior half.

Aedeagus: Aedeagal apodeme devoid of apical appendage. Terminal portion of aedeagus (fig. 5) conspicuous but with very compact as compared with that of *K. tiptoni*. Proximal spur weak, upturned, not strong and curved backwards as in *K. tiptoni*. Median dorsal lobe not prominent, barely sinuate. Primary median dorsal lobe outstanding, strongly curved backwards as a sharp blade. Paradorsal lobe represented by structure of irregular shape, with very sclerotized margin. Lateral lobes arched, very expanded. Crochet prominent, spiculose, developed as a broad blade caudally subacuminate and barely curved, anteriorly connected with accessory membrane. Sclerotized inner tube well defined; its armature simple, claw-shaped, not bilobed. Apex of sclerotized inner tube well developed and arched. Crescent sclerite represented by reduced and inconspicuous structure. Alate lobe provided with scale-like pattern. Fulcral lateroventral lobe well sclerotized, with terminal portion sharply bent upwards. Virga dorsalis beginning on area of fulcral latero-ventral lobe and extending into aedeagal apodeme. True penis rods not coiled, reaching beyond terminal portion of aedeagal apodeme.

FEMALE: General appearance as in the male, with the exception of the more rounded head and the sexual structures.

Modified abdominal segments (fig. 7): Sternum VII having almost parallel lateral margins, with three rows of bristles in front of antepygidial bristles. Sternum VIII well developed, broad, with hind margin irregular, strongly sinuate, and provided with bristles of various sorts. Sensilium with about 21 sensory pits per side. Dorsal anal lobe and ventral anal lobe of proctiger armed with several inconspicuous bristles. Anal stylet about four times as long as its maximum width, attenuated distally, bearing long apical bristle and minute dorsal bristle. Sternum VII characterized by distinctly sinuate posterior margin with deep subcaudal

indentation producing a broad sinus. This sternum armed with several bristles as illustrated. Spermatheca (fig. 7, 8) obviously of the same type presented by *K. tiptoni*. However, in the present new species the bulga is more convex dorsally and the hilla is narrower anteriorly and moderately upturned, not strongly bent as in *K. tiptoni*. Bursa copulatrix (fig. 7) having distinctly sinuate duct and broad, rounded perula.

Taxonomic discussion: *Kohlsia falcata*, n. sp. displays several remarkable features which are also found on *Kohlsia tiptoni*. These species possess a characteristic tibial comb of spines on all legs, a detail distinctive of the allied genus *Jellisonia* Traub. Also, as in *Jellisonia*, the ninth sternum distal arm of the two species of *Kohlsia* under discussion present a number of subspiniform bristles and a typical prominent bristle located on its dorsal margin. In these fleas the acetabular bristles of the fixed process are medially located, not caudally oriented as normally occur in other *Kohlsia* species. The spermatheca and the bursa copulatrix of *K. falcata*, n. sp. and *K. tiptoni* are somewhat similar morphologically.

In spite of the high degree of similarity existing between *K. falcata*, n. sp., and *K. tiptoni*, they differ in several details. One of the most distinctive differences is the presence of 3 stout bristles on the movable finger in the new species, instead of the 4 which are peculiar to *K. tiptoni*. The sternum VIII, which is present in *K. tiptoni* as a reduced structure provided with an apical bristle, seems to be almost completely absent in *K. falcata*, n. sp. in which it appears as an amorphous, semimembranous structure without any bristle. Other details in which the 2 species differ are mentioned in the diagnosis and in the description sections of this paper. Other differences may be detected in the accompanying figures which should be compared with those of *K. tiptoni* as presented by Méndez and Altman (1960).

In light of some of the factors outlined above, a revision of the genus *Kohlsia* might reasonably regard *K. falcata* n. sp. and *K. tiptoni* as members of a particular subgenus, perhaps phylogenetically near the genus *Jellisonia* Traub.

Remarks: The association of *Kohlsia falcata*, n. sp. with the Collared Anteater, *Tamandua tetractyla*, is probably not normal. In general, most of the information on the host-parasite relationship of the genus indicates that rodents of the family Cricetidae and Sciuridae are the natural hosts. It may be well founded to think that the present new species is a natural parasite of an arboreal or semi arboreal rodent. The possibility exists that this anteater, being partially arboreal, obtained the fleas from the nest of a tree-inhabiting rodent, perhaps a species of squirrel. It is significant to note that the few specimens of the closely related species, *Kohlsia tiptoni*, were obtained from the following hosts: *Didelphis marsupialis*, *Tylomys panamensis*, *Sciurus*

granatensis, and an unidentified rat. The first three animals mentioned, are either partial or completely arboreal.

The specific name, *falcata*, adopted for this flea, refers to the aedeagal primary dorsal lobe which resembles a sickle blade.

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AN ADDITIONAL NOTE ON THE NESTING BEHAVIOR
OF DIPLOPLECTRON PEGLOWI KROMBEIN
(HYMENOPTERA: SPHECIDAE)

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ABSTRACT—New information on the nesting behavior of *Diploplectron peglowi* is revealed. Nest structure and dimensions, prey type, and number of prey and prey weight per cell are described and discussed as they extend the range of behavioral variation in this species.

In 1972 I described the components of the nesting behavior of *Diploplectron peglowi*, based primarily upon the observations of two provisioning females and their completed nests. In the same paper, I compared these components with those of some other species of Astatinae. Williams (1946) reported briefly on the nesting behavior of this species under the name *Diploplectron* sp. Parker (1972) presented information on a female of *D. peglowi* nesting in California. On June 29, 1972, I had the opportunity to observe a female of *D. peglowi* nesting at the same locality where my previous study was made (Selkirk Shores State Park, New York) and I should like to record this information below because it extends the range of behavioral variation in this species.

The female nested in flat, almost bare sand at the periphery of a sand pit, about ¼ mile from the area described in my 1972 paper. She began constructing her burrow on June 28 at 1:05 P.M. at the base of a clump of grass. Burrow construction lasted for more than an hour and contained the species-typical features described in my earlier paper. Then, instead of beginning to provision as is customary in this species, the wasp closed herself within the burrow for at least two hours and presumably for the night. She reopened the burrow from inside the next morning at 10:05 A.M. but did not bring the first prey to the nest until 11:30 A.M. Prey transport, entry, and exit was species-typical (see Kurczewski, 1972). She brought her second prey to the nest at 12:10 P.M. and, after spending 22 minutes below the surface, reappeared head first in the entrance making the final closure. I captured the female just after she had filled the burrow flush with the sand surface.

The burrow, 3 mm in diameter, entered the sand at about a 55° angle and proceeded inward for 5.3 cm, including cell length. The single cell, 3 × 6 mm, was located 3.1 cm beneath the surface, including cell depth. It contained only two prey, both positioned head-inward and ventral-side-upward. Both were last instar nymphs of the lygaeid

Emblethis vicarius Horv. The wasp's egg, 1.3 mm long and 0.4 mm wide, was placed on the bug which had been put near the back end of the cell. It was attached in the species-typical position (see Kurczewski, 1972, Fig. 4). The egg-bearing prey weighed 3.5 mg and the other bug. 4.2 mg, or, a total of 7.7 mg for the cell contents.

<div align="center">DISCUSSION</div>

It is now apparent that *D. peglowi* is not so restricted in habitat as indicated by Krombein (1939) and substantiated by Kurczewski (1972). Rather, the species seems to occur in a variety of habitats with sandy soil and sparse vegetation (see Parker, 1972). Burrow structure and dimensions vary with variation in nesting-site. For example, Kurczewski (1972) reported *D. peglowi* nesting in the slopes of small sand hills and constructing 3- and 4-celled nests with burrows ranging from 8.5 to 12.5-cm-long. Parker (1972), observing this species in California, noted a 1-celled nest with an "antechamber" and a burrow, 11-cm-long. In the present study the nest excavated in flat sand was single-celled and the burrow, only 5.3-cm-long.

The kinds of prey stored in the cells of *D. peglowi* also reflect the habitat and, possibly also, the season and year of study. Previously, the species had been reported to prey upon the nymphal lygaeids *Sphragistus nebulosus* (Fallén) (Williams, 1946) and *Sphaerobius insignis* (Uhler) and *Lygaeus* sp. (Kurczewski, 1972); and, upon the nymphal rhopalid *Aufeius impressicollis* Stål. (Parker, 1972). In the present study, the prey utilized by *D. peglowi* comprised nymphs of the lygaeid *Emblethis vicarius*.

The fact that the female of *D. peglowi* in the present study stored only two prey per cell while those studied by Williams (1946), Parker (1972), and Kurczewski (1972) stored "several," three, and three to six bugs per cell, respectively, is not as surprising as the disparity in the total weights of prey per cell in my two studies. In the study published in 1972 this figure ranged from 12 to 18 (mean, 15.1) mg, whereas in the present study the two prey stored in the fully-provisioned cell weighed only 7.7 mg.

<div align="center">REFERENCES</div>

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NEW SYNONYMY AND COMBINATIONS IN SAWFLIES (HYMENOPTERA: SYMPHYTA)

In the paper "On some Tertiary sawflies (Hymenoptera, Symphyta) from Colorado" by Zhelochovtzev and Rasnitsyn (1972, Psyche. 79:315–327), the authors gave some new combinations but did not express the following generic synonymy.

(1) The authors placed *Paremphytus ostentus* Brues (Blasticotomidae) in the genus *Runaria*. However, *ostentus* is the type-species of the genus *Paremphytus* Brues which has priority over *Runaria*.

> *Paremphytus* Brues, 1908. Bul. Mus. Comp. Zool. 51:265.
>> Type-species: *Paremphytus ostentus* Brues. Monotypic.
>
> *Runaria* Malaise, 1931. Zool. Anz. 94:212. N. SYN.
>> Type-species: *Runaria reducta* Malaise. Monotypic.
>
> *Paremphytus flavipes* (Takeuchi). N. COMB.
> *Paremphytus ostentus* Brues.
> *Paremphytus reductus* (Malaise). N. COMB.

This genus is known from two living species in Japan and the fossil species from Colorado.

(2) *Lithoryssus parvus* Brues was placed in the genus *Fenusa* (Tenthredinidae). Because *parvus* is the type-species of *Lithoryssus* Brues, *Lithoryssus* becomes a synonym of *Fenusa*.

> *Fenusa* Leach, 1817. Zool. Misc., v. 3, p. 126.
>> Type-species: *Tenthredo* (*Emphytus*) *pumila* Klug. Monotypic.
>
> *Lithoryssus* Brues, 1906. Bul. Amer. Mus. Nat. Hist. 22:492. N. SYN.
>> Type-species: *Lithoryssus parvus* Brues. Orig. desig.

(3) The new combination "*Mesoneura* (?) *vexabilis* (Brues)" (Tenthredinidae) was given by the authors. Rohwer based a new genus on *vexabilis*; consequently, that genus, *Lisconeura*, becomes a synonym of *Mesoneura*.

> *Mesoneura* Hartig, 1837. Fam. Blattwespen und Holzwespen, nebst Einleitung Naturgesch. Hym., p. 229.
>> Type-species: *Tenthredo opaca* Fabricius. Monotypic.
>
> *Lisconeura* Rohwer, 1908. Bul. Amer. Mus. Nat. Hist. 24:529. N. SYN.
>> Type-species: *Scolioneura vexabilis* Brues. Orig. desig.

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SOME INSECTS OTHER THAN BEES ASSOCIATED WITH
LARREA TRIDENTATA IN THE SOUTHWESTERN UNITED STATES

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ABSTRACT—This study reports the results of a preliminary investigation of some insects other than bees associated with the creosote bush, *Larrea tridentata*, in the southwestern United States.

Like many plants with chemical and physical properties which reduce predation by vertebrate and invertebrate herbivores in general, the creosote bush (*Larrea tridentata* (De Candolle) Coville, Zygophyllaceae) has its own constellation of insects which have evolved a tolerance for its leaves, stems, roots and flowers. While carrying out field studies of the desert bees involved in the pollination of this plant in New Mexico, Arizona and southern California (Hurd and Linsley, 1975), it was inevitable that we encountered many of these insects. No attempt was made to conduct a survey of *Larrea* insects, a project which would no doubt prove to be rewarding. However, samples were taken and observations were made on a few of the more conspicuous or ubiquitous insects, especially those which offered competition to bees for pollen or nectar, or were large enough to disturb the activities of the bees, or those which utilized the plant as a haven for predation on bees and other insect visitors.

While theoretically it is possible that every species of insect which occurs where *Larrea* grows could ultimately be found on this plant, it is evident that such exceptional visitations for whatever purpose are of little or no evolutionary significance.

References to *Larrea* insects have been cited where known to us, but a thorough survey of the literature was not undertaken in view of the preliminary nature of this report.

Descriptions of the procedures and the principal sampling and survey sites from which most of the records referred to here were obtained may be found in Hurd and Linsley (1975).

There has been lack of agreement among botanists as to the appropriate name for the species of *Larrea* inhabiting North America, some regarding it as conspecific with the South American *Larrea divaricata* Cav., others as a distinct species, *L. tridentata*. We follow Porter (1963, 1974) and Raven (1963) in utilizing the designation *Larrea tridentata*.

In the discussions that follow, the species are arranged by family which in turn are arrayed by order in general phylogenetic sequence. As will be noted the orders Orthoptera and Hemiptera are treated for convenience of presentation in the broad, and hence more inclusive, sense.

Orthoptera

Three families of this order contain a number of species which have evolved some dependence on *Larrea* in the southwestern United States and adjacent Mexico.

Acrididae

Among the acridids, the creosote grasshopper, *Bootettix punctatus* Scudder, is perhaps the most widely distributed of the grasshoppers associated with *Larrea*. Although we have encountered it mainly in southern Arizona and southeastern California, it is reported to occur throughout the range of its host plant (Barnum, 1964) and its known occurrence in California has been recorded and mapped by Strohecker, Middlekauff and Rentz (1968). As emphasized by Ball (1936) and Ball et al. (1942), the coloration of this species is re-

markably similar to that of the creosote bush katydid and, like that species, it is difficult to see in the foliage.

Another widespread and ubiquitous *Larrea* grasshopper is the desert clicker, *Ligurotettix coquilletti* McNeill. Rehn (1923) has given a good account of its habits, recognizing three subspecies, as do Strohecker, Middlekauff, and Rentz (1968). The form most commonly encountered by us during our sampling program in southern Arizona, Sonora and New Mexico, we interpret as *L. coquilletti kunzei* Caudell. Although this species is generally regarded as more or less restricted to *Larrea*, some of the populations apparently exceed the range of this plant and presumably overlap onto other hosts. Although of a different cryptic coloration than *Bootettix tenellus*, being grayish and brown, *Ligurotettix* is nevertheless difficult to locate, even when the presence of the males is clearly announced by their characteristic stridulation.

Another species of grasshopper considered by Ball et al. (1942) as confined to *Larrea* in parts of Arizona, Sonora and the Chihuahua Desert of Mexico, *Clematodes larreae* Scudder, has not been seen in the field by us. It is also said to be mottled grey and brown, similar to the stems of the plants.

In the vicinity of Portal, Cochise County, Arizona, we have frequently collected *Conalcea huachucana* Rehn, a brownish or grayish-brown species with small oval whitish wingpads and a dark brownish black lateral stripe on the thorax. The species, inconspicuous on the *Larrea* plants, frequently turns up in the net along with a deliberately collected bee sample.

A widespread acridid, appearing casually on *Larrea*, is *Schistocerca vaga* (Scudder), which prefers other habitats but is not uncommon on this plant in the summer and fall near Lake Cienega, Hidalgo County, New Mexico.

The only katydid regularly encountered by us in southeastern Arizona and western New Mexico has been the creosote bush katydid, *Insara covilleae* Rehn and Hebard. The nymphs and adults are so cryptically colored that they are difficult to discern among the *Larrea* foliage. Most of our examples turned up in the net as a "bonus" when we were capturing a bee. Rehn and Hebard (1914) have given an account of the behavior and coloration of this remarkable insect and their observations and distributional data have been supplemented by Ball et al. (1942) and Barnum (1964).

PHASMIDAE

Phasmids are not uncommon on *Larrea* but like so many inhabitants of this plant they are cryptically colored and difficult to discern. In southern Arizona and western New Mexico, the species most frequently encountered were *Diapharomera covilleae* Rehn and Hebard,

the creosote bush walking stick, and *D. arizonensis* Caudell. In the San Simon Valley, and southeastern Arizona and adjacent New Mexico, where much of our bee sampling was done, *D. covilleae*, the larger of the two, with the female brown and gray, was the less common. *Pseudosermyle straminea* Scudder, a gray species, was also found on *Larrea* in the San Simon Valley.

MANTIDAE

Mantids, especially *Stagmomantis limbata* (Hahn) are common on *Larrea* in southern Arizona and New Mexico. This species is very cryptically colored and can often be located most readily by the prey which it holds. We have observed females capturing bees and wasps as they visit the flowers of *Larrea* in the summer and fall, including males of the large carpenter bee, *Xylocopa californica arizonensis* Cresson, feeding first on the muscles of the thorax.

HEMIPTERA

While our investigations have revealed the varying dependence on *Larrea* of a comparatively large number of species belonging to 11 families of this order, there are doubtless additional species which will be found to derive a significant part of their economy from or in association with *Larrea* in the southwestern United States and adjacent Mexico.

MIRIDAE

The most abundant of the mirids encountered on *Larrea*, particularly in southern Arizona and New Mexico, were the cryptic brown to greenish *Phytocoris*. Sweeping the plants at several of our sites would no doubt have yielded thousands of specimens. Several species were involved, mostly taken in May and June. Knight (1925) described *Phytocoris covilleae* from *Covillea* (= *Larrea*) at Tucson, Arizona, and subsequently recorded *P. nigripubescens* Knight from *Larrea* in Nevada (Knight, 1968). In the collection of the California Insect Survey, University of California, Berkeley, there is a long series of this last species from Hopkins Well, Riverside County, California, collected from *Larrea* on April 16, 1958 by Dr. Jerry Powell (det. J. C. M. Carvalho).

Other mirids found on *Larrea* from time to time were *Neurocolpus nubilis* (Say), *Oncerometopus nigriclavus* Reuter, *Lygus desertinus* Knight, *L. lineolaris* (Palisot de Beauvois), *Rhinacloa forticornis* Reuter, and *Parthenicus covilleae* Van Duzee. This last species has been recorded from *Larrea* (or *Covillea*) at Palm Springs, Riverside County, California (Van Duzee, 1918), Guadalupe Point and Carmen Island, Baja California (Van Duzee, 1923, as *P. percroceus*), the Nevada Test Site, Nevada, Tucson, Arizona, and Fabens, Texas

(Knight, 1968). Knight (loc. cit.) states that "it now appears from material examined that *Parthenicus covilleae* Van D. is found on *Larrea divaricata* [= *tridentata*] over the range of this plant in Arizona, southern California and Nevada."

REDUVIIDAE

As would be expected, predaceous bugs of the family Reduviidae utilize *Larrea* foliage and flowers as a source for their prey. The most abundant and widespread of these in our experience is *Zelus socius* Uhler, which we encountered frequently from southern California to New Mexico. *Sinea complexa* Caudell and *Apiomerus flaviventris* Herrich-Schaeffer were also taken occasionally. The latter was observed feeding on solitary bees among the blossoms of *Baccharis glutinosa* and *Prosopis juliflora* as well as those of *Larrea*. Coquillett (1892) has reported adults and nymphs of this species preying on honeybees in southern California.

LYGAEIDAE

Our limited samples did not yield many lygaeids, only *Xyonysius californicus* (Stål) and *Nysius raphanus* Howard, which were no doubt casual visitors to *Larrea*.

PYRRHOCORIDAE

Individual specimens of the ubiquitous *Largus cinctus* Herrich-Schaeffer were found on *Larrea* from time to time, especially near Tucson, Pima County, Arizona in the spring and summer.

COREIDAE

Mozena arizonensis Ruckes was found occasionally on *Larrea* plants near Tucson, Pima County, Arizona, and Douglas and Portal, Cochise County, Arizona in both spring and summer. In one instance a robberfly, *Promachus giganteus* Hine had captured and was feeding on an individual from *Larrea*. We have also found this coreid on mesquite (*Prosopis juliflora* (Swartz) DeCandolle).

The widespread ubiquitous *Liorhyssus hyalinus* (Fabricius) was found on *Larrea* at Portal and Douglas, Cochise County, Arizona, in May.

PENTATOMIDAE

The most commonly encountered pentatomid on *Larrea* was the cryptic, brown *Dendrocoris contaminatus* Uhler. We have taken it at Palm Springs, Riverside County, California and other Colorado Desert localities in April and May, at Tucson, Pima County, Arizona in May,

at Tombstone, Douglas and Portal, Cochise County in the spring and fall, at Granite Pass and Lake Cienega, Hidalgo County, New Mexico, in August, at Deming, Luna County and Las Cruces, Dona Ana County, New Mexico, also in August, and at various other localities in the southwestern desert area.

Another pentatomid commonly found on *Larrea* in southern Arizona and New Mexico was the green *Thyanta perditor* (Fabricius). This is a widely distributed Neotropical species and was observed on a variety of other plants.

More casual *Larrea* visitors included *Chlorochroa ligata* (Say) and a species of *Brochymena*.

Membracidae

The membracid most frequently encountered by us on *Larrea* plants was *Centrodontus atlas* (Goding). It was abundant in May and June at several localities in Cochise County, Arizona, including Portal, Douglas, Tombstone and Naco.

Cixiidae

Oecleis campestris Fall was found on *Larrea* plants in May at Granite Pass, Hidalgo County, New Mexico.

Flatidae

Flatids of the genus *Ormenis*, including *O. saucia* Van Duzee, were taken on *Larrea*, sometimes in fairly large numbers, in May and August, at Portal and Douglas, Cochise County, Arizona.

Issidae

Hysteropterum sepulchralis Ball was occasionally taken on *Larrea* at Portal and Douglas, Cochise County, Arizona, in May.

Coccidae

Among the scale insects associated with *Larrea*, the best known species is the creosote bush lac scale, *Tachardiella larreae* (Comstock). Ferris (1919b) summarized the knowledge of the species then extant, including its potential as a producer of commercial lac. Chamberlin (1923) treated it taxonomically. We have encountered this insect at various localities, especially in western Arizona, Sonora and southern California, where it is particularly abundant in the lower Colorado River drainage. Essig (1958) describes the general appearance of an infestation and illustrates infested twigs.

Several diaspids have been recorded from *Larrea* in the southwestern United States. *Chrysomphalus covilleae* Ferris (1919a) was described

from Mormon Flat, east of Phoenix, Arizona where it was found on the bark and in cracks on exposed roots of *Larrea*. Ferris (1938) later synonymized it with *Targionia yuccarum* (Cockerell), a desert species ranging from Texas to Arizona, Baja California and Colima, Mexico, where it is found on a variety of plants, mostly Compositae. Cockerell (1897) described *Pseudodiaspis larreae* from Yuma, Arizona, where the females were said to be abundant on the stems of the host plant. Although Ferris (1921, 1938) subsequently referred to the species, he apparently based these citations on his previously reported collections. A third species, *Clavaspis covilleae* (Ferris), described initially in the genus *Aspidiotis* (Ferris, 1919a), was also collected originally at Mormon Flat, Arizona, beneath loose bark on exposed roots.

In addition to the above, Cockerell (1895) described the margarodid *Icerya* (*Proticerya*) *rileyi* from Las Cruces, New Mexico, reporting it as common on mesquite (*Prosopis*) and rather rare on creosote bush (*Larrea*). It is a widespread species and has been recorded from *Prosopis* in Arizona (Ferris, 1919a) and Baja California (Ferris, 1921) as well as from other plants. In 1902, Cockerell separated the *Larrea* form from the *Prosopis* form under the name *Icerya rileyi* var *larrae* (sic!) from Chihuahua, Mexico, a fact apparently overlooked by Ferris.

Finally, a dactylopiine, *Eriococcus larreae*, was described by Cockerell and Parrott (1899) from New Mexico where it was found on the crowns of *Larrea tridentata* underground, and a mealybug, *Spilococcus larreae* Ferris, appears to be regularly associated with *Larrea* in California and Arizona (Ferris, 1950; McKenzie, 1956) and we have encountered it on several occasions.

Although we have made no attempt to evaluate the status of the species involved, it is interesting to note that Leonardi (1911) described five species of coccids from Cacheuta, Argentina: *Birchippia americana* n. sp. from *L. divaricata* and *L. cuneata*, *Eriococcus diverspinus* n. sp. from *L. divaricata* and *L. cuneata*, *Ceroplastes irregularis* n. sp. from *L. cuneata*, *Eulecanium elegans* n. sp. from *L. cuneata* and *L. divaricata*, and *Protargionia* (n. gen.) *larreae* n. sp. from *Larrea divaricata* and *L. cuneata*.

COLEOPTERA

Although there are a number of species of this order occasionally encountered on *Larrea* on either the flowers or the vegetative parts of the plant, a relatively large number of species belonging to the following 6 families are known to depend to some extent upon this plant for their survival.

CLERIDAE

The only clerid taken in numbers on *Larrea* was *Phyllobaenus arizonica* Schaeffer. It was found in the spring at Naco, Tombstone, Douglas and Portal, Cochise County, Arizona and Granite Pass, Hidalgo County, New Mexico.

BUPRESTIDAE

The most conspicuous buprestids visiting *Larrea* flowers belong to the genus *Hippomelas*. The most abundant species encountered by us was the large, yellow-pollinose *H. planicosta* (LeConte), especially in southeastern Arizona and New Mexico during the summer-fall blooming period. In southern California it has been taken in June and July on *Larrea* when the plants are not in bloom and thus they are believed to be the larval host. During this off-season, J. W. MacSwain took long series from *Atriplex* at Blythe, Riverside County, California. In the San Simon Valley of Arizona and New Mexico, *H. sphenica* LeConte, a species ordinarily associated with mesquite (*Prosopis juliflora*), also feeds occasionally at *Larrea* flowers.

Acmaeodera cribricollis, originally described from Texas by Horn, (1894), was first recorded from *Larrea* as *Acmaeodera larreae* by Fall (1907), based upon three specimens from Mojave, California. Subsequently, Burke (1918) reported that the species mines heartwood of dying and dead stems of the creosote bush in Arizona. Adults were taken from the wood in January (also reported as *A. larreae*). Van Dyke (1917) recorded it from Imperial County, California without host data but the area is within the *Larrea* zone. In California, we have taken it in April on *Larrea* at a site 18 miles west of Blythe, Riverside County, at Palm Springs, Riverside County, and Borrego, San Diego County. In Arizona, we have taken numerous specimens on *Larrea* 18 miles west of Tucson in June and less abundantly in the San Simon Valley of Arizona and New Mexico in June and again in August. Adults generally fly in the heat of the day, although our Tucson examples span the period from 0800 at 25° C to 1900 at 32° C with the midday temperatures at 36° C. They fly like some bees and wasps and are cryptically colored, blending well with the *Larrea*. The ground color is brown with variable yellow-brown markings, unlike most other species of the genus. Although they feed at the flowers of *Larrea* when the plants are in bloom, they also feed at other plants after the flowering period, at least in southern California. Species of *Acmaeodera* known to be regularly associated with other hosts, occasionally visit *Larrea* flowers but we have not found any of these in significant numbers.

In the genus *Chrysobothris*, a single specimen of the uncommon *C. humilis* Horn was taken on *Larrea* at Douglas, Cochise County, Arizona, on May 20, 1973.

MELOIDAE

Among the numerous beetles associated with *Larrea*, meloids are perhaps the most commonly encountered. Of these, two are particularly striking, *Pyrota postica* LeConte, and *Eupompha fissiceps* LeConte. The former, like other members of the genus, is gregarious (Selander, 1964) and we have seen aggregations of many hundreds of individuals on its favored plant, the creosote bush, in several localities in southeastern Arizona, especially near Douglas and Portal in Cochise County, and in western New Mexico, where they appear to be associated with the Chihuahuan Desert *Larrea* formation. The beetles are large (15–18 mm) with the integument shining and yellow orange and the elytra yellow with black spots. The male is beautifully illustrated by Selander (1964, fig. 26) and also adorns the cover of the January/February issue of The Insect World Digest in full color (photograph by Tschinkel). Although *P. postica* are aposomatically colored and are conspicuous in large aggregations, individual specimens are difficult to see among the stems and foliage of *Larrea*. Although individuals of a related but very dissimilar species, *Pyrota akhurstiana* Horn were found on *Larrea* plants at several localities, no aggregations were observed, and it was not determined whether or not they were feeding.

Eupompha fissiceps, on the other hand, although as large or larger than *Pyrota postica*, has the head and appendages reddish and the elytra shining, rugose, and green, blue-green or blue. We have found it in much the same sites as *Pyrota postica*, most commonly in small numbers (e.g., Lake Cienega and Portal in the San Simon Valley, Douglas, Cochise County) but on one occasion, hundreds of individuals were encountered flying about *Larrea* along the edge of a highway north of Deming, New Mexico. Large numbers were mating, others feeding on the flowers. It was almost impossible to capture a bee without obtaining one or more of these in the net. When present in small numbers the insects are very inconspicuous, as commented upon by Werner, Enns and Parker (1966), the green body blending with the foliage and the head with the blossoms.

A second species presently assigned to *Eupompha*, formerly known as *Calospasta elegans* LeConte, is usually found on desert spring ephemerals, particularly Compositae, but we have taken it on flowers of *Larrea* near Yuma, Arizona. Werner, Enns and Parker (1966) report it as most frequent on *Sphaeralcea*, but also include *Larrea* among their flower records.

Species of *Epicauta* are often found on *Larrea* but in our experience, rarely in numbers. At Tombstone, *E. pardalis* LeConte, an insect that we have usually seen on mesquite, was found on *Larrea* plants that were just coming into bloom. Werner, Enns and Parker (1966) record the species from *Prosopis* and *Solanum*. Individuals of *E. lauta* Horn

were found on *Larrea* at several localities in southern Arizona and
E. nigritarsis (LeConte) in New Mexico. Since most of the desert
Epicauta appear to be associated with Solanaceae, especially *Solanum
elaeagnifolium* Cav. or low growing plants like *Kallstroemia grandi-
flora* (Torrey) Gray, the flowers of which they often severely damage,
their presence on *Larrea* is probably fortuitous but is worthy of further
study.

The large, ponderous, flightless *Cysteodemus armatus* LeConte are
often found on *Larrea* plants growing within their range. In March we
encountered hundreds of individuals feeding on *Larrea* at a site just
north of Yuma, Arizona.

Because of the large number of bees that visit *Larrea*, it is not
surprising that this is a common host for nemognathine meloid para-
sites. Among the species most commonly encountered by us in Arizona
and New Mexico were *Nemognatha nitidula* Enns and *N. meropa*
Enns and in the Colorado and Mojave Deserts of California, *N. mac-
swaini* Enns (1956). These last two are also recorded from *Larrea* by
Werner, Enns and Parker (1966). The type series of *N. macswaini*, and
also of *Pseudozonitis vauriae* Enns, included specimens from *Larrea*,
and we have taken the latter from flowers of this host just north of
Portal, Cochise County, Arizona and at Lake Cienega, Hidalgo County,
New Mexico.

Tenebrionidae

A single example of the unusual tenebrionid *Eupsophulus castaneus*
(Horn) (det. John T. Doyen) was taken on *Larrea* flowers at Tucson,
Pima County, Arizona, 6 August 1973.

Cerambycidae

Three species of Cerambycidae were taken while feeding at flowers
of *Larrea* at various localities in southern Arizona and New Mexico:
Aethecerinus latecinctus Horn (May to July), *Plionoma suturalis* (Le-
Conte) and *P. rubens* (Casey) (spring and fall). The first two have
been recorded previously from flowering desert shrubs (Linsley, 1962).
In the Tucson area we have taken *A. latecinctus* abundantly on
blossoms of the desert ironwood (*Olneya tesota*).

A fourth species, *Perarthrus linsleyi* Knull, was found at *Larrea*
flowers at Palm Springs, Riverside County, California in April.

Curculionidae

The large, flightless, largely nocturnal, desert weevils of the genus
Ophyrastes are commonly found on *Larrea*, although their exact re-
lationship to this plant remains to be determined. In Death Valley,
California, we have taken *O. mortivagus* (Fall) from *Larrea* at Stove-
pipe Wells. At Palm Springs, Indio, and 18 miles west of Blythe,

Riverside County, we have found *O. varius* LeConte on *Larrea*, and Kissinger (1970) regards this plant as one of its most frequent hosts.[1] In southeastern Arizona we have taken three species from *Larrea*, *O. argentatus* LeConte (also found on *Larrea* by us at Palm Springs, Riverside County, California), *O. marmoratus* (Fall), and *O. nivosus* (Fall). This last is the most abundant *Larrea* species in the San Simon Valley and was common in the vicinity of Portal, Cochise County, Arizona and Lake Cienega, Hidalgo County, New Mexico. A second species found on *Larrea* at Portal is apparently near *O. dunnianus* (Casey). Kissinger records *O. dunnianus* from "*Larrea divaricata*" and *Viguiera stenoloba*. In New Mexico, *O. variabilis* (Pierce) was captured on *Larrea* at Deming, Luna County and 5 miles west of Elephant Butte, Sierra County.

In addition to our records, Kissinger lists *Larrea* as the only known host or one of several hosts, for *O. aridus* (Fall) (one record on creosote bush), *O. geminatus* (Horn) (mostly on shrubby composites in addition to *Larrea* and *Prosopis*), *O. mixtus* Kissinger (among the paratypes, 5 individuals from near Edom, California, *Larrea tridentata*, H. L. McKenzie), *O. speciosus* LeConte, *O. variabilis* (Pierce) (also on *Acacia* and *Prosopis*).

Miscellaneous Families

Among the families of flower-visiting beetles collected at *Larrea*, only Melyridae, especially species of the genus *Trichochrus*, were present in numbers. *Lucaina discoidalis* Horn (Lycidae) was taken in the spring at Naco and Portal, Cochise County, Arizona; *Rhipiphorus sexdens* Linsley and MacSwain and *Rhipiphorus* sp. (Rhipiphoridae) at Naco; and *Eurygenius* sp. (Pedilidae) at Naco and Douglas, Cochise County, Arizona also during the spring of the year. Predaceous beetles were represented primarily by species of the genus *Collops* (Melyridae) and *Olla abdominalis* (Say). Leaf-feeding beetles were scarcely sampled. However, among those taken in Arizona were *Pachybrachys haematodes* Suffrian at Portal and Douglas and *P. desertus* Fall at Naco and Tombstone. *Diabrotica* spp. were usually not numerous and were confined to the flowers.

Lepidoptera

Butterflies and moths could not be sampled conveniently during *Larrea*-bee surveys because of the lack of compatibility of sampling techniques. Among the former, the Lycaenidae were by far the most abundant at most sites in southeastern Arizona and western New

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[1] Kissinger utilizes three different names for the U.S. species of *Larrea*, sometimes as though there were three species, undoubtedly following labels on the specimens.

Mexico. Moths were sometimes numerous about the flowers at dusk, before sunrise, on overcast days, and undoubtedly at night. Among these, geometrids were almost always represented, and some of these may have been host specific in the larval stage. Rindge (1959) records larvae of *Synglochis perumbraria* Hulst from southern California, southern Nevada, southern Utah, and across Arizona to western Texas. His map of the distribution of this species is extremely suggestive of that of *Larrea*, and he actually records two specimens from Tucson labelled "larva on *Covillea*." Two moths, *Heliodines metallicella* (Busck), described from Williams, Arizona (Busck, 1909), a diurnal species which we have taken at other flowers, particularly composites, and *Phalonia leguminiana* Busck, a nocturnal species which lives in seeds of Leguminosae (Busck, 1907), were taken from *Larrea* flowers near Yuma and Douglas, Arizona, respectively.

<div align="center">DIPTERA</div>

Even though many representatives of this order are frequently encountered at *Larrea*, especially its flowers, there are relatively few species which have developed a dependent relationship or association with this plant.

<div align="center">CECIDOMYIIDAE</div>

Among the plant-infesting Diptera associated with *Larrea*, the cecidomyiids are the most conspicuous since their galls ornament nearly every bush in many areas. Several types are abundant, but the most conspicuous is a globose, filamentous, woody, many-celled gall, one half to one inch in diameter, presumed to be formed by *Asphondylia auripila* Felt. This midge was reared from galls on *Larrea tridentata* collected at Tucson, Arizona, February 6, 1897 (Felt, 1908) and later he figured the gall (Felt, 1940). Another cecidomyiid gall which we have encountered is quite likely the one described but not named by Ballou (1925). The unknown midge is solitary but the galls occur in groups of two at the nodes near the ends of small twigs and resemble a group of leaves or a bud about ready to bloom. However, a variety of other galls are found in various parts of the range of *Larrea*, and as emphasized by Pritchard (1953) a study of the several midges attached to this host is much needed. In a preliminary survey, Szerlip (*in litt.*) recognized six distinct morphological types of *Larrea* galls.

<div align="center">ASILIDAE</div>

The stems and branches of *Larrea* provide convenient perches for asilids which prey upon the bees, wasps and other insects that visit the flowers. In southeastern Arizona, these include *Mallophora fautrix*

bromleyi Curran which perch high on vertical or nearly vertical branches and prey upon *Nomia mesillensis* Cockerell, *Megachile texana* Cresson, *Melissodes tristis* Cockerell and other medium sized *Larrea* visitors. *Mallophorina pulchra* Pritchard which perches in the lower part of the plant, frequently well inside, captures *Exomalopsis solani* Cockerell, *Dialictus* spp., *Perdita* spp. and other small bees. Large bees and wasps flying to *Larrea* flowers are preyed upon by *Diogmites grossus* Bromley and *Blepharepium secabilis* (Walker), but in general these flies prefer other habitats.

Other asilids present included three species of *Saropogon*, a genus of which more than twenty species are known from the southwestern United States (Wilcox, 1966). Except for *S. dispar* Coquillett, a notorious predator of honeybees (Alex, 1947), the feeding habits of these species appear to be relatively unknown. We found *S. bryanti* Wilcox on *Larrea* 11 miles south of Hermosillo, Sonora, Mexico, and *S. mohawki* Wilcox at Las Cruces, Dona Ana County, New Mexico, but neither were carrying prey when captured. However, at Las Cruces, *S. coquilletti* Back were particularly abundant about *Larrea* plants, and were feeding on both sexes of *Melissodes tristis* Cockerell, females of *Megachile texana* Cresson and no doubt other species.

When *Larrea*-feeding meloids were present, such as *Pyrota postica*, and various species of *Epicauta* and *Nemognatha*, they were fed upon by *Ospriocerus abdominalis* (Say) (*O. ventralis* Macquart), which frequented *Larrea* plants in several localities in southern Arizona and New Mexico. The habitats and coloration of most of these robberflies have been discussed by Linsley (1960).

The only other species of Asilid captured with prey derived from *Larrea* was *Promachus giganteus* Hine which was feeding on the large coreid *Mozena arizonensis* Ruckes. Other species of this genus appear to prefer bees and wasps (Bromley, 1934; Alex, 1947; Fattig, 1945; Linsley, 1960).

Three species of *Efferia* were taken on *Larrea*, *E. benedicti* (Bromley) at Naco, Cochise County, Arizona, *E. frewingi* Wilcox, 10 miles south of Santa Ana, Sonora, Mexico, and *E. fugax* (Williston), 11 miles south of Hermosillo, Sonora, Mexico.

BOMBYLIIDAE

A variety of medium sized to large bee flies may be found at *Larrea* flowers in most localities, including *Anthrax xylocopae* Marston (1970), the parasite of the Arizona carpenter bee, *Xylocopa californica arizonensis* Cresson (Hurd, 1959). Others among our limited samples included: *Exoprosopa deris* Osten Sacken (Las Cruces, New Mexico), *Aphoebantus micropyga* Melander (Douglas, Arizona) and several unidentified species of *Villa*. The most regular, however, appear to be some of the very small species, some of which literally swarm about

the blossoms near sunrise, resembling small bees. In southeastern Arizona, the most abundant of these belonged to the genera *Pthiria*, of which one species each was taken at Portal, Douglas and Tombstone, Cochise County, Arizona, and *Geron*, with *G. albarius* Painter at Portal, *G. argutus* Painter at Douglas, and *G. grandis* Painter at Tombstone. In western Arizona and southern California, *Mithicomyia* were sometimes numerous. Melander (1961) who has recently revised the genus and described 126 new species and nine new varieties, records only one species, the widespread *M. rileyi* Coquillett as having been taken with some frequency at *Larrea* flowers. Most of the remaining species have been found on *Eriogonum*.

Syrphidae

As would be expected, syrphid flies were conspicuous among visitors to the flowers of *Larrea*. The most widespread and abundant was *Eupeodes volucris* Osten Sacken, which at Palm Springs, Riverside County, California in March was present in such large numbers that they exceeded the abundant bees of the genus *Colletes* and provided a serious distraction to the sampling of bees. The species was also present in the spring at Yuma, Yuma County, Arizona, Tucson and vicinity, Pima County, Arizona, Benson, Cochise County, Arizona and Lordsburg, Hidalgo County, New Mexico. Other syrphids present at *Larrea* flowers included *Copestylum marginatum* (Say) (Douglas, Cochise County, Arizona), *C. haagii* Jaenncke (Portal, Cochise County, Arizona), *Eristalis tenax* (Linnaeus) and *Metasyrphus* sp. (Tucson and vicinity, Pima County, Arizona) and *Allograpta obliqua* (Say) (Palm Springs, Riverside County, California).

Tephritidae

Tephritids were often numerous on *Larrea* but only four species were taken for identification: *Neotephritis inornata* (Coquillett) (Portal, Cochise County, Arizona), *Euaresta bellula* (Snow) (Naco and Douglas, Cochise County, Arizona), *Trupanea nigricornis* (Coquillett) (Douglas) and *Trupanea* sp. (23 miles west of Stanfield, Maricopa County, Arizona).

Sarcophagidae

As would be expected, sarcophagids were found at the flowers of *Larrea* in many areas. Only a few species were taken, as follows: *Blaesoxipha* (*Acanthodotheca*) spp. (Naco, Cochise County, Arizona), *Ravinia cherminieri* (Robineau-Desvoidy) (Tombstone, Cochise County, Arizona), and *Senotainia rubriventris* Macquart (Naco, Douglas, Portal and Cochise County, Arizona and Las Cruces, Dona Ana County, New Mexico).

TACHINIDAE

Tachinids, especially males, visited *Larrea* flowers in practically all of our study sites. The following species were taken among casual samples, mainly in southeastern Arizona and New Mexico: *Aravaipa atrophopoda* Townsend (Douglas, Cochise County, Arizona), *Archytas lateralis* (Macquart) Portal, Cochise County, Arizona), *Chaetogaedia desertorum* (Townsend) (Portal), *Chaetonodexodes vanderwulpi* (Townsend) (Douglas and Tombstone, Cochise County, Arizona), *Lespesia archippivora* (Riley) (18 mi. W. Stanfield, Maricopa County, Arizona and Douglas), *Muscopteryx chaetosula* Townsend (Las Cruces, New Mexico), *Peleteria valida* Curran (Portal), *Spalanzania hebes* (Fallen) (Deming, Luna County, New Mexico), and *Stomatomyia parvipalpis* (Wulp) (Douglas).

HYMENOPTERA

As noted elsewhere in this article, the bees associated with *Larrea* in the southwestern United States and adjacent Mexico have been discussed by us (Hurd and Linsley, 1975). Among the other members of this order commonly found in association with *Larrea* and especially about its flowers, are numerous aculeate wasps usually in quest of nectar. At times other wasps, such as braconids, chalcidoids and ichneumonids, were also encountered flying about the foliage, sleeping, searching for hosts or on occasion visiting the flowers for nectar.

CHRYSIDIDAE

Cuckoo wasps were seen on *Larrea* plants at many of our sampling stations, but their relations with the plant were not clear. Among the voucher specimens taken was the widespread *Holopyga ventralis* (Say), found at the flowers in May between 0930 and 1000 near Portal and between 1630 and 1700 at Douglas, Cochise County, Arizona. *Spintharosoma mesillae* (Cockerell) was also taken near Portal in May.

TIPHIIDAE

Males of *Myzinum dubiosum* Cresson were fairly numerous about the flowers of *Larrea* in the morning during the summer at Las Cruces, Dona Ana County, New Mexico and at Deming, Luna County, New Mexico. A female taken at Las Cruces between 1730 and 1800 may be *Myzinum frontale* Cresson.

SCOLIIDAE

Scoliids were abundant during the summer at flowers of *Larrea* in most of our sampling sites in southern Arizona and New Mexico. Because pollen adheres to the legs and body hairs, some of the species

undoubtedly play a role in pollination (c.f. Cazier and Linsley, 1974). In August females and an occasional male of *Campsomeris tolteca* (Saussure) were present at *Larrea* flowers throughout the day (0830–1800) at Las Cruces, Dona Ana County, New Mexico and were also numerous near Portal, Cochise County, Arizona. Males were taken at the flowers in May, 18 miles west of Tucson, Pima County, Arizona. However, the most abundant and commonly encountered species was *Triscolia ardens* (Smith). In New Mexico this species was collected from *Larrea* flowers 5 miles west of Elephant Butte, Sierra County, Las Cruces, Dona Ana County, and Granite Pass, Hidalgo County. In Arizona, we found it near Portal, Douglas and Tombstone, Cochise County, and Tucson, Pima County. All collections were in July and August.

Trielis octomaculata (Say) was taken on the flowers in August at Las Cruces and Deming, New Mexico and Tucson, Arizona. *Scolia nobilitata fulviventris* Bartlett was present in small numbers at Granite Pass, Hidalgo County, New Mexico in July and was very abundant at Tucson, Arizona in August.

Vespidae

As would be expected, a variety of vespids visit *Larrea* flowers, but we rarely encountered them in numbers. *Eumenes bollii* Cresson was taken at Palm Springs, Riverside County, California in March and April, 18 miles west of Tucson, Pima County, Arizona in May, 4 miles west of Don Luis and 1 mile north of Portal, Cochise County, Arizona in May, at Lordsburg, Hidalgo County, New Mexico in August. This species was especially abundant at the Portal locality.

Another species encountered rather frequently during the spring was *Stenodynerus apache* Bohart, samples of which we took at Granite Pass, Hidalgo County, New Mexico, and near Portal and Douglas, Cochise County, Arizona. A related but unidentified species was captured at Tucson, Pima County, Arizona.

The remaining vespids in our samples included *Polistes fuscatus centralis* Hayward (Portal and Douglas, Cochise County, Arizona), *P. exclamans arizonensis* Snelling (Old Tucson, Pima County, Arizona), *Zethus guerreroi arizonensis* Bohart (Tombstone, Cochise County, Arizona), *Euodynerus hidalgo* (Saussure) (Douglas, Cochise County, Arizona), and related but undetermined species of *Euodynerus* (Saussure) (Portal and Douglas, Arizona), *Stenodynerus lixovestis* Bohart (7 miles southwest of Robles Junction on Highway 286, Pima County, Arizona), *Stenodynerus* sp. (Tucson Airport, Pima County, Arizona), *Parancistrocerus toltecus* (Saussure) (Portal and Douglas, Cochise County, Arizona) and *Pterocheilus pedicellatus* Bohart (Portal, Arizona).

SPHECIDAE

For convenience of discussion we have grouped under this family heading the several sphecoid families represented by our material.
The most numerous sphecids at flowers of *Larrea* were species of the genus *Ammophila*. *Ammophila aberti* Haldeman was taken at Socorro, Socorro County, New Mexico in August, and at Portal and Douglas, Cochise County, California in May. *A. breviceps* Smith was present on *Larrea* at Lordsburg, Hidalgo County, New Mexico in May, *A. karenae* Menke at Benson, Cochise County, Arizona in May, *A. novita* (Fernald) at a site 24.5 miles north of Yuma, Yuma County, Arizona in May, and *A. wrightii* (Cresson) at Douglas, Cochise County, Arizona in May. However, by far the most abundant *Ammophila* belong to the *pruinosa* complex. They were present at six of our sampling sites in New Mexico, eight sites in southern Arizona, and one site in southern California, on dates ranging from May to September. Other sphecids included *Sphex ashmeadi* (Fernald) (Las Cruces, Dona Ana County, New Mexico, in August), *S. lucae* Saussure (5 miles west of Elephant Butte, Sierra County, New Mexico, in August; Douglas, Cochise County, Arizona, in May; and Tucson, Pima County, Arizona, in August), *Podalonia argentifrons* (Cresson) (Chiriaco Summit, Riverside County, in May), *P. melaena* Murray (Portal and Douglas, Cochise County, Arizona, in May) and *Sceliphron caementarium* (Drury) (Douglas, Cochise County and 18 miles west of Tucson, Pima County, Arizona, in July and May, respectively).

Astatine sphecids were represented by *Astata bakeri* Parker (Portal, Cochise County, Arizona, in May); tachytines by *Tachysphex coquilletti* Rohwer (Portal, Cochise County, and Casa Grande, Pinal County, Arizona, in May) and undetermined species from Douglas, Cochise County, Arizona, and Lordsburg, Hidalgo County, New Mexico; psenines by *Ammopsen masoni* Krombein (Tucson Airport, Pima County, Arizona, in May); and gorytines by *Tanyoprymnus moneduloides* (Packard) (Douglas, Cochise County, Arizona, in July) and undetermined species of *Hoplisoides* (Portal and Douglas, Cochise County, Arizona, in May).

Among the bembicines, *Bembix U-scripta* (Fox) was the most numerous species visiting *Larrea* flowers at any one locality. At Las Cruces, Dona Ana County, on August 12 and 13, New Mexico, females were active from 0530–0630 and from 1830–1853 (sunset), although one was also taken at about 1800. Males, on the other hand were captured only between 1730 and 1830. Evans (1960) has recorded females hunting their dipteran prey in the dusk, around and after sunset, and males engaged in a "sun dance" both morning and evening. Cazier and Linsley (1974) reported males and females taking nectar from beneath the flowers of *Kallstroemia* in the morning as the flowers

began to unfurl. Apparently both sexes are bimodal in their diurnal flower-visiting habits.

Other bembicines included *Bembix sayi* Cresson (Portal, Cochise County, Arizona, in May), *Steniolia duplicata* Provancher (Yuma, Yuma County, Arizona, in April), *Stictiella pulchella* (Cresson) (Deming, Luna County, New Mexico, in August), *Glenostictia clypeata* (Gillaspy) (Portal, Cochise County, Arizona, females active between 0600 and 0700 in August, and Deming, Luna County, New Mexico, one female at approximately 0930) *G. gilva* Gillaspy (Douglas, Cochise County, Arizona, in May), and *G. scitula* (Fox) (Portal, Cochise County and 18 miles west of Tucson, Pima County, Arizona, in May).

Philanthus neomexicanus Strandtmann was the most numerous philanthine encountered on *Larrea*, 15 examples being represented in samples at Portal in May. Others included *P. gibbosus* (Fabricius) (Douglas, Cochise County, Arizona, in May), *P. multimaculatus* Cameron (Lordsburg, Hidalgo County, in May) and *Clypeadon evansi* Bohart (Deming, Luna County and Lordsburg, Hidalgo County, New Mexico, in August and May, respectively.

Cercerines and crabronines were captured at *Larrea* flowers as follows: *Eucerceris arenaria* Scullen (18 miles west of Tucson, Pima County, Arizona and Chiriaco Summit, Riverside County, California, in May). *E. canaliculata* (Say) Douglas, Cochise County, Arizona, in May), *Cerceris macrosticta* Viereck and Cockerell (Las Cruces, Dona Ana County, New Mexico, in August), unidentified species of *Crabro* and *Ectemnius* (Yuma and Tucson, Arizona, respectively, in May and *Moniaecera asperata* (Fox) (18 miles west of Tucson, Pima County, Arizona, in May).

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SEX: INSECT STYLE (RATED X) PRESIDENTIAL ADDRESS, 1974

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ABSTRACT—Male and female insects frequently fail to respond to materials determined to be attractants by electrophysiological techniques. The reason that some insects seem to prefer a living member of the opposite sex of the same species to the attractant is not known, but it may well relate to the rituals that most insect species go through before mating. Some scientists may fail to take such considerations into account and so work only with those sexes which respond.

I would like to begin by giving you some of the reasons why I have selected "Sex: Insect Style (Rated X)" as my Presidential address. I study, electrophysiologically, possible attractants and repellents of adult economically important insect pests. The work involves the use of electroantennograms (EAG), a method originated in 1955 by Dietrich Schneider and his associates in Germany.

Last November, I attended an electrophysiological workshop at the Stanford Research Institute, Menlo Park, California, where 37 scientists gathered to discuss informally the responses of insects to certain stimuli, mainly sex pheromones. I was amazed to learn that few of the scientists knew that most insects go through a courtship period before mating. The scientists also did not realize that insects reared in laboratories are denied, in many cases, the ritual of courtship performed in nature. Entomologists who have attempted to rear insects from an initial colony of only a few specimens often encounter failure rather than success, perhaps for this reason. Approximately one million species of insects have been described; they have an almost equal number of different courtships.

Another reason for my interest in "Sex: Insect Style" is that unless we know how insects communicate intraspecifically (e.g. odor, sound, etc.) we may never find a good attractant. However, we do know that many insects release odors (sex pheromones) to attract the opposite sex. The primary purpose of the sex pheromone is to bring the opposite sex into the immediate area, but little is known about the mechanism of communication. Dr. Phillip Callahan of the Gainesville, Florida, ARS laboratory, measured the body temperature of an adult sphingid moth and found that the temperature climbed from 24°C at rest to 39°C while flying. The measured infrared wavelength produced by this moth peaked out at 9.25 micrometers. It is at this frequency, he postulated, that the moths detect each other in total darkness.

In a choice between sex and food, sex appears to be the stronger

attractant. When adults emerge, food is generally plentiful, but as you know some adult insects never feed. If one is to believe Darwin's theory about the importance of the propagation of the species, then sex is definitely a primary drive.

Before I discuss the courtship of insects, I would like to define three terms and tell you a little more about EAGs. A pheromone is a chemical substance produced and released externally by a living organism; it elicits a behavioral response in another member of the same species, and it is used primarily as a means of communication. Examples of this are sex and alarm pheromones. Sex pheromones are used basically to attract the opposite sex; however, males of some species emit odors that attract other males. The sex pheromone is similar to a perfume that may be used by a person to attract attention or a mate. Alarm pheromones have been found in insects, fish, and mammals; they warn others of the same species of impending danger. An aphrodisiac, according to the dictionary, is a substance that arouses, increases, or stimulates one's sexual desires. In some adult male Lepidoptera, hair pencils found at the end of the abdomen appear to emit an aphrodisiac substance; this is well shown in Dr. L. P. Bower's film "The Courtship of the Queen Butterfly." In some countries where aphrodisiacs are sold for human use, rhinoceros horns, oysters, shark liver, and liquids containing various potent substances are reported to act as stimuli. If we pursued this subject, we would find at least a thousand other stimuli to aid the poor human race. A stimulus is generally a synthetic compound that attracts insects of one sex or another. However, some of these stimuli, when used bring out homosexual tendencies within many insect species. I will attempt to demonstrate this at the end of my talk with some adult male American cockroaches, *Periplaneta americana* (L.), using a female pheromone to stimulate the males. Lately a number of articles on insect homosexuality have appeared in various journals.

The EAG records the overall slow electrical potential responses of the various receptors of insect antennae to odorous stimuli. The number of receptors per insect will vary from just a few to the thousands found on the antenna of the adult male silkworm, *Bombyx mori* (L.). The electrical response tells us one of two things: (1) the receptors were not stimulated, or (2) the receptors were stimulated. If they were stimulated, we can tell whether it was a strong or weak stimulation. In the case of a sex pheromone, the response is always a large downward (negative) sharp deflection as observed on an oscilloscope. If the stimulus is a repellent, then there may be two types of responses noted; one that is similar to that of an attractant or another that has an upward response (in the opposite direction from an attractant). When one observes this upward response, one can predict with certainty that the stimulus will fail to attract insects of that

species to a trap. This method helps us evaluate large numbers of un-
known compounds for use as attractants. It is not known exactly how
many insects use only their antennae for chemoreceptor communica-
tion since they must have other ways (in addition to audible sound)
of locating each other. The reason I mention this now is that a little
later I will discuss the courtship of the antler moth (Noctuidae)
which involves neither odor, audible sound, nor visible contact.

While studying EAGs, I observed that not all males or females
responded to a known sex attractant of that species. Further thought
on the subject indicated that there was no reason why 100% should
respond (it doesn't occur in other species of animals). If one female
or male had the ability to attract all of the opposite sex of that species,
how could that species survive? As with humans, insects too show
preference in selecting a mate. This may be the reason, as previously
mentioned, for the failures encountered when only one or two pairs
of insects are used in mating studies. For example, those who have
worked with the yellow fever mosquito, *Aedes aegypti* (L.), know
how unlikely it is that a single pair will mate in a cage or container.
However, when both the male and female are decapitated and their
abdomens are brought together, copulation will take place. This may
be the forerunner of the saying "Fools (someone who has lost his
head over love) rush in where wise men (or women) fear to tread."
Because of these rejections, I decided to review the entire subject of
insect courtships.

I found rather few courtships described, in relationship to the num-
ber of insect species described, but too many to actually discuss here.
No attempt has been made to put these courtships in any order. Also,
observers have described many variations in courtship within a species
of insect. In the literature that I have reviewed, there are no theories
as to how mates are selected.

Courtship of insects, like courtship of man, plays an important
part in reproductive life. As always, there are exceptions, such as re-
production by parthenogenesis or paedogenesis. I would like to make
clear that courtship and mating are two distinct acts. Courtship al-
ways precedes copulation, and without it the act is almost never
consummated. Also copulation is never complete until there has been
an exchange of sperm.

Drs. Tobin and Stoffolano (1973) described the courtship of the
house fly, *Musca domestica* L., not as a simple affair as most people
believe it to be, but as a rather elaborate one. It is possible that a re-
leased pheromone may be the forerunner of the courtship (Carlson
et al., 1971), but the female is quite discrete in her selection of a mate.
Observations by Dr. S. C. Chang (1965) indicated that 98% of the
females mated only once under laboratory conditions. The courtship
begins by the male orienting himself to the female. Once in position,

he leaps upon her and lands on her thorax with his wings beating and legs thoroughly fixed to her. He then moves forward and when his head is directly over hers he extends his proboscis and begins to lap the head of the female as though kissing her. This lapping continues as he slowly moves forward until he can go no further. His foretarsi move forward and appear to rub the female's antenna. The female then raises her forelegs, and the male grabs them. Each holds on to the other and begins to move the legs in a circular motion. This stage of the courtship is called "boxing." Soon the legs are released, and the male moves backward and attempts to copulate. If unsuccessful, he will fly off only to return immediately and resume the courtship. If successful, the copulating flies are normally quiescent during the act; however, if disturbed they do move. The female may fly short distances carrying the male. At the end of the mating period (approximately 64 minutes), the flies become active and part. At any time throughout the courtship the female, for reasons unknown, can terminate the romance by rejecting the advances of the male. Sometimes the female will notify the male that she is willing by extending her ovipositor. At other times she will tease him by extending her ovipositor in short spurts and will then leave.

In some species of cockroaches, the female attracts the male; in other species the attracting is done by the male. Drs. Roth and Dateo (1966) described the courtship of the male *Nauphoeta cinerea* (Oliver) who attracts the female by a substance called "seducin," (not all the females are attracted to seducin, as shown in laboratory tests). This material is secreted by a tergal gland situated on the first abdominal segment. The female approaches the male and mounts his back to feed on this substance. The feeding puts her in a position that makes it possible for the male to grasp her genitalia. If she is receptive, mating occurs with the female leaving the male's back, and the pair assuming an end-to-end position, with the sexes facing in opposite directions. This illustrates what a little "sweet" will do.

Males of some species of empidids are also noted for their ingenuity. Instead of a pheromone, they use a small ball of silk that they weave, possibly to enclose a small insect victim, though in many cases it is just a ball of silken thread. This is offered to the female as a gift which must be unraveled. The unsuspecting female becomes so involved in unraveling the gift that she never realizes its true purpose until the male grabs her and attempts to mate.

In another group of empidids, the male offers the virgin female tidbits of food in some frothy material. This material delays the female in finding the food and occupies her while the male attempts to mate. If the female is kept busy until mating is over, all is well. However, if she should first finish eating, she will turn on her mate and consume him.

In the family Bittacidae (hanging flies), the female of one species catches a prey and then starts to nibble on it, (with perhaps a "smile on her face") to entice some young male to come and join her. If one does and the meal pleases him, he will then mate with her. However, if he finds the meal displeasing, he will go off looking for a more delectable dinner.

The male of one species of black fly, (Diptera: Simuliidae) skims over the water in an attempt to capture small prey. When he catches one, he spins a web around it and attaches a long line. This done, he will seek out a group of swarming black flies, approach it from above, and dangle his bait until a female accepts it. Once she does, she will hold on to it. The male then reels her in, and mating occurs. Is this the way man learned to fish?

The female of a species of lacewing (Neuroptera) pursues the male. When she has found a suitable mate she will induce him to land, at which time the courtship begins, with both sexes jerking their abdomens up and down in a manner reminiscent of the Gooney birds on Midway Island, who jerk their heads up and down during courtship. As the two approach each other, the female attempts to rub her antennae with those of the male. This may scare off the male. In any event, the male does fly off, only to be pursued by the female. When she catches him, they go through the same elaborate dance again. If the male is receptive, he lines up next to her and attempts to copulate. If he is successful the pair remains in the linear position for approximately 30 minutes. The female, once appeased, will make several attempts to leave until, by mutual consent, they finally part.

The semaphore flies, Dolichopodidae, have a rather long courtship. The romance begins with the female spending the first day dancing around the male who just sits and watches. While dancing, she will approach him from either side, momentarily sit, stand still, and then flutter her wings and begin again. After the dance, she stops fluttering and moves directly in front of the male. With her extruded ovipositor she begins to tickle the male's head. Soon the ovipositor is retracted, and the dancing starts again. This may go on for 3–5 days. If the male is pleased, he will start a dance of his own, and will tickle the female occasionally with his front legs. At first, she will coyly move away. As the tickling continues, she apparently enjoys it and in return flutters her wings and extends her ovipositor. Finally on the last day (5–6 days from the start), mating occurs unless the female changes her mind (and many do) and goes off looking for a new lover.

The female of the beetle, *Drilus flavescens* (Geoffroy) spends her nights on leaves close to the ground. On this leaf or on the surrounding area, she scatters a substance that Dr. Balduf (1939) calls a "corrupt odor," whatever that may be. A male stimulated by this odor will

seek out the female. When she is sighted, he approaches her rapidly.
She in turn flees when discovered, and the chase is on. If the male
catches her, they will mate for up to three hours; then the male dies.
If the female is satisfied, she does not mate again; if not, she
will mate immediately with another partner. In one case, the
female carried two males, one in copula and the other (which had
obviously himself copulated with her shortly before) hanging limp
from her body. If the female is still not content, she will continue
to lure males in the same area for days.

The male tiger beetle (Coleoptera: Carabidae) possesses a strong
desire to mate and continuously pursues females. When he finds one,
he will pounce on her, fasten his mandibles between her pronotum
and elytra, and attempt to appease her. If she does not accept him,
she puts up a fierce battle to dislodge him. When she is successful,
he will turn and race away. If he succeeds in penetration, he must
continue to appease her while mating and must then leave in a hurry
before she turns on him.

The male European field cricket, *Gryllus campestris* L., will chirp
his heart out by his burrow until a group of females approaches. From
this group he will select his mate and woo her with antennal caresses.
When her will is finally broken down, courtship takes place. Now,
what is so different here? The difference is that, being a female,
her true nature now emerges, and she reveals her shrewishness and
jealousy. She rends his wings and breaks his fiddle to definitely put
him out of the casanova class. Termite queens have been known to
fight off other females for a male's affection; however, after mating
has occurred and the eggs are hatched, her cortege waits on both of
them. On the other hand, a Greek poet wrote "Happy the Cicadas'
lives, since they all have voiceless wives."

The male cockchafer performs his courtship during the day by
hovering in front of his selected female and waving his horny limbs
in the approved manner. Occasionally he will land, sit beside her, and
then fly up and continue his dance, which either pleases or displeases
her. If she is pleased she waits until evening and then goes with him.

The female European stag beetle (Coleoptera: Lucanidae) will
only accept a suitor who will battle for her with another male. The
winner then picks her up and carries her off.

In some species of Collembola (springtails), the male fertilizes the
female by smearing his sperm on his mouth parts and then inserting
them into the female's genital orifice.

In most species of insects, the female is monogamous, and the male
is polygamous. A male bark beetle (the 2-toothed species) takes the
initiative by excavating a roughly circular chamber under the bark
of a tree. In this chamber he receives 4–6 females and proceeds to
mate with each one. After the final mating, he will take off, leaving

the impregnated females alone. Each member of his harem then starts her own tunnel where she eventually lays her eggs. The male goes off to build another chamber.

My last tale of courtship deals indirectly with Dr. Callahan's theory concerning the emission of infrared wave frequencies for communication. Male antler moths will converge from all directions on a newly emerged female and fly around her in a wide circle; one or two of the more brazen ones will fly to her side to woo her, but without success. These males immediately go back into place in the circle. Then as if by some special signal one male will leave the circle, approach the female, and begin their courtship. The remaining males will then fly off to look for another female. By what invisible means is this lucky male selected?

As in everyday life, not everything follows a normal pattern. This is also true with insects. Redfern (1973) showed me a series of slides that he had taken of the southern armyworm, *Spodoptera eridania* (Cramer). He attracted several males by using a female sex lure in laboratory tests. When the males found no females available, they began to copulate with one another. The pair was actually united and could not be pried apart, and another male stood by silently waiting his turn. Many reports now exist of homosexuality in insects. In my little demonstration, you will observe several male American cockroaches attempting to copulate with each other when a female sex pheromone is placed in their container. This also occurs with the larch bud moth, *Zeiraphera diniana* Guenée. Benz (1973) observed the transfer of a spermatophore from one male codling moth, *Laspeyresia pomonella* (L.), to another male. In my own electrophysiological studies of attractants and repellents, I found that male Japanese beetles, *Popillia japonica* Newman, responded more to extracts from pulverized adult males than to extracts from adult females. The purpose of this homosexuality is not known, but it isn't to propagate the species.

As a closing remark, the flea circus is a hard act to follow, but it takes the termites to really bring down the house.

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LECTOTYPE DESIGNATION FOR HEBRUS SOBRINUS UHLER (HETEROPTERA: HEBRIDAE)

In connection with the preparation of a work on the aquatic Hemiptera of California, it became necessary to fix the identity of *Hebrus sobrinus* Uhler. P. R. Uhler published two descriptions of this species, as new, in the same year (1877, Bull. U.S. Geol. Geog. Surv. Terr. 3(2):452, and 1877, Ann. Rept. Chief Eng. for 1877:1330 (Wheeler Report, Appendix NN of Rept. Secy. War for 1877, Vol. 2, Part 2)). The first of these has priority as it was published April 30, 1877 while the latter was published after June, 1877. The two descriptions are essentially identical but the type localities differ. "Ponds west of Denver" was cited in the first description, and localities in New Mexico were cited in the second. Unfortunately the specimens from near Denver referred to in the first publication cannot be located. Two specimens that were apparently used for the second publication were located by Arnold Menke in the U.S. National Museum and kindly submitted to me for study; Dr. Menke also checked the original references for both publications, for which I am grateful.

Uhler did not designate types, and did not state the number of specimens he had before him. The specimen I have selected as lectotype is glued to a point and bears three labels as follows: A. "San Ildefonso," B. "New Mexico," C. "*Hebrus sobrinus* Uhler." I have added a lectotype label. The original labels do not appear to be in Uhler's handwriting, but he stated he had material from "San Ildefonso, N. Mex., in July, Dr. H. C. Yarrow," and the specimen is apparently from the Uhler collection although it does not bear such a label. The lectotype matches the modern concept of *H. sobrinus* although the row of pits on the collar of the pronotum is faint medially and only showed plainly when wetted with alcohol.

The other specimen examined also bears three labels as follows: A. "N.M.," B. "*Hebrus sobrinus* Uhler," C. "PR Uhler Collection." This specimen is in rather poor condition, being pinned, and apparently is a different species, *Hebrus hubbardi* Porter. The latter is distinguished from *H. sobrinus* by having the row of pits adjacent to the collar medially interrupted; no medial pits can be seen on this specimen, even when wetted with alcohol. *Hebrus hubbardi*, while found in southern Colorado, has not been found close to Denver in spite of intensive collecting there. Two *Hebrus* species are common in the Denver area: *buenoi* Drake and Harris and *sobrinus* sensu the lectotype selected above. Lacking other evidence, we must assume that the Denver material of Uhler's first *sobrinus* description was conspecific with the New Mexico material from which the lectotype was chosen.

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BIOLOGY AND IMMATURE STAGES OF THREE
SPECIES OF NEARCTIC OCHTHERA (DIPTERA: EPHYDRIDAE)

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ABSTRACT—Adults of *Ochthera mantis* (DeGeer) and *O. tuberculata* Loew are most commonly found on mud and sand shores of various aquatic habitats. *Ochthera exsculpta* Loew, a southeastern species, occurs frequently in roadside ditches, moist grass-sedge meadows, and cypress swamps. The adults of all 3 species actively prey on small terrestrial insects, and on midge and mosquito larvae to a lesser extent. A foreleg-waving behavior of the adults serves as a species recognition pattern, which prevents cannibalism and may induce courtship and mating. Adult longevity in laboratory colonies was 6–128 days. First- and second-instar larvae are obligate predators of larval Chironomidae (Diptera). Third-instar larvae preferred chironomid larvae, but occasionally fed on other aquatic insect larvae and were cannibalistic when denied alternative prey. Larval development required 10–15 days. Pupariation occurred beneath the surface of the larval habitat, with the posterior breathing tube projecting above. Individuals required 15–23 days, under laboratory conditions, to pass through all developmental processes. The natural abundance of these 3 species apparently is regulated by the amount of physically suitable larval habitat which supports ample numbers of chironomid larvae.

The egg, 3 larval instars, and puparium of each species are described. All immature stages of *Ochthera mantis* and *O. exsculpta* are illustrated. For *O. tuberculata*, only the egg is illustrated because of the extreme similarity of all other stages with those of *O. mantis*.

INTRODUCTION

The genus *Ochthera* was established by Latreille (1802) for 2 species of Palearctic Ephydridae. Adults in this genus are among the most easily distinguished Ephydridae, due to the possession of raptorial, mantidlike forelegs that are modified for capturing and holding prey. They are generally placed in the subfamily Parydrinae, although Dahl (1959) placed them in their own subfamily, Ochtherinae. The Parydrinae are characterized by a bare median facial area and lateroclinate frontal bristles which curve over the eyes (Wirth and Stone, 1956). There as presently 8 recognized Nearctic species in the genus, but examination of male genitalia and other less obvious characters may reveal that at least the most widely distributed and common taxon, *Ochthera mantis* (DeGeer), is actually a species complex.

The adults are commonly encountered along mud or sand shores of streams, lakes and ponds, along drainage ditches, or in swampy areas, although they are occasionally collected in apparently terrestrial habitats (Sturtevant and Wheeler, 1954; Dahl, 1959; Deonier, 1964;

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Scheiring and Foote, 1973). Several species have been observed feeding on various small insects, both larvae and adults. Sturtevant and Wheeler (1954) observed *O. tuberculata* feeding on a number of small Diptera, including *Drosophila* sp., *Leptocera* sp., *Discocerina* sp., and *Scatella* sp. Hobby (1931) reported an *Ochthera* in England with a chloropid adult (Diptera) as prey. Deonier (1972) reported *O. mantis* preying on adult *Hydrellia, Discocerina* (Diptera: Ephydridae), and 1 species of Delphacidae (Homoptera). He also noted an *O. mantis* that made repeated probings with its proboscis into a mud substrate, "excavated" a larval Chironomidae, and fed on its hemolymph. Bohart and Gressit (1951) and Travis (1947) observed adult *Ochthera* sp. skating on a water surface and striking below it to obtain mosquito larvae.

Very little is known regarding the structure and habits of immature *Ochthera*. Johannsen (1935) described a single puparium "tentatively described as *O. mantis*," but did not figure it. Hennig (1943) figured various structures of mature larvae of *O. pilimana* Becker from the Orient, and suggested that they feed on small aquatic organisms. Wirth and Stone (1956) and Scheiring and Foote (1973) also briefly mention that the larvae are predaceous.

MATERIALS AND METHODS

Adults were collected by sweeping with a standard aerial insect net. Immature stages of *Ochthera mantis* and *O. tuberculata* were found by placing small portions of shoreline mud in a small vegetable strainer, thoroughly rinsing the material, then searching the residue for larvae and puparia. Occasionally, puparia were found by locating their posterior breathing tubes, which protruded from the mud like tiny twigs.

Most of the rearings were made in the Freshwater Invertebrate Laboratory, 50 Comstock Hall, Cornell University, where the temperature ranged between 19 and 26 degrees C. In the laboratory, field-collected adults were anaesthetized with carbon dioxide, determined to species, sexed, and placed in modified 40-dram plastic vials, which served as adult breeding jars. Only 1 female was placed in each jar to assure that immature stages of only 1 species were obtained from each container. Cotton was used as the bottom substrate for the breeding jars, and was moistened to provide water and a suitable oviposition site. The white substrate also facilitated searching for the black eggs. A dab of honey and brewers' yeast paste was affixed to the side of each jar as a diet supplement. Adults and larvae of *Chironomus riparius* Meigen served as the main food source in these rearings, and a laboratory colony of them was maintained as described by Biever (1965).

Eggs were removed from the jars and placed on 2 layers of moist paper toweling in small plastic rearing boxes. Larvae usually were segregated into individual rearing boxes after eclosion to insure accurate determination of individual stadial lengths. After puparia were formed, they were transferred onto moist cotton at the bottom of 4-dram vials. The vials were then plugged with cotton and checked daily for newly-emerged adults.

Eggs were placed directly into 70% ethanol. Larvae were killed and fixed in water heated to just below the boiling point, then preserved in 70% ethanol. Puparia were lanced several times with an insect pin and placed in 70% ethanol. Cast exuviae of first- and second-instar larvae found after larval molts were placed on microscope slides in a small drop of glycerine. They later provided material for describing and illustrating structures of thse stages. Structures of third-instar larvae were obtained by placing freshly-killed larvae in tap water and letting them decompose. After a few days, the sclerotized portions were easily separated from the soft parts of the larvae, which had become flaccid. The sclerotized structures were then placed in glycerine on microscope slides. Most of the specimens collected and reared during this study are on deposit in the Entomology Museum at Cornell University under Lot #1031.

After being fixed in hot water, most larvae become fully extended, and the measurements given are based on specimens in this position. "Main body length" refers to the distance from the anterior end of the specimen to the posterior margin of its peri-anal pad. "Breathing tube length" is the distance from the posterior margin of the main body to the apex of the fully extended posterior breathing tube. The tube is partially retracted in many preserved specimens, but is easily extended to its full length by grasping the apex with forceps and gently pulling posteriorly while holding down the body of the larva.

Mean values are given for the sizes of all eggs and puparia in addition to the ranges of values. These 2 stages have a fixed structure, and the mean value for each therefore gives an indication of the size of an average specimen. Only the size ranges are given for each larval instar because the size of a specimen depends on its age and the suitability of its habitat. The numbers of field-collected versus reared specimens are given after each description because the reared specimens, especially third-instar larvae and puparia, are generally smaller than comparable field-collected specimens. To standardize variations of certain sclerotized structures, fully grown larvae of all 3 instars were used for the descriptions. As an example of these variations, the posterior spiracular caps increase in length basally as the larvae of each instar develop.

NATURAL HISTORY INFORMATION

General

In the present study, adults of *Ochthera mantis* have been observed feeding on various small insects including leafhoppers (Homoptera: Cicadellidae), plant bugs (Hemiptera: Miridae), fruit flies (Diptera: Drosophilidae), mosquitoes (Diptera: Culicidae), and midges (Diptera: Chironomidae). They have also been observed feeding on larvae of both Chironomidae and Culicidae. They are not sedentary predators, but rather actively stalk prey, and occasionally capture prey while in flight.

Ochthera adults depend greatly on visual cues for recognizing and capturing terrestrial prey. To demonstrate the importance of visual cues, small (2 × 5 mm) strips of white paper were attached to pieces of string and twirled in front of hungry adults in a manner described by Rilling et al. (1958). Awareness and striking responses were re-

Fig. 1.   *Ochthera mantis*, "waving" behavior of adults.

corded, but the *Ochthera* released the paper after having tested the material with their probosces.

Tactile cues are apparently used for detecting chironomid larvae in mud banks, as first reported by Deonier (1972), a behavior which I have also observed. Adults of *O. mantis* were seen along Fall Creek in Ithaca, New York, probing a mud substrate with their probosces and simultaneously tapping it with their fore tarsi. Each individual would strike suddenly through the mud and obtain a chironomid larva, on which it fed.

Laboratory-maintained adults of all 3 species supplemented their diet of live prey by feeding on the honey and brewers' yeast paste in the rearing containers. However, when ovipositing females were denied live food for 2 or more days, they commonly fed on their own eggs. This may not occur in nature where proteinaceous food is always available and the black eggs are not so distinctive as they are on the white cotton.

Although adults of *Ochthera* will attack and consume most small insects resembling themselves in size and shape, cannibalism among adults has not been observed in this study. In addition to numerous field observations which support this conclusion, several sets of conspecific adults were placed together and starved to death without cannibalism occurring.

A behavior pattern observed when 2 or more individuals are in

visual contact may serve to prevent cannibalism and perhaps induce courtship and mating. Immediately after initial visual contact, the flies orient themselves directly facing one another. They then extend and withdraw their forelegs in an anterolateral direction (fig. 1), a very characteristic behavior termed "waving" in this paper. This behavior exposes the inner surfaces of the legs which are covered with a fine, silver-colored pile that is highly reflective. Although conspecific individuals may batter one another with their forelegs, no apparent physical injury has ever been observed. Unless the flies are very hungry, or the prey is far away, waving is also directed toward prey organisms before striking occurs. Deonier (1972) commented that this behavior may be a threat or recognition display and not actually integrated into courtship behavior. *Ochthera mantis* and *O. tuberculata*, so closely related that Sturtevant and Wheeler (1954) considered them conspecific, have very similar waving motions. The waving pattern of *O. exsculpta* is very jerky and erratic in comparison.

The larvae did not seem to pursue their prey actively, but rather wandered randomly throughout the rearing dishes, many times crawling under one or both layers of the paper toweling. It seems that the larvae preferred to be covered in some manner. When individual rearings were in progress, a small piece of filamentous algae was often placed in the dishes, and the larvae were usually found nestled in it. When no algae were provided, the larvae would crawl to an edge of the dish and work their way under the toweling until only the posterior spiracles were exposed to the air.

After encountering a potential prey, the maggots would react in one of two ways. The first response consisted of a violent contraction of the anterior portion of the maggot, as if it had been injured in some manner, and then moving away from the area where the contact occurred. This behavior was most common in first-instar larvae.

The second response was attempted feeding. Immediately after contacting a potential prey (most often a chironomid), the maggot began to scrape the exoskeleton of the prey lightly with its mouthhooks. The maggot then moved laterally on the body of the midge until it contacted an intersegmental membrane, at which time more intense scraping commenced. The mouthhooks, which are used to penetrate the exoskeleton, first move anteriorly until fully extended, then lateroventrally, creating a tearing effect. To begin another stroke, the tips come together as the mouthhooks move dorsally. This process is repeated until the exoskeleton of the prey is ruptured. After penetration is accomplished, the mouthhooks are maintained in a lateroventral position with the tips recurved and pointing posteriorly, functioning to grasp the prey during the feeding process.

A cibarial pump (Snodgrass, 1953) is apparently used for removing the body fluids of the prey. During the feeding process, the posterior

Fig. 2.   *Ochthera mantis*, third-instar larva curled around and feeding on a chironomid larva.

portion of the pharyngeal sclerite can be seen moving laterally in wavelike motions, while the food material passes into the gut in a series of rhythmic spurts. After feeding in this manner for a few minutes, the larva usually moves from the initial feeding site to another area within the prey, using the mouthhooks for grasping and scraping. The larvae apparently feed on all parts of the chironomid larvae except the exoskeleton and the digestive tract.

If the prey struggled to free itself after an initial feeding attempt by a larval *Ochthera*, the larva commonly curled around the prey perpendicularly (fig. 2). Although this behavior may have been somewhat helpful in subduing the prey, it did not appear to be very efficient, at least under laboratory conditions. Even when only a small amount of free water was in the rearing dishes, noticeably restricting the mobility of the prey, many individuals escaped. Chironomid exoskeletons often were ruptured to facilitate feeding by *Ochthera* larvae. Naturally occurring larvae of *Ochthera* apparently feed on chironomids in areas where the wiggling movements are severely restricted, as in mud banks, thick algal mats, and/or areas where chironomids are extremely dense.

First-instar larvae survived only on a diet of chironomid larvae, although larvae of mosquitoes, black flies, and caddisflies were offered as food, and sometimes partially consumed. First-instar larvae were never cannibalistic. Second-instar larvae are more aggressive, and are much less apt to withdraw after contact with a prey organism. Third-instar larvae are still more aggressive, and also seem to have less specific food preferences. Late third-instar larvae of *O. mantis* developed normally after feeding on mosquito larvae, decapitated larvae of *Chaoborus*, and larvae of *Psychoda*. Larval cannibalism has been observed several times. However, when ample food was provided, the larvae crawled over one another and even fed on the same prey individual without attempting to feed on one another. This suggests that larval cannibalism occurs only during periods of stress caused by starvation and overcrowding.

The postfeeding larval period preceded pupariation (Fraenkel and Bhaskaran, 1973) by 2 to 4 hours. During this time, the larvae voided their guts, became almost completely inactive, and did not feed, even when a ruptured chironomid larva was placed in front of them. Pupariation always occurred beneath the surface of the substrate such that only the anterior and posterior spiracles were exposed. The anterior spiracles were inconspicuously located at the air-water interface, while the posterior breathing tube often projected into the air.

Immediately after emergence, the poorly sclerotized adults ranged from being colorless to light gray, and were somewhat transparent. Under laboratory conditions, the wings straightened and the exoskeleton hardened so that flight was possible 45–75 minutes after emergence.

Ochthera mantis (DeGeer)

Ochthera mantis (DeGeer) is Holarctic and is the most common and widely distributed species of *Ochthera* in North America. In this region, it occurs from Alaska to Nova Scotia, south to California, Texas, and North Carolina (Wirth, 1965). In Iowa, adults were commonly collected on mud and sand shores; occasionally on floating vegetation, sedge meadow, *Eragristes* mat and freshet seep; and rarely on marsh reeds and limnic wrack (Deonier, 1964). In northeastern Ohio, they were abundant on sand shores, common on mud shores, and rare at rain pools and sedge meadows (Scheiring and Foote, 1973). In Scandinavia, Dahl (1959) collected them only rarely in the following habitats: limnic sand high beach, mud shore, reed vegetation, and moist meadow. He stated that they are not restricted to particular habitats, as are many Ephydridae which have specific diets provided by certain habitats. In the present study, adults were collected most commonly on the mud and sand shores of various streams in the Ithaca area.

Adults of this species may be distinguished from others in the genus by the following characters: parafacial area broader than facial area just below tubercle, its hairs rather numerous and not in regular rows; face without a median black polished area; tibial spur of first leg nearly as long as basal tarsal segment; fore tarsi black with reddish hairs below (Sturtevant and Wheeler, 1954).

The earliest seasonal record for adults in New York is 29 March 1962 at McLean (Tompkins Co.); the latest, 30 October 1960 at Newfield (Tompkins Co.). Collecting and rearing records indicate that this species is multivoltine.

Rearings were initiated with material collected on the following dates at localities in Tompkins Co., New York; Ithaca, bank of Fall Creek on 24 June 1969 and 23 June 1971, and Ludlowville, bank of Salmon Creek on 29 July 1970. Field-collected males lived 6–25 days in laboratory colonies; females, 9–48 days. Laboratory-reared individuals often were maintained for over 30 days, but no longevity records were completed.

Mating behavior was observed 3 times in the laboratory and twice in the field. The male and female positioned themselves directly facing one another and waved their forelegs as described above. The male then gave a series of quick, scissorlike movements with his wings and quickly mounted the female. However, actual copulation did not commence until 5–17 minutes after the male mounted the female. During this period, the male apparently stimulated the female by rubbing her genitalia with his hind legs and periodically scissored his wings. His fore tarsi were located on her thorax just anterior to the transverse suture, and his mid tarsi were resting in the constriction between her thorax and abdomen. The female held her wings flat over her abdomen in the typical resting position and was able to move about freely. Just before copulation began, the stimulatory behavior of the male became much more vigorous than before.

The female then either spread her wings voluntarily, or had them forced apart by the hind legs of the male. He then shifted his body posteriorly and placed his hind tarsi on the substrate. The fore tarsi had shifted to a position just anterior to the wing bases, and the middle legs were extended out over the spread wings of the female, the tarsi lying on the costa between the second costal break and R_1. After this shift was completed, the pair began to copulate. During copulation, the male pushed on the substrate intermittently with his hind tarsi which produced a rhythmic, rocking motion of the pair. Copulation ceased after 5–8 minutes. In 2 instances, the male simply dismounted and left; in the others he was thrown off and driven away by the female.

For one female, 14 days elapsed between emergence and first oviposition (pre-oviposition period). Females oviposited readily on the

moist cotton substrate in the laboratory, usually in small crevices. Oviposition was also observed in nature, and it consisted of 3–5 quick pumps of the abdomen into a mud substrate. Eggs were recovered from the areas where this behavior was observed, and were positioned so that only the micropylar end was exposed above the surface of the mud. The eggs are probably scattered under natural conditions, but were sometimes found in clusters of up to 13 eggs in the confined area of the breeding containers.

Up to 155 eggs were laid by one female over a period of 38 days, with a maximum daily output of 25 eggs. The incubation period at room temperature was 2–3 days (34 observations), with 30 of the eggs hatching on the second day.

The first stadium lasted 2–3 days (30 observations), and in 8 cases of 10, the larvae fed only once. In the other 2 cases, the larvae fed twice. The second stadium lasted 1–3 days (28 observations), and the larvae took 1–3 meals (9 observations).

The third stadium lasted 3–5 days (25 observations), the larvae feeding 4–6 times (8 observations). The pupal stage lasted 7–10 days (22 observations). It required 16–21 days at room temperature for individuals to develop from eggs to adults. Of 25 puparia collected on 3 July 1971 along the bank of Fall Creek near Forest Home, New York, 13 produced adults of Ochthera mantis and 2 produced parasitoid wasps (Ichneumonidae, Atractodes sp.).

Ochthera tuberculata Loew

Ochthera tuberculata Loew has been recorded in the Nearctic region from Illinois to Massachusetts and south to Texas and Florida (Wirth, 1965). It replaces O. mantis in the Atlantic and Gulf coastal plain areas (Sturtevant and Wheeler, 1954). In northeastern Ohio, they were common on mud and sand shores (Scheiring and Foote, 1973). The adult is so similar morphologically to O. mantis that Sturtevant and Wheeler (1954) and Philip J. Clausen (personal communication) believe it is merely a subspecies of O. mantis. The adults differ externally from those of O. mantis in having reddish to yellowish fore tarsi and being generally smaller in overall size.

Rearings were initiated with adults collected from a roadside ditch near Eastpoint, Franklin Co., Florida on 4 April 1969; from Highlands Hammock State Park, Highlands Co., Florida on 30 March 1971; and from Bombay Hook National Wildlife Refuge, Kent Co., Delaware on 18 August 1971.

Field-collected males lived 13–128 days in laboratory colonies; females, 25–118 days. No longevity records were obtained for reared specimens.

No mating behavior was observed in either the laboratory or the field. Two pre-oviposition periods were obtained of 35 and 43 days.

Females oviposited on the moist cotton substrate, placing the eggs in small crevices whenever possible. Maximum recorded egg production was 175 eggs over a 48-day period, with a maximum daily output of 18 eggs.

The incubation period was 2–3 days (29 observations), with 27 of the eggs hatching on the second day. The larvae fed and behaved very similar to those of *O. mantis*. The first stadium lasted 1–3 days (23 observations), and the larvae fed 1–3 times (10 observations). The second stadium had a duration of 1–3 days (22 observations), the larvae accepting 2–4 meals (9 observations).

One second-instar larva was observed in the process of molting to a third-instar larva. When first observed, the maggot was inactive and would not feed, even when a ruptured chironomid larva was placed directly in front of it. The cephalopharyngeal skeleton was slowly being pulled into the body, moved slowly from side to side, then returned to the resting position. Simultaneously, the posterior breathing tube was periodically pulled into the body and then relaxed and allowed to reextend. The actual molt was initiated when a V-shaped split occurred anterodorsally in the body wall of the larva, with the point of the "V" directed posteriorly. The split extended approximately ⅙ the total length of the body, or approximately ¼ the distance from the anterior end to the base of the breathing tube. The anterior end of the larva then became noticeably swollen, the cuticle of the third-instar larva conspicuously bulging above the sides of the exuvial split. The maggot next pulled its anterior end dorsally until the cephalopharyngeal skeleton of the second-instar larva was pulled free from the body, remaining attached to the exuvium being shed. The third-instar larva was unable to slide backwards inside the exuvium as the head was pulled dorsally, the bulging thus providing the necessary leverage for the mouthpart-removal process. The anterior end of the larva was then moved to the extreme left and stretched repeatedly until the newly-formed right anterior spiracle was released. The same process was repeated to the right side to free the new left spiracle from the old one. The entire body then moved in a series of contractions, including additional constrictions of the breathing tube, apparently to loosen the old cuticle from the new one. The third-instar larva then crawled out of the exuvium with no difficulty, still possessing dark food material in its gut, and fed immediately when offered a freshly-ruptured chironomid larva.

The third stadium usually lasted 2–4 days (19 observations), although one larva spent 6 days in this stage. Third-instar larvae fed 2–4 times (7 observations), and became cannibalistic under conditions of crowding and starvation. The pupal stage usually lasted 7–10 days (20 observations), although one individual emerged 12 days after

pupariating. It required 15–23 days for an individual to complete all developmental processes (20 observations).

The only field-collected puparium (from Trap Pond, Sussex Co., Delaware on 24 June 1970) produced a parasitoid wasp (Ichneumonidae, *Atractodes* sp.).

Several adults collected at Highlands Hammock State Park on 30 March 1971 were infested with a fungus (Order Laboulbeniales). This is a fairly large group of insect and arachnid ectoparasites which cause no apparent injury to their hosts (Alexopoulos, 1962). However, the fungus became so dense on the legs and thorax of 2 specimens that it impaired their movements and evoked almost continuous grooming of the infested area. The fungus was tentatively identified as *Stigmatomyces ochtheroideae* Thaxter by Dr. Richard K. Benjamin of the Rancho Santa Ana Botanic Garden in Claremont, California. This species was described as ectoparasitic on a different genus of Ephydridae, *Ochtheroidea*. The fungi are highly host specific and these specimens differ from the available material of *S. ochtheroideae* by having a slightly different conformation of the tip of the perithicium. These facts suggest to Dr. Benjamin that the material may represent a closely related but undescribed species of *Stigmatomyces*.

Ochthera exsculpta Loew

Ochthera exsculpta Loew occurs in the West Indies, Cuba, and in the Nearctic region from Florida to North Carolina (Wirth, 1965). Individuals are generally much smaller than those of the 2 preceding species, and may be distinguished from other species of *Ochthera* by the following characters: parafacial area nowhere broader than face at tubercle, its hairs few and usually in one or two definite rows; face with a distinct median, black, polished area which extends well below the median tubercle (Sturtevant and Wheeler, 1954).

Adults were collected in limnic biotopes including grass-sedge meadows, roadside ditches, and cypress swamps. No immature stages were found. The following collecting notes, recorded from various specimens in different collections, give clues to some of this species' habits: "black light" (Morris, U.S. National Museum); "on ship from Bahamas" (Allen, U.S. National Museum); "from grasses on seashore" (Stegmaier, U.S. National Museum); "citrus" (Bickner, University of Florida); and "from *Erigeron quercifolius*," a daisy occurring in moist, sandy areas (Weems, Florida State Collection of Arthropods). All specimens examined (142) were collected between December and June.

Rearings were initiated with adults taken at the following dates and localities, all in Florida: Alachua Co., Gainesville, swampy area near Biven's Arm of Paine's Prairie on 29 March 1971; Highlands Co., roadside ditch near Archbold Biological Station on 30 March 1971; and

St. John's Co., roadside ditch near Crescent Beach on 31 March 1971. Field-collected males survived 43–82 days in laboratory colonies; females, 13–110 days.

Although actual mating was never observed, several male-female encounters suggested a possible courtship behavior. After an exchange of quick taps with the forelegs, a field-collected male twice mounted a field-collected female, but was thrown off both times before mating could occur. The female thwarted the attempts of the male by turning her forelegs up over her thorax and pushing him off. A male was once observed mounted on a female that had her wings spread, but the pair never copulated. This observation suggests that there is a stimulatory period between mounting and copulation, similar to that for *Ochthera mantis.*

Another series of encounters was noticed when a male and female, both laboratory-reared and unmated, were placed together 14 days after they had emerged. The abdomen of the female was fully distended and appeared full of eggs. As the male would approach and wave, the female struck at him 2 or 3 times. During this same period, the female occasionally turned toward prey organisms (*Drosophila* sp.) and waved, but never struck at them. Observations were terminated after 30 minutes with no record of attempted copulation. However, mating evidently occurred overnight; 3 viable eggs were found on the cotton substrate the following morning. Fifteen days had elapsed between emergence and the first oviposition of this female; one other pre-oviposition period of 12 days was obtained.

One female was observed during oviposition. During the entire process, the apical portion of her abdomen was extended much more than usual, an apparent adaptation for the oviposition process. The female first tested the cotton substrate for suitability by tapping it with her fore tarsi, then turned around and probed the same area with the ventral valve of her ovipositor. During actual oviposition, she rocked anteroposteriorly while pumping the egg out of her abdomen, and shook violently for 3–5 seconds. Just after each egg left the abdomen, it was groomed by the hind tarsi for 3–5 seconds. She then groomed her ovipositor briefly with her hind legs before leaving the area. Each egg was partially extruded for 1–3 seconds, then pulled back into the abdomen 63–140 seconds before oviposition. This is probably the time when each egg was fertilized. After 63 minutes, this female retracted the terminal portion of her abdomen, having deposited 26 eggs.

Maximum egg production for this species was 421 eggs over a 93-day period, with a maximum daily output of 26 eggs. The incubation period at room temperature was 1–3 days (66 observations), with 58 eggs hatching on the second day. The first stadium usually lasted 2–4 days (44 observations), during which the larvae accepted 1–3 meals (10 observations). Two abnormally long stadia of 6 and 7 days

were recorded. The first-instar larvae developed and molted on a diet of chironomid larvae, but died after feeding on mosquito larvae. Their feeding behavior was very similar to that described for *O. mantis*, but the mouthhooks seemed to penetrate the exoskeletons of the chironomid larvae more easily.

The duration of the second stadium ranged mostly from 2 to 4 days (36 observations), the larvae feeding on chironomid larvae 2–3 times (11 observations). Single stadial lengths of 5 and 6 days were obtained from 2 individuals. One second-instar larva was observed in the process of molting. When first noticed, the larva was lying motionless on the paper toweling and did not react at all to a prey organism that was placed in contact with it. The only noticeable activity for the first 5 minutes of observation was considerable movement of the internal organs. After 5 minutes, and again 2 minutes later, it defecated a dark fluid, but still remained motionless. Six minutes after the second defecation, the larva began moving the posterior portion of its cephalopharyngeal skeleton slowly from side to side, while keeping the mouthhooks stationary. These slow movements occurred for short periods during the next 13 minutes. At this time, the exoskeleton separated along a V-shaped anterodorsal split, the point of the "V" directed posteriorly. The body material in the anterior region was increased in a fashion similar to that described for a molting larva of *O. tuberculata*, and the mouthparts were shed. The head was then moved laterally in both directions until the second-instar anterior spiracles were freed from the emerging larva. The head was then fully extended in all directions, as if the larva were testing its new exoskeleton. Two minutes after the formation of the split, the third-instar larva crawled out of the old skin with no difficulty. Total time from commencement of the observations until completion of the molt was 30 minutes. The larva did not feed until 15 minutes after molting.

The third stadium lasted 2–5 days (23 observations), and the larvae fed 2–3 times (8 observations). Puparia were formed at the bottom of the rearing dishes, with both anterior and posterior spiracles usually exposed above the surface. Adults emerged 6–9 days after the puparia had formed (17 observations). One adult was sufficiently sclerotized to take flight 75 minutes after emerging. It required 16–22 days under laboratory conditions for an individual to pass through all developmental processes (17 observations).

Description of Immature Stages

Ochthera mantis (DeGeer)

Egg (fig. 3, 4): Length 1.11–1.26 mm ($\bar{x} = 1.17$); maximum width in dorsal view 0.33–0.42 mm ($\bar{x} = 0.37$). More convex ventrally than dorsally. Black to brown-black, rarely light gray; usually opaque. Most of egg striated longitudinally with anastomosing ridges. Micropylar end with short, blunt elongation,
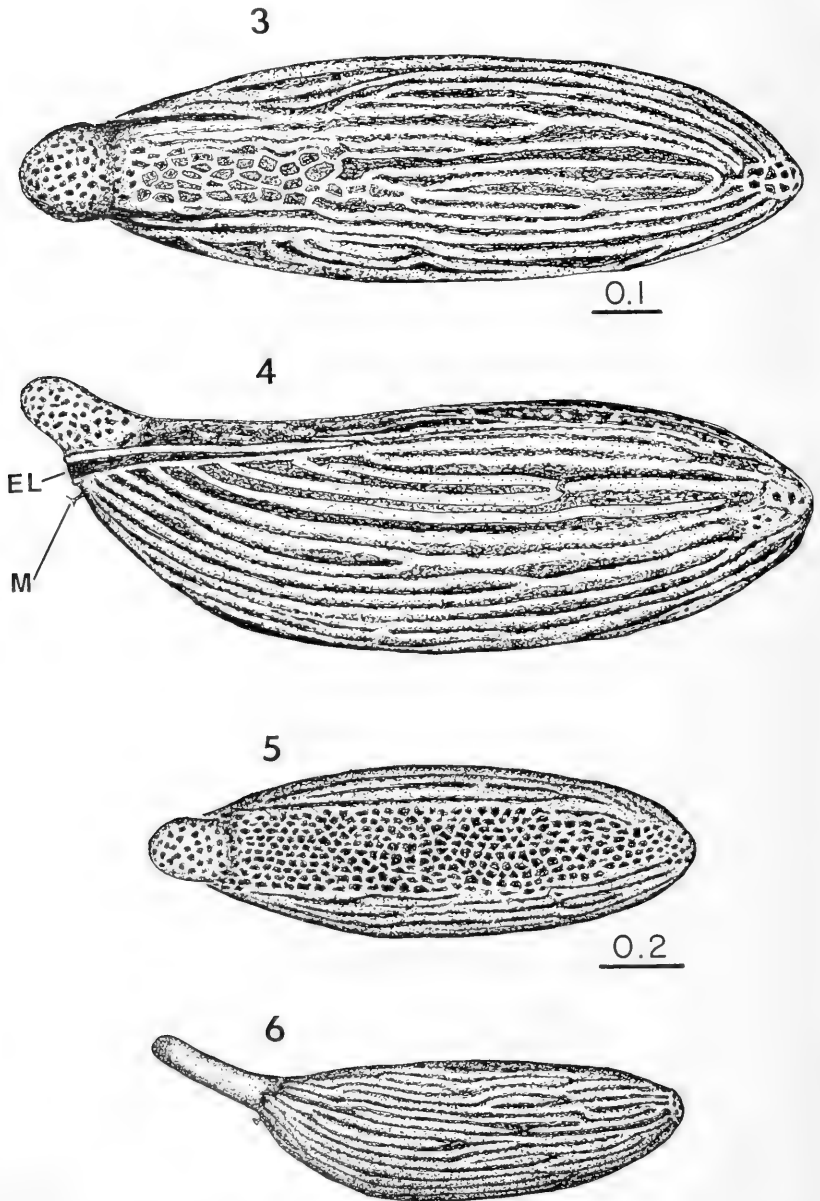
Fig. 3–6. Eggs of *Ochthera*. 3, *O. mantis*, dorsal view. 4, *O. mantis*, lateral view. 5, *O. tuberculata*, dorsal view. 6, *O. exsculpta*, lateral view.
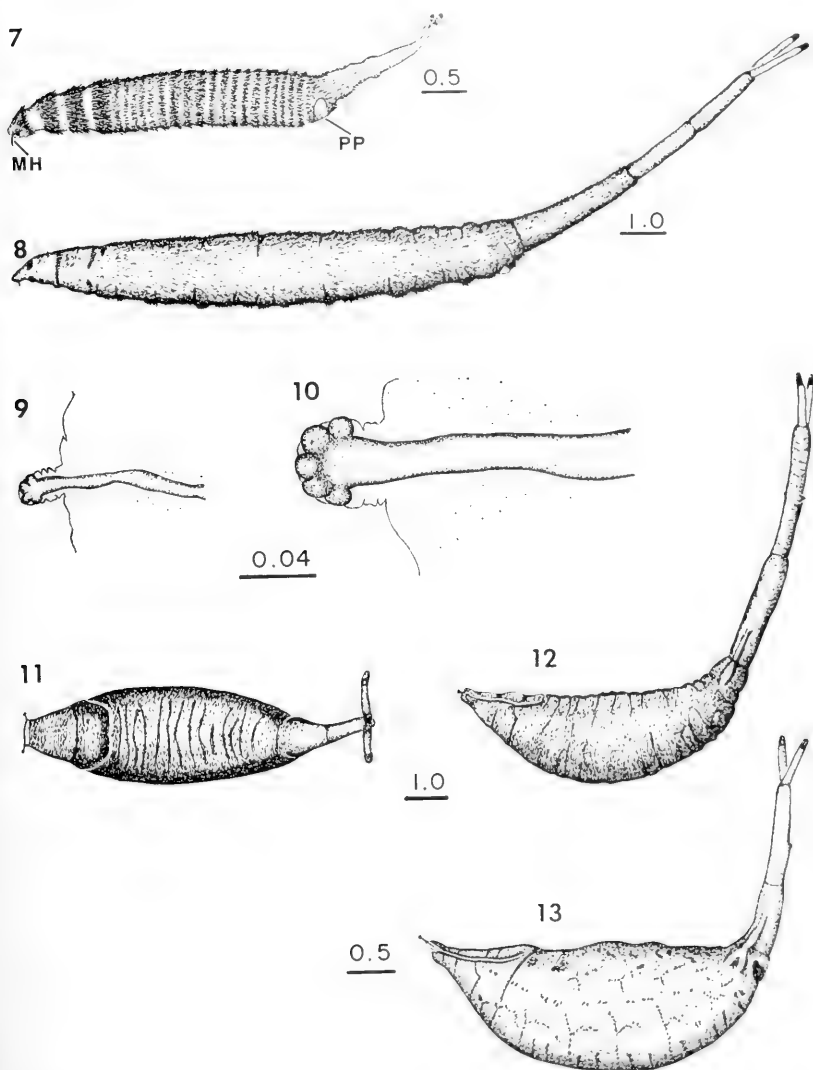
Fig. 7–12. *Ochthera mantis.* 7, first-instar larva, lateral view. 8, third-instar larva, lateral view. 9, anterior spiracle of second-instar larva, lateral view. 10, anterior spiracle of third-instar larva, lateral view. 11, puparium, dorsal view. 12, puparium, lateral view. Fig. 13. *O. exsculpta,* puparium, lateral view.

extending approximately 0.10 mm from rest of egg and sculptured with small round pits; micropyle funnel-shaped, located posteroventrad to elongation. Anterior ⅓ of dorsum with reticulate pattern, forming irregularly shaped depressions. Opposite end with patch of similar depressions apically and bluntly rounded. (Based on 38 specimens, 35 from rearings and 3 field collected.)
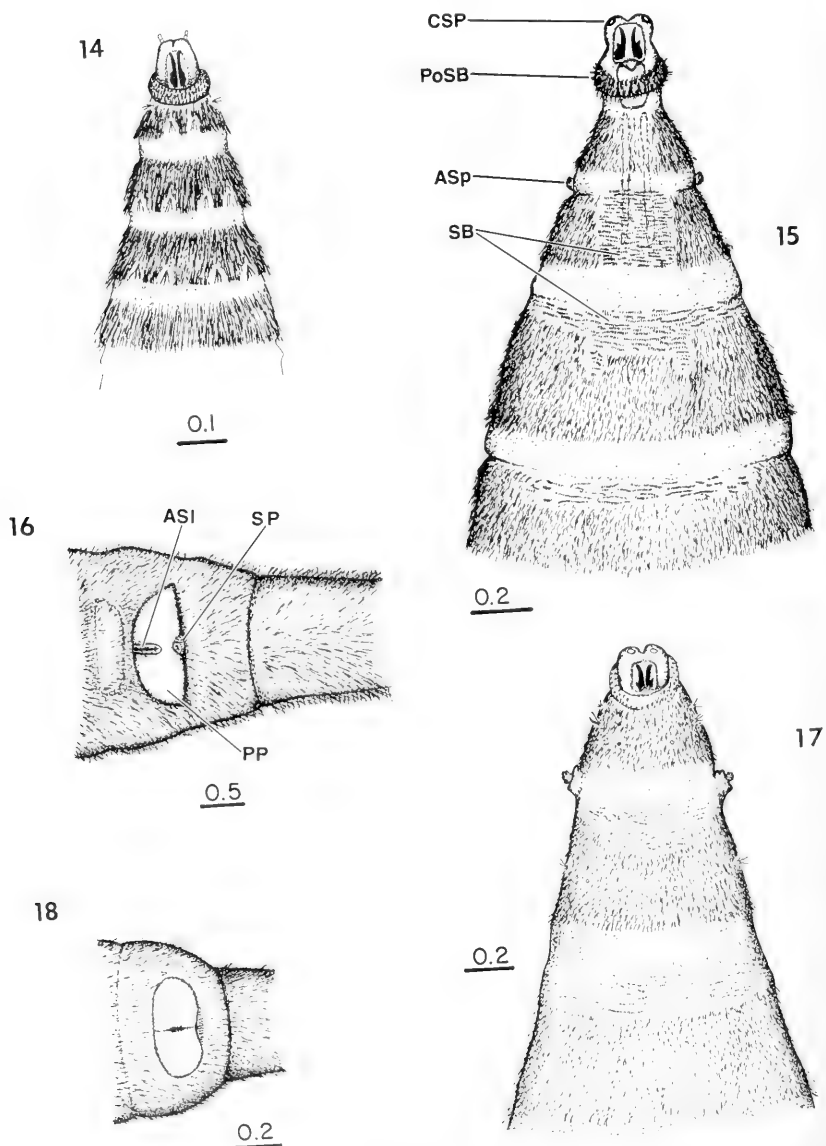
Fig. 14–16. *Ochthera mantis*, ventral views. 14, anterior portion of first-instar larva. 15, anterior portion of third-instar larva. 16, segment XII of third-instar larva. Fig. 17–18. *O. exsculpta*, ventral views. 17, anterior portion of third-instar larva. 18, segment XII of third-instar larva.

First-instar larva (fig. 7): Main body length 1.88–3.72 mm, breathing tube length 0.76–1.68 mm; maximum width in dorsal view 0.30–0.56 mm. Similar to third-instar larva except in following characters. Rows of stout spinules absent; integument covering more obvious, hairs much longer and dark brown. Hair covering on segments 2–4 very dense and proportionately much longer, occupying anterior ½ of segment 2 and anterior ⅔ of segments 3 and 4 (fig. 14); 10 deep indentations along posterior margin of hair covering on all 3 segments, each bearing a 3-branched, dark brown, hairlike sensillum. Anterior spiracles absent. Segments 5–11 each with 3 subequal annuli; integument covering less obvious than on segments 2–4, occupying entire segment and slightly darker on crest of each annulus. Posterior spiracular cap (fig. 25) elongate, tapering and cleft medially to basal ⅓; apical ⅔ light brown, parallel-sided and bluntly rounded; 2 indistinct spiracular openings, more or less fused together (fig. 19). Cephalopharyngeal skeleton (fig. 31, 32) length 0.37–0.40 mm; generally less pigmented. Mouthhook length 0.11–0.12 mm; hook part lacking ventral serrations, tapering to a fine point; basal part with several strong teeth anteroventrally and lacking posterodorsal projection. Ligulate sclerite lightly pigmented, articulating with mouthhook and hypostomal sclerite. Hypostomal sclerite fused to pharyngeal sclerite. Epistomal sclerite fused to hypostomal sclerite posteriorly and occupying most of area between hypostomal arms. Darkest pigmentation in pharyngeal sclerite more or less comma-shaped; dorsal bridge lightly pigmented and not reticulate; dorsal and ventral cornua mostly lightly pigmented and without windows. (Based on 30 reared specimens.)

Second-instar larva: Main body length 3.73–6.31 mm, breathing tube length 1.74–3.49 mm; maximum width in dorsal view 0.58–1.08 mm. Similar to third-instar larva except in following characters. Integument covering less noticeable, spinule bands lighter. Anterior spiracles (fig. 9) much smaller, 4–5 marginal papillae. Each posterior spiracular cap (fig. 26) with deep, unsclerotized cleft medially; tapering to midlength. Spiracular openings smaller; spiracular scar rounded and less distinct (fig. 21). Cephalopharyngeal skeleton (fig. 35) length 0.58–0.61 mm. Accessory mouth sclerite, parastomal bars and epistomal sclerite lighter. No dorsal projection posterior to window in ventral cornua. (Based on 28 reared specimens.)

Third-instar larva (fig. 8): Main body length 7.47–10.79 mm, breathing tube length 5.98–8.47 mm; maximum width in dorsal view 1.25–2.11 mm. White except for light-brown posterior spiracular caps and black cephalopharyngeal skeleton. Shape cylindrical, tapering somewhat anteriorly, first 2 segments retractile, invaginated or evaginated in preserved specimens; caudal segment greatly elongate, telescoping and branching distally. Segment 1 (pseudocephalic) (fig. 15) bilobed anteriorly, each lobe with minute, fleshy, 3-segmented sensory papilla (antenna) directed anterodorsally from evaginated segments and anteroventrally from invaginated specimens; lightly pigmented circular sensory plate ventral to each antenna; atrium ventral; area surrounding atrium glabrous. Segment 2 (prothoracic) completely encircled anteriorly by well developed postoral spine band; posterior ¼ glabrous, anterior spiracles present laterally near posterior border; remainder of segment with fine, pale hairs. Anterior spiracles (fig. 10) clublike, tubular, elongate and retractile; white with tips of papillae light brown; 4–5 marginal papillae, arranged in a definite row. Spinule band completely encircling segment 3 (mesothoracic) anteriorly, composed of ir-

regularly arranged rows of minute, stout spinules; width dorsally ⅛–¹⁄₁₀ segment length, tapering laterally and becoming very narrow behind prothoracic spiracles; ventral portion with median subsquare extension projecting from anterior margin to ⅔ segment length. Short, dense hairs on anterior ⅔ of segment, except where replaced by spinules. Spinule band on segment 4 (metathoracic) with numerous spinule rows dorsally, occupying anterior ⅕ of segment; decreasing to 3–6 rows laterally; widening ventrally to ⅕ segment length with 2 short, pointed, posterior projections (fig. 15). Posterior ⅓ of segment 4 glabrous; area between spinule band and glabrous area clothed in short, dense hair. Spinule band on segment 5 (1st abdominal) incomplete laterally, dorsal and ventral portions extending from anterior margin to ⅙ segment length, tapering laterally until disappearing; short, dense hair on remainder of segment except posterior ⅙; posterior ⅙ glabrous. Segments 6–11 covered with dense hairs, more or less in rows; spinules completely absent; sensilla small and indistinct; each segment weakly triannulate, middle annulus of each segment slightly larger ventrally. Segment 12 not as broad basally; with bilobed peri-anal pad ventrally (fig. 16), each lobe subtriangular with rounded anterolateral margin; anal slit longitudinal in middle of pad; ovoid patch of minute, dark spinules at medioposterior border. Breathing tube extremely long and tapering distally; with long, fine, pale hairs basally and minute hairs distally; branches bearing spiracles with rows of minute hairs. Posterior spiracular caps (fig. 27) light brown, parallel-sided and bluntly rounded apically; 3 elongate, somewhat curved spiracular openings bordered basally by 4 webbed, hydrofuge structures, each structure composed of 4–7 pale, moderately branched float hairs, interconnected proximally by membranous webbing; spiracular scar somewhat lighter, shaped as illustrated (fig. 20). Cephalopharyngeal skeleton (fig. 37) mostly darkly pigmented; length 0.78–0.87 mm. Mouthhooks paired, length 0.17–0.20 mm, width through window 0.04–0.05 mm; hook parts slightly and evenly decurved, mucronate at tip and each with evenly rounded serrations ventrally; basal parts each with 1 small window and 1 moderately pigmented, digitate, accessory tooth on anteroventral margin; postero-ventral portion weakly flanged apically; accessory mouth sclerite beneath accessory tooth on each side, moderately pigmented. Ligulate sclerite paired; each piece long, thin, moderately pigmented; lying below junction of mouthhooks and hypostomal sclerite and directed anteriorly toward midline. Hypostomal sclerite length 0.10–0.13 mm, mostly darkly pigmented; not fused to mouthhooks or pharyngeal sclerite; U-shaped in ventral view; anterolateral arms enclosing epistomal sclerite, broader in dorsal view than distance between them; broad bridge posteroventrally with trun-cate posterior projection; presumed parastomal bars fused along their entire length to median edges of lateral arms, less heavily pigmented. Epistomal sclerite small, lightly pigmented and convex dorsally; with rounded anterior margin and pos-

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Fig. 19–30. Posterior spiracular caps (R = right cap; L = left cap). Fig. 19–21, *Ochthera mantis*, distal views. 19, first-instar larva (R). 20, third-instar larva (L). 21, second-instar larva (R). Fig. 22–24, *O. exsculpta*, distal views. 22, first-instar larva (R). 23, second-instar larva (R). 24, third-instar larva (R). Fig. 25–27, *O. mantis*, medial views. 25, first-instar larva (R). 26, second-instar larva (R). 27, third-instar larva (R). Fig. 28–30, *O. exsculpta*. 28, first-instar larva (L), lateral. 29, second-instar larva (R), medial. 30, third-instar larva (L), lateral.
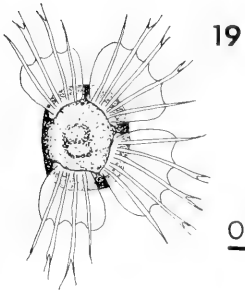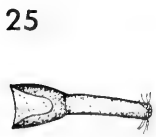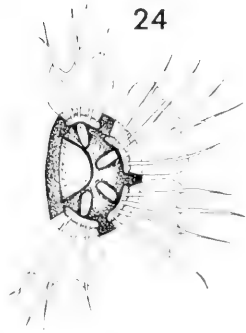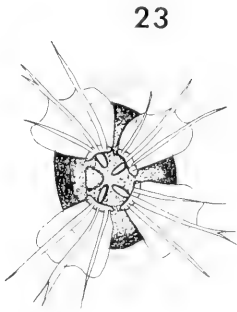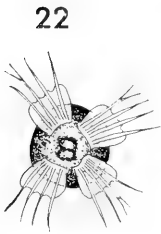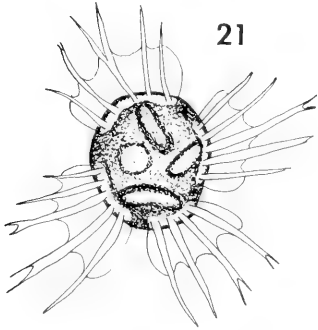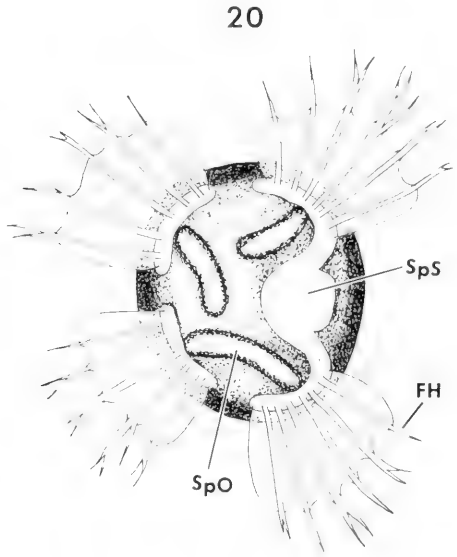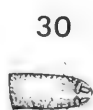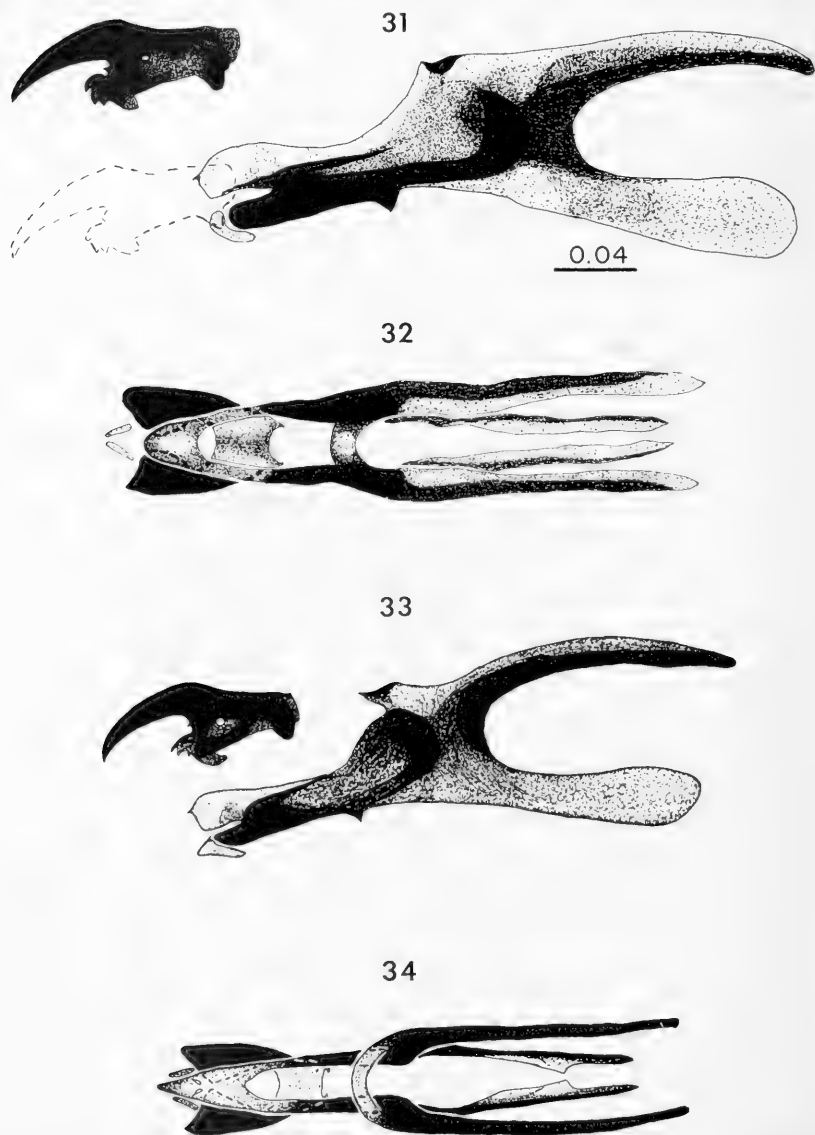
Fig. 31–34. Cephalopharyngeal skeletons of first-instar larvae. 31, *Ochthera mantis*, lateral view. 32, *O. mantis*, dorsal view. 33, *O. exsculpta*, lateral view. 34, *O. exsculpta*, dorsal view.

terior indentation in ventral view. Pharyngeal sclerite length 0.51–0.55 mm; indentation index (length of sinus separating dorsal and ventral cornua/total length of pharyngeal sclerite × 100) 57–59; mostly darkly pigmented and strongly compressed; anteroventral portion articulating with hypostomal sclerite; lightly pigmented, evenly rounded lobe between anteroventral portion and dorsal bridge; dorsal bridge short and moderately reticulate. Dorsal cornua slightly longer than ventral cornua, with elongate window posteriorly; window of ventral cornua bordered posteriorly by thin, upright projection. (Based on 38 specimens, 30 reared and 8 field collected.)

Puparium (fig. 11, 12): Main body length 5.23–6.31 mm ($\bar{x} = 5.88$), breathing tube length 4.40–8.66 mm ($\bar{x} = 6.68$); maximum width in dorsal view 1.92–2.41 mm ($\bar{x} = 2.13$). Venter arcuate and dorsum flattened in lateral view; anterior end flattened dorsally and tapering; posterior end extremely elongate and upcurved. Usually dark brown and opaque; integument covered by small, dark hairs, more or less arranged in rows. Segment 1 and most of segment 2 invaginated; anterior spiracles arising from anterolateral corners of puparium, elongate and diverging. Dorsal cephalic cap flattened; delineated by line of weakness extending laterally along segments 2–4, evenly curving along segment 5, and transversing segment 5 near its posterior border. Ventral cephalic cap delineated by line of weakness transversing segment 5 near its anterior ⅓. Segments 6–11 more or less with 3 annuli, strongest dorsally. Segment 12 with peri-anal pad ventrally and breathing tube distally. Breathing tube with pronounced lateral ridges basally; 1 pair of small tubercles near distal ¼; with dark hairs on basal portion; tapering, bearing minute hairs and becoming lightly pigmented distally; angle formed with longitudinal axis of body usually 60–90°; branches usually diverging 60–90°; posterior spiracular caps slightly darker than on third-instar larva. (Based on 35 specimens, 21 reared and 14 field collected.)

Ochthera tuberculata Loew

Egg (fig. 5): Length 1.12–1.30 mm ($\bar{x} = 1.21$); maximum width in dorsal view 0.38–0.49 mm ($\bar{x} = 0.42$). Similar to Ochthera mantis except dorsum with reticulate pattern along entire length of egg, forming irregularly shaped depressions. (Based on 26 specimens from rearings.)

First-instar larva: Main body length 1.80–3.52 mm, breathing tube length 0.72–1.76 mm; maximum width in dorsal view 0.32–0.57 mm. Cephalopharyngeal skeleton length 0.33–0.38 mm. Similar to O. mantis. (Based on 28 reared specimens.)

Second-instar larva: Main body length 3.65–5.98 mm, breathing tube length 1.59–3.24 mm; maximum width in dorsal view 0.67–1.14 mm. Cephalopharyngeal skeleton length 0.51–0.57 mm. Similar to O. mantis. (Based on 22 reared specimens.)

Third-instar larva: Main body length 5.56–8.47 mm, breathing tube length 2.82–4.98 mm; maximum width in dorsal view 1.13–1.98 mm. Cephalopharyngeal skeleton length 0.68–0.75 mm; mouthhook length 0.14–0.15 mm; hypostomal sclerite length 0.12–0.13 mm; pharyngeal sclerite length 0.42–0.50 mm, indentation index 56–61. Similar to O. mantis. (Based on 18 reared specimens.)

Puparium: Main body length 4.15–5.81 mm ($\bar{x} = 4.79$), breathing tube length 3.32–5.40 mm ($\bar{x} = 4.27$); maximum width in dorsal view 1.41–2.08 mm
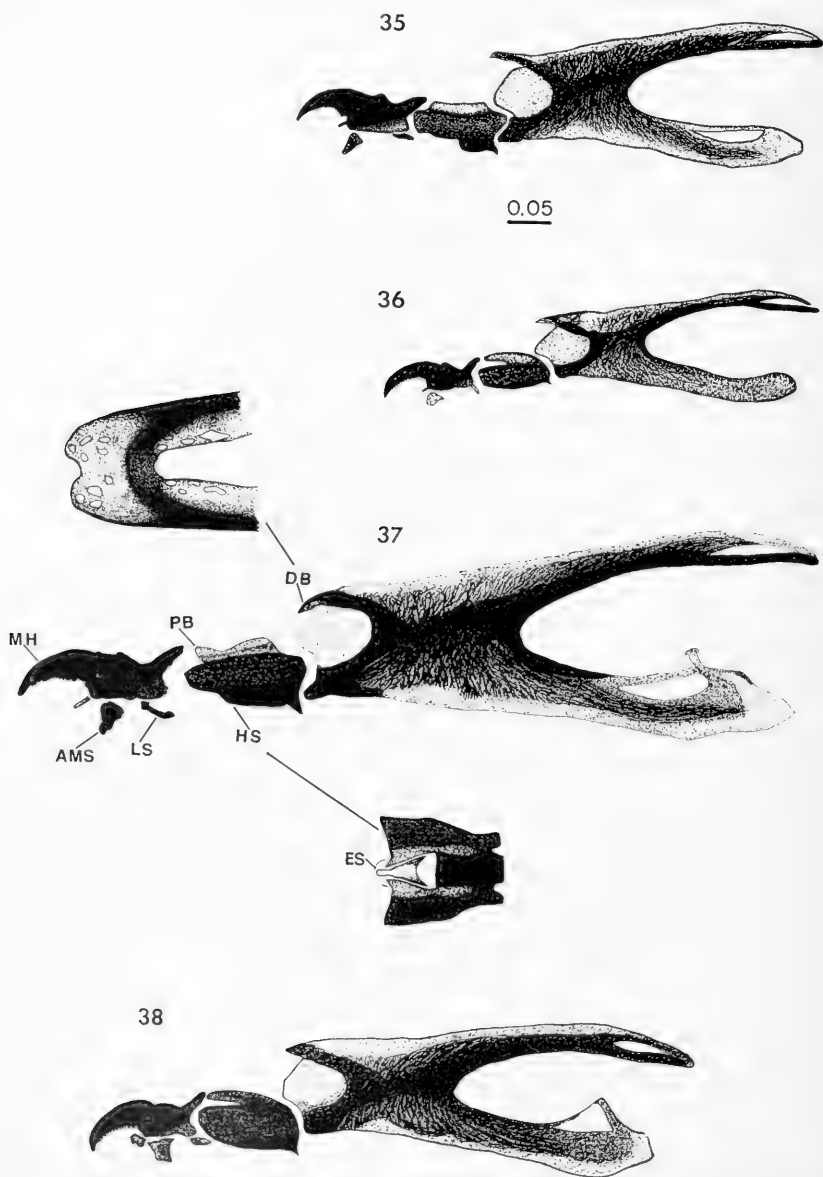
Fig. 35–38. Cephalopharyngeal skeletons, lateral views. 35, *Ochthera mantis*, second-instar larva. 36, *O. exsculpta*, second-instar larva. 37, *O. mantis*, third-instar larva. 38, *O. exsculpta*, third-instar larva.

($\bar{x} = 1.88$). Similar to *O. mantis*. (Based on 27 specimens, 26 reared and 1 field collected.)

Ochthera exsculpta Loew

Egg (fig. 6): Length 1.16–1.24 mm ($\bar{x} = 1.20$); maximum width in dorsal view 0.30–0.32 mm ($\bar{x} = 0.31$). More convex ventrally than dorsally in lateral view. Black to brownish-black, rarely light gray. Most of egg striated longitudinally with anastomosing ridges. Micropylar end with smooth, narrow elongation, ⅓ to ¼ as long as remainder of egg; micropyle funnel-shaped, located posteroventrad to elongation. Opposite end bluntly rounded and with patch of irregularly shaped depressions apically. (Based on 53 specimens from rearings.)

First-instar larva: Main body length 1.20–2.76 mm, breathing tube length 0.60–1.12 mm; maximum width in dorsal view 0.24–0.47 mm. Similar to *Ochthera mantis* except in following characters. Posterior spiracular caps (fig. 28) narrower and somewhat tapering distally; each hydrofuge structure smaller, usually with 4 float hairs (fig. 22). Cephalopharyngeal skeleton (fig. 33, 34) length 0.30–0.34 mm; mouthhook length 0.09–0.10 mm. (Based on 24 reared specimens.)

Second-instar larva: Main body length 2.72–4.99 mm, breathing tube length 0.96–1.99 mm; maximum width in dorsal view 0.50–0.75 mm. Similar to *Ochthera mantis* except in following characters. Anterior spiracles smaller, usually with 5 less distinct marginal papillae. Dorsal and ventral portions of each spinule band on segments 2–5 occupying ¼ to ⅕ segment length. Ventral extensions of spinule bands on segments 2 and 3 less obvious. Peri-anal pad ovoid and somewhat emarginate posteriorly; with 2–5 rows of minute, dark spinules posteromedially. Posterior spiracular caps (fig. 29) more narrow and tapering; 4 elongate ovoid spiracular openings; 1 webbed hydrofuge structure bordering each opening basally, each structure with 3 float hairs; spiracular scar lighter (fig. 23). Cephalopharyngeal skeleton (fig. 36) length 0.44–0.49 mm; presumed parastomal bars free from hypostomal sclerite along its distal ½; window in ventral cornua lacking. (Based on 11 reared specimens.)

Third-instar larva: Main body length 4.73–8.30 mm, breathing tube length 1.83–3.90 mm; maximum width in dorsal view 0.75–1.33 mm. Similar to *Ochthera mantis* except in following characters. Anterior spiracles smaller, with 6–7 less distinct marginal papillae. Spinule band on segment 3 ⅓ segment length dorsally; ventral extension shorter. Spinule band on segment 4 ¼ segment length dorsally and ventrally; ventral portion without posterior projections (fig. 17). Peri-anal pad (fig. 18) ovoid and slightly emarginate posteriorly; bordered posteromedially by 2–5 rows of minute, dark spinules; distinct spinule patch lacking. Posterior spiracular caps (fig. 30) narrower, slightly more elongate and bluntly rounded; 4 elongate ovoid spiracular openings present, each bordered basally by 1 webbed, hydrofuge structure consisting of 3–5 interconnected float hairs (fig. 24). Cephalopharyngeal skeleton (fig. 38) length 0.63–0.65 mm; mouthhook length 0.12–0.13 mm, accessory tooth wider and not digitate; hypostomal sclerite length 0.10–0.11 mm, presumed parastomal bars free along their anterior ½; pharyngeal sclerite length 0.43–0.45 indentation index 56–59. (Based on 10 reared specimens.)

Puparium (fig. 13): Main body length 2.75–4.16 mm ($\bar{x} = 3.49$), breathing tube length 1.58–2.91 mm ($\bar{x} = 2.31$); maximum width in dorsal view 1.33–1.59 mm ($\bar{x} = 1.44$). Similar to *Ochthera mantis* except in following characters.

Main body stouter, anterior end more abruptly tapered. Generally less heavily pigmented, light to moderately dark brown and translucent; patterned with series of irregular, dark brown markings. Peri-anal pad dark brown. Branches of breathing tube often diverging more than 90°, angle of divergence highly variable. (Based on 17 reared specimens.)

DISCUSSION

Population regulation

Natural enemies of *Ochthera* larvae apparently include the larvae of Tabanidae and Dolichopodidae (Diptera). These larvae were collected in the same habitats as were larval *Ochthera* and readily fed upon them in laboratory rearing dishes. This pressure, in addition to the cannibalistic tendency of mature *Ochthera* larvae under crowded conditions may contribute to population regulation. However, the influence of all predators combined probably is not very important in limiting populations of these flies. Any nonspecialized vertebrate or invertebrate predator could just as easily feed on other more abundant organisms, such as chironomid larvae.

The only recorded enemy of the pupal stage was the parasitoid wasp *Atractodes* sp. (Hymenoptera: Ichneumonidae), which was obtained from field-collected puparia of *O. mantis* and *O. tuberculata*. The number of field-collected puparia was insufficient to assess the importance of this mortality factor.

Ochthera larvae possess neither an effective means of locomotion in open water nor a particularly efficient prey capture mechanism. Larvae of *Ochthera mantis* and *O. tuberculata* apparently require shallow, muddy habitats which have an abundance of chironomid larvae. Similarly, larvae of *O. exsculpta* seem to be restricted to dense, filamentous algal mats, which also contain numerous chironomid larvae. Therefore, the amount of suitable larval habitat is limited, and this may be an important factor in limiting the abundance of these 3 species.

Respiratory adaptions of the immature stages

Many insect egg shells, including those of many terrestrial species, are equipped with areas capable of trapping a gaseous plastron that is functional in increasing the efficiency of their cuticular respiration. Hinton (1969) pointed out that the plastron used by Diptera-Cyclorrhapha is often restricted to the area between the hatching lines, and may consist of a few or many discrete islands or craters scattered over the surface of the shell. The depressions on the egg surfaces of *Ochthera mantis* and *O. tuberculata* fit Hinton's description, and it appears that these areas are used for respiration when the eggs are submerged.

The eggs of *Ochthera tuberculata* are deposited in moist banks in areas along the coastal plain of North America, and may be subjected to frequent submersions, such as daily tidal flooding. The extensive areas of craters dorsally on these eggs may explain their ability to tolerate these submersions by utilizing a large, gaseous plastron. The eggs of *O. mantis* have a much less extensive area of craters, but it seems that they have less need for an efficient mechanism for underwater respiration. The habitats in which they occur (the banks of inland streams, lakes, and ponds) are not subjected to the frequent changes in water level experienced in the coastal regions. These eggs are therefore usually quite close to the air-water interface, where the dissolved oxygen content is characteristically much higher.

The only craters on the eggs of *Ochthera exsculpta* are clustered at the posterior tip; the dorsal craters are completely lacking. The function of the dorsal craters may have been assumed by the anterior projection on these eggs. This structure most likely projects from the substrate into the air, and may provide a site for gaseous exchange between the egg and the atmosphere. Similar projections termed "respiratory horns" have evolved several times on various insect eggs, and have been shown to have a respiratory function (Hinton, 1969).

The eggs of the 3 species studied are deposited with the micropylar (or anterior) end protruding and the opposite end buried within the substrate. The small patch of craters located at the posterior end of these eggs may provide a small plastron through which the submerged portions of these eggs can respire.

Larvae of *Ochthera* are among those ephydrid larvae which have a well developed posterior breathing tube. Other dipterous larvae which have a similar structure are the "rattailed maggot" (Syrphidae) and the larvae of phantom crane flies (Ptychopteridae). The breathing tubes on these larvae are longer than those of the Ephydridae, and function to allow these larvae to penetrate and feed far below the surface of highly organic, oxygen-deficient materials (Chapman, 1969). The posterior spiracles of all these organisms are borne on the apex of the breathing tube and possess hydrofuge hairs. These water-repellent hairs keep the spiracular openings above the water surface, allowing free gaseous exchange between the atmosphere and the larval tracheal system.

Third-instar larvae of *Ochthera mantis* and *O. tuberculata* have 3 spiracular openings on each posterior spiracular plate, as do the mature larvae of most cyclorrhaphous Diptera (Peterson, 1953). *Ochthera exsculpta* has 4 such openings. It appears that the 2 ventral openings on this species are represented by a single, long, curved opening in the other 2 species.

Most dipterous species change from metapneustic to propneustic respiration when pupation (or pupariation) occurs. This would explain

the need for *Ochthera* larvae to position themselves with both anterior and posterior spiracles exposed for pupariation.

ABBREVIATIONS USED IN FIGURES

AMS, accessory mouthhook sclerite; ASl, anal slit; ASp, anterior spiracle; CSP, circular sensory plate; DB, dorsal bridge; EL, eclosion line; ES, epistomal sclerite; FH, float hair; HS, hypostomal sclerite; LS, ligulate sclerite; M, micropyle; MH, mouthhook; PB, parastomal bar; PP, peri-anal pad; PoSB, postoral spine band; SB, spinule band; SP, spinule patch; SpO, spiracular opening; SpS, spiracular scar.

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REPRODUCTION BY A GROSSLY MALFORMED FLY
(DIPTERA: SCIOMYZIDAE)

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ABSTRACT—A reared female of *Dictya pictipes* (Loew) having only one wing and 5 legs fed normally, survived for 49 days, mated, and laid more than 200 viable eggs. The mesothorax was almost completely missing on her left side, and many thoracic bristles were either absent or deformed. All of her offspring were normal morphologically; the females laid viable eggs after mating with their male siblings and with field-collected males. This gross malformation does not appear to have any genetic basis; it probably was caused by an accident of development.

FOREWORD

The promising entomological career of William Lloyd O'Neill was terminated at the early age of 24, when he was a doctoral student at Cornell University. This dedicated young biologist had made significant observations on the sciomyzid flies, and more particularly on their parasitoid Hymenoptera (O'Neill, 1973). Everyone associated with him felt that the data in his research notes should be published. However, his doctoral research involved a bewildering series of undescribed species of Ichneumonidae. When his study of them was interrupted by his final illness, he said that at least another year of intensive research would be needed before he could reliably distinguish the various species and recognize the subtle biological differences among them. None of his associates could devote the time required to do this.

Alternatively, it seemed that Bill O'Neill's memory could be honored, however inadequately, by completing and publishing his rearing notes on a morphologically abnormal fly. Unfortunately, Bill's last paper thus concerns a subject that is only tangentially related to the major focus of his interests. More importantly, its scientific value cannot begin to approach the value that his completed doctoral dissertation would have had. This alternative is chosen only because it seems to be the only one attainable.

Bill took the picture reproduced here as figure 1 before he became ill. The 3 drawings were commissioned after his death.

Clifford O. Berg

INTRODUCTION

Described teratologies of the Sciomyzidae include partially duplicated antennae (Berg, 1973) and gynandromorphism (Steyskal, 1974). Those abnormalities were discovered after the insects were killed. There was no chance to determine their effects on competence in feeding, locomotion, and reproduction, nor to get any evidence con-

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[1] Deceased May 27, 1974.
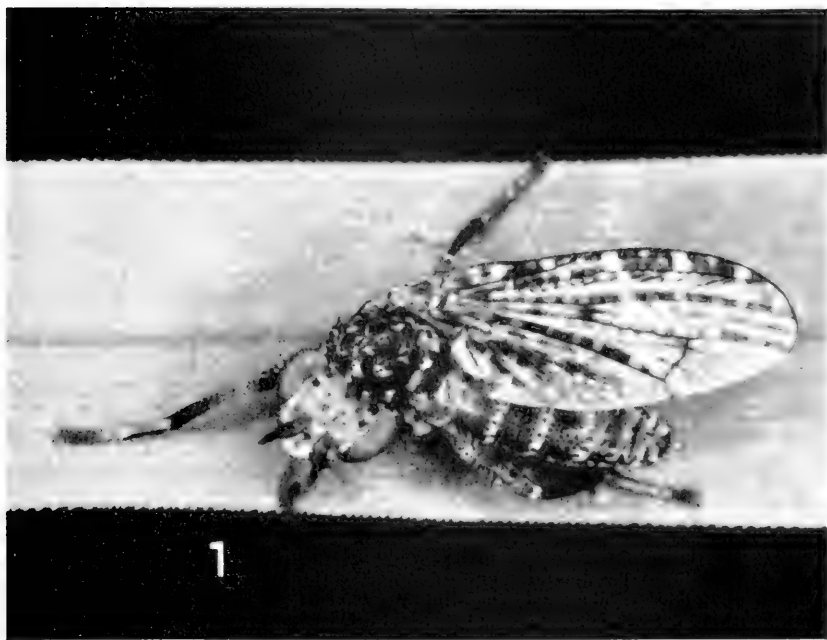
Fig. 1. Malformed fly—dorsal view during life.

cerning their inheritance. A living female of *Dictya pictipes* (Loew) that had only 5 legs and one wing stimulated us to seek the answers to these questions. It seemed that the mesothorax was missing on her left side and that fusion of the metathorax to the prothorax there had caused a permanent flexure of almost 90 degrees in the longitudinal axis of her body (fig. 1).

REARING NOTES

The individual on which this paper is based was collected as a fully grown larva on May 25, 1973, at Bool's Backwater, Ithaca, New York, a natural area described by Eckblad (1973). It appeared normal in all respects, and it formed an apparently normal puparium on May 29. The malformed female emerged from this puparium on June 8. She walked hesitantly and clumsily, but she fed normally on both the staple diet of honey-yeast paste and the crushed snails added as a protein supplement. On June 16, a male *D. pictipes* collected at Bool's Backwater was added to the jar in which she was kept, and mating was observed a few minutes later. She laid her first eggs (a group of 9) on June 19, and these hatched after 2 days of development at laboratory temperatures. Her preoviposition period of 11 days is
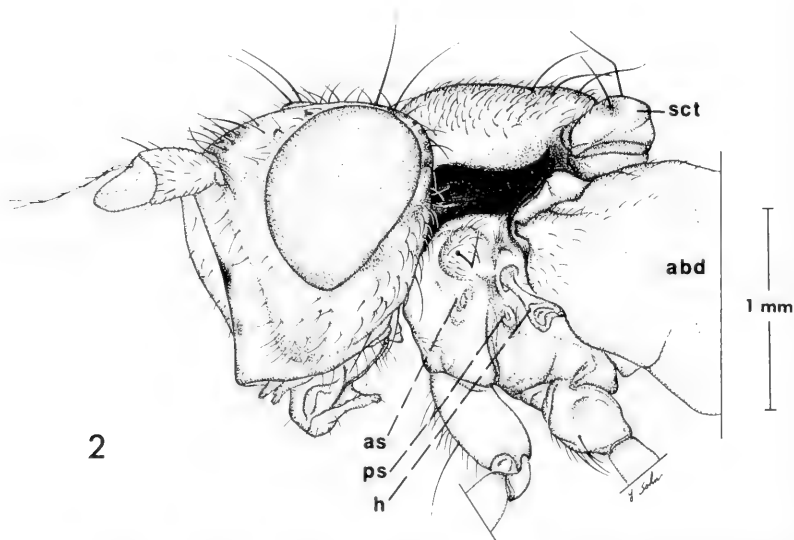
Fig. 2. Malformed fly—left lateral view of head, thorax, and anterior segments of abdomen. abd, abdomen; as, anterior thoracic spiracle; h, halter; ps, posterior thoracic spiracle; sct, scutellum.

within the range of 6 to 38 days reported for other females of *D. pictipes* (Valley, 1974).

When the aberrant female was transferred to a clean breeding jar on July 7, 90 eggs were counted in the old container. At that time, 14 of her offspring were mature larvae ready to form puparia, and there were other third-instar larvae almost as well developed.

Emergence of the F_1 generation began on July 18 with the eclosion of 3 female flies. Nineteen more of her offspring emerged during the next 6 days. These 22 flies seem morphologically normal in all respects. Time within their puparia averaged about 11 days and extended to a maximum of 13 days. Valley (1974) reported 7 to 10 days as the puparial period of this species.

Death of the malformed female parent in the moist breeding jar could have resulted in molding or partial decay if she were not discovered immediately. Therefore, we decided to kill and carefully preserve her on July 27, 49 days after she emerged from her puparium. She had laid at least 208 eggs (almost all of them viable) and was still ovipositing at intervals. Valley (1974) recorded egg counts of 179 to 354 for laboratory-reared females of this species.

Meantime, an effort was made to inbreed the F_1 generation by segregating pairs in breeding jars on July 22. No mating was seen immediately, nor were any viable eggs produced. Wild-caught males from Bool's Backwater were placed with other F_1 females on August
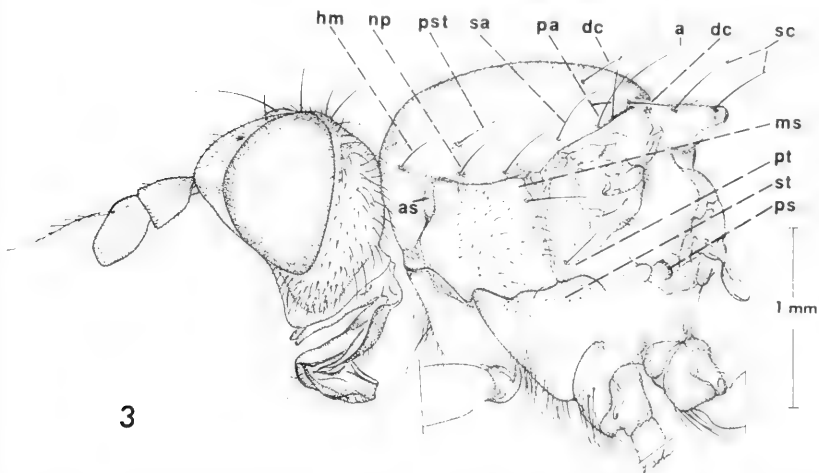
Fig. 3. Normal specimen of *D. pictipes*—left lateral view of head and thorax. a, acrostical bristle; as, anterior thoracic spiracle; dc, dorsocentral bristle; hm, humeral bristle; ms, mesopleuron; np, notopleural bristle; pa, postalar bristles; ps, posterior thoracic spiracle; pst, presutural bristle; pt, pteropleuron; sa, supra-alar bristle; sc, scutellar bristles; st, sternopleuron.

8. When their efforts to copulate were observed, the female flies were not receptive.

After other field-collected males were substituted in the breeding jars on September 8, eggs were found to contain developing larvae on September 18. On October 28, embryonating eggs were found in a jar containing a brother-sister mating of the F_1 generation. Eggs from both inbred and outbred females hatched, and the larvae fed and began to develop normally. However, no adults of this F_2 generation were obtained. When O'Neill became gravely ill and anxiety about his health crowded out other concerns, the rearings were neglected.

MORPHOLOGY OF THE MALFORMED FLY

Examination of the abnormal female parent discloses such gross anomalies of structure that her long survival and successful reproduction seem quite remarkable. The thorax on the left side is so reduced that the distance from head to anterior end of the abdomen is less than the width of the compound eye (fig. 2). Almost all of the meso-thorax is missing, but the anterior thoracic spiracle, which developmentally belongs to the mesothorax, appears to be normally developed and functional. The space between posterior and anterior thoracic spiracles is less than one-sixth that of normal specimens (from ps to as in figs. 2 & 3). A deep, wide furrow, glabrous and shiny black, extends from the head back and to the scutellum (sct, fig. 2), passing
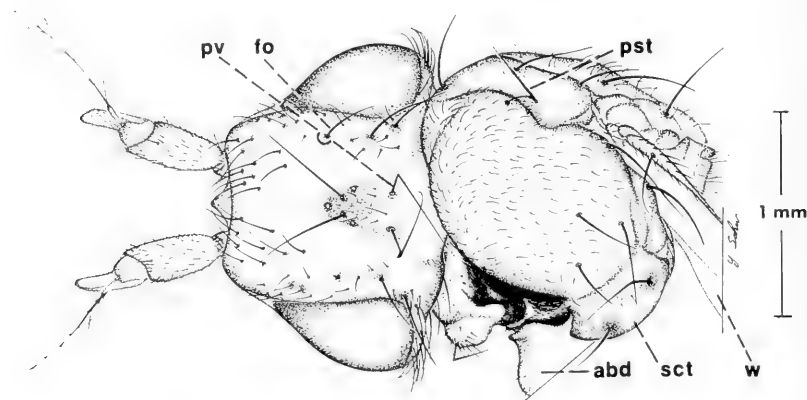
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Fig. 4. Malformed fly—dorsal view of head, thorax, and left anterior corner of abdomen. abd, abdomen; fo, fronto-orbital bristle; pst, presutural bristle; pv, postvertical bristle; sct, scutellum; w, wing.

through the area where the left wing should have developed. The two legs, which must be interpreted as prothoracic and metathoracic because of their morphology and associated structures, are closer together than the prothoracic and mesothoracic legs of a normal speci-men. A narrow groove that extends dorsally from between their bases seems to mark the plane of fusion of prothoracic to metathoracic elements. The whole sternopleuron (st, fig. 3) evidently is missing as well as the mesothoracic leg. Just anterad from the base of the halter (h, fig. 2) a convexity unlike any structure on the thorax of a normal *Dictya* bears several small bristles and one large one that is turned at an acute angle one-third of the way from its base to its tip (see also on fig. 4). The only pleural sclerite bearing a large bristle and several smaller ones is the mesopleuron (ms, fig. 3), so this strange convexity probably was formed by mesopleural elements that were crowded into an abnormal position above the anterior spiracle.

The aberrant female lacks many of the large thoracic bristles normally present on *D. pictipes*, and others are variously malformed. Above the mesopleural and pteropleural bristles, normal specimens have the following large bristles on the dorsum on each side of the middorsal line: 1 humeral (hm), 2 notopleurals (np), 1 presutural (pst), 1 supra-alar (sa), 2 postalars (pa), 2 dorsocentrals (dc), 1 acrostical (a), and 2 scutellars (sc) (fig. 3). Most if not all of these are missing from the female's left side, where the deep, longitudinal furrow extends through their positions. On the right side, the ptero-pleural and mesopleural bristles are normal, as are the humeral, both

notopleurals, the supra-alar, and one of the postalars. The other postalar bristle is missing, and the presutural bristle is acutely angled and obviously malformed (pst, fig. 4). The more posterior bristles are so strangely placed that identification is doubtful, but relative positions suggest that the 3 anterior to the scutellum (sct, fig. 4) are the 2 dorsocentrals and the acrostical of the right side. The scutellars (only 2 present on the whole scutellum) may be either the median pair or the 2 bristles on the right side. The right one, obtusely angled, is appreciably larger than the other.

Abnormality of bristle development extends also to the head. The fronto-orbital bristle on the left side is represented merely by a short stump, and both postverticals are acutely angled and crossed (fo & pv, fig. 4).

This malformed specimen, her puparium, and several of her off-spring can be examined in the insect collection of Cornell University. They are placed under *Dictya pictipes* (Sciomyzidae), but pinned in a separate tray and assigned lot no. 1051.

DISCUSSION

Empirical evidence and the literature indicate that anomalies of the type reported here are not hereditary. Morgan et al. (1925: fig. 33) showed 2 similarly deformed specimens of *Drosophila* and discussed them in their chapter, "Abnormalities that are not inherited." They labelled this condition "half-thorax," suggested that it is caused by "an accident of development," and stated that these flies usually have somewhat enlarged eyes. Comparison of eye widths in figures 2 and 3 indicates that this applies also to the present case. There are exceptions, but most abnormalities that appear on only one side of the body are not inherited (Morgan et al., op. cit.). Thus it seems that none of the anomalies thus far reported for the Sciomyzidae has any genetic basis, and inherited deviations that would enable us to study the genetics of the Sciomyzidae are yet to be discovered.

However, this case study does suggest some conclusions concerning behavior. It is interesting that this monstrosity proved attractive to a male fly and that mating was accomplished despite the extreme flexure of her body. As demonstrated for many other insects, the female *Dictya* probably is recognized, and mating is stimulated, far more by chemical (olfactory) than by visual cues. And orientation of the male during copulation evidently is controlled by factors that enable him to find the female genitalia even if the longitudinal axis of her body is flexed through an angle approaching 90 degrees.

Physiological conclusions also are indicated. All vital systems of this malformed individual must have functioned almost or quite normally. Although in nature her flightless condition would have made her

extremely vulnerable to predators, her abnormalities evidently imposed no inherent limits on her competence in feeding and reproduction.

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THE GENDER OF THE GENUS-NAME *STOMOXYS* GEOFFROY, 1762 (DIPTERA, MUSCIDAE)

The name *Stomoxys* was proposed in a way which made it necessary to apply to the International Commission on Zoological Nomenclature for its validation. The name was placed on the Official List under Opinion 441, published in 1957, wherein the name was stated to be of feminine gender.

Stomoxys was proposed with one included species, *Conops calcitrans* Linnaeus. This specific name is invariable and thus does not indicate gender. Geoffroy, however, in the French form of the name "le Stomoxe" indicated it as masculine, and the Latin form of the name even more unmistakably shows it as of that gender. In Latin transcription from the original Greek, the 3 gender-forms of this basically adjectival name are *stomoxys* (masc.), *stomoxia* or *stomoxeia* (fem.) and *stomoxy* (neuter). Under all rules of the Code, the name is therefore clearly of masculine gender.

Although the species of this genus are important and often-referred-to pests, one species, S. *calcitrans*, is mentioned far more often than any other, but that name is not affected by the gender of the genus. In the monograph by Zumpt (1973, the Stomoxyine Biting Flies of the World, Fischer, Stuttgart, viii + 175 pp.), the following 10 species-group names, including one in a new genus formed by a prefix added to *Stomoxys*, are affected as shown by a change to a masculine form:

Parastomoxys mossambica Zumpt, 1973—*P. mossambicus.*
Stomoxys nigra Macquart, 1851—*S. niger.*
S. *n. bilineata* Grünberg, 1906—*S. n. bilineatus.*
S. *taeniata* Bigot, 1888—*S. taeniatus.*
S. *indica* Picard, 1908—*S. indicus.*
S. *pulla* Austen, 1909—*S. pullus.*
S. *inornata* Grünberg, 1906—*S. inornatus.*
S. *transvittata* Villeneuve, 1916—*S. transvittatus.*
S. *pallida* Roubaud, 1911—*S. pallidus.*
S. *luteola* Villeneuve, 1934—*S. luteolus.*

The names of 12 other species and subspecies recognized as valid by Zumpt, including one in the new genus *Prostomoxys* are not affected. One name, S. *xanthomelas* Roubaud, 1937 was proposed in a masculine form; the feminine form of *xanthomelas* is *xanthomelaena*.

In view of the fact that no ruling on gender of the names dealt with in Opinion 441 was specifically requested, an error seems to have been introduced into either the original application or the Opinion. In Appendix I to the Opinion, the classical adviser to the Commission, the late L. W. Grensted, refers to *Stomoxys* as masculine. I wish at this time merely to point out the facts involved. If anyone wishes to apply to the Commission for a ruling, he may of course do so.

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OBSERVATIONS OF ZETHUS SPINIPES SAY
(HYMENOPTERA: EUMENIDAE)[1]

Two individuals of *Zethus spinipes* Say were observed and collected from loblolly pine (*Pinus taeda* L.) research plots at Beltsville, Md. during the 1st week of July, 1974. The pines averaged 1.3 m tall and were bordered on one side by an alfalfa field and on the other by mixed grasses and shrubs next to a mature forest of Virginia pine (*P. virginiana* Mill.), white oak (*Quercus alba* L.), with the understory dominated by blackgum (*Nyssus sylvatica* (Walt.)) and American beech (*Fagus grandifolia* Ehrh.).

The wasps were observed foraging for larvae of the Nantucket pine tip moth (*Rhyacionia frustrana* (Comstock)). While foraging on a pine tip, the wasp oriented head downward and chewed the tip to expose the larvae. The wasp began at the distal end and worked inward. During both observations the foraging took from 45 sec to 1 min. The wasp seized the larva with its mandibles, then grasped it between the first 2 pair of legs and stung it twice. At this time the wasp and larva were collected on both occasions. The larvae lived for 3 weeks but did not recover from the sting.

By the time the tip moth attains the last instar, the tunneled buds have become brown and very brittle. Those tips that have been excavated are easily detected, for the hole is 1–2 mm wide and up to 15 mm long depending on the size of the bud. There are often bits of debris hanging from the foraged tip. The terminal cluster and large protruding laterals are the preferred foraging sites.

The wasp has been observed on other occasions but not collected at Smallwood State Forest, Charles Co., and Carmichael, Queen Annes Co., Md. On July 4, 1974, a wasp (*Zethus*) was observed foraging in Smallwood State Forest in a stand very similar to the one described at Beltsville. The larva was captured by the wasp but once it was seized by the mandibles, it was dropped. The larva was examined and found to be parasitized by a tachinid, *Lixophaga mediocris* Aldrich.

The overall effect of *Zethus spinipes* on tip moth populations is unknown but may be of more than transitory importance. Foraged tips have been observed by the authors for 3 years in loblolly pine stands planted in old fields. As many as 10% of the tips in the terminal cluster and large laterals have been foraged and nearly every tree has had some foraging activity in the stands at Smallwood State Forest and Carmichael, Md. The foraging at Beltsville has been less extensive because the tip moth populations have been removed as part of an ongoing experiment on reinfestation of stands by the tip moth.

We wish to thank Arnold Menke, Systematic Entomology Laboratory, IIBIII, Agr. Res. Serv., USDA, for identification of specimens.

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A REPORT OF INDIAN WAX SCALE CONTROLLED BY BIRDS
(HOMOPTERA: COCCIDAE)

According to Gimpel et al. (1974, Misc. Publ. 841, Agric. Expt. Sta., U. Md.), 11 species of wax scales, *Ceroplastes* spp., occur in the United States. Of these species, *Ceroplastes ceriferus* (Fabricius), the Indian wax scale (also called the Japanese wax scale), has become a serious ornamental plant pest in the southeastern United States. Various *Ilex* spp., except *I. opaca* Aiton, are among the preferred hosts.

During the course of his nursery inspection work in the fall of 1973, the second author found a heavy infestation of *ceriferus* in a holly nursery, St. Michaels, Maryland, on *Ilex cornuta* 'Burfordii'. The holly trees were from 6 to 15 feet tall and well spaced over a 4 A tract. The infestation was so heavy that branches appeared white from a considerable distance. The owner agreed to allow the authors to evaluate insecticides for wax scale control the following June when the crawlers appeared.

Accordingly, in June, 1974, we arrived at the holly nursery prepared to spray insecticides. Unfortunately (for us) the wax scale population was gone except for a few scattered individuals. We questioned the owner about the disappearance of the scales. He stated that a large flock of birds, mostly robins (*Turdus migratorius* L.), took refuge in the holly grove during a mid-January snow. When the birds left a few days later, many holly berries and nearly all of the wax scales were gone.

McAtee (1906, U.S. Dept. Agric., Yrbk.) reported 57 species of birds in 12 families feeding on scale insects. It is interesting to note the robin is not included in this list.

JOHN A. DAVIDSON, *Department of Entomology, University of Maryland, College Park, Maryland 20742 and* WILLIAM F. GIMPEL, JR., *Maryland Department of Agriculture, Division of Plant Industry, Pest Management Section, College Park, Maryland 20742.* Scientific Article No. A2042, Contribution No. 4995, of the Maryland Agricultural Experiment Station, Department of Entomology.

SOCIETY MEETINGS

815th Regular Meeting—May 2, 1974

The 815th Regular Meeting of the Entomological Society of Washington was called to order by President Burks at 8 P.M. on May 2, 1974 in Room 43 of the National Museum of Natural History. Twenty-five members and 9 guests were present. Minutes of the previous meeting were read and approved.

The name of a new applicant for membership, Steven L. Jensen of Southwest Missouri State University, Springfield, Mo., was read for the first time.

The main speaker of the evening was Dr. Frederick W. Whittemore, Deputy Director of Operations Division, Office of Pesticides Program, who spoke on the subject of Entomological Activities of International Organizations. His talk was stimulating and made the alphabet soup of international organizations more meaningful.

Notes and Exhibitions:

Dr. Campbell showed slides of the "Marlatt wood carvings of insects" which grace the living room of the Marlatt mansion on 16th St. in Washington. Mark Roth was instrumental in having the carvings photographed for the Smithsonian Archives, before the house was occupied by the Russian Embassy.

The meeting was adjourned at 9:50. Punch and cake were served following the last meeting of this Society to be held in Room 43 of the N.M.N.H. E. C. Bay took movies to commemorate the occasion.

R. J. GAGNÉ, *Recording Secretary*

816th Regular Meeting—May 31, 1974

The 816th Meeting, the Annual Dinner held jointly with the Insecticide Society of Washington, was held on the evening of May 31, 1974 at the National 4-H Club Foundation in Chevy Chase, Md. One hundred and thirty-five persons attended. The principle speaker was William Eilers of the Smithsonian Institution whose presentation was titled: "1984: An Environmentalist's View of 'Limits of Growth.' "

R. J. GAGNÉ, *Recording Secretary*

CONFERENCE REPORT

The First International Working Conference on Stored-Product Entomology was held in Savannah, Georgia, October 7–11, 1974. Meetings were held at the DeSoto Hilton Hotel and the USDA-ARS Stored-Product Insects Research and Development Laboratory.

The Conference objective was to provide a forum on current research and future research needs. The program included symposia and panels on:

1. Tropical Stored-Product Entomology
    Symposium convener—W. H. Jepson, England
    Panel convener—Fred Ashman, Malawi

2. Biology, Ecology, and Integrated Control
    Symposium convener—J. H. Boczek, Poland
    Panel convener—S. C. Saxena, India

3. Pesticides, Toxicity, and Insect Resistance
    Symposium convener—E. J. Bond, Canada
    Panel convener—C. E. Dyte, England

4. Radiation and Other Physical Means of Insect Control
    Symposium convener—Moshe Calderon, Israel
    Panel convener—F. L. Watters, Canada

5. Pesticide Residues, Tolerances, and Registration
    Symposium convener—L. S. Henderson, U.S.A.
    Panel convener—E. E. Turtle, FAO (Italy)

The program consisted of 50 symposium and panel presentations and 27 submitted papers. Attendance exceeded all expectations with 214 agricultural scientists, marketing specialists, and administrators from 27 nations. Special invitational addresses were presented by T. W. Edminster, Administrator, Agricultural Research Service, USDA, and Curtis W. Sabrosky, Systematic Entomology Laboratory, ARS, president of the XV International Congress of Entomology.

At an informal meeting of Conference participants on October 10, a Permanent Committee on Working Conferences on Stored-Product Entomology was constituted. The objectives of this Committee are to assist in maintaining future liaison among the Conference participants and to establish a mechanism for holding future Conferences. The members of the this committee are:

Jan H. Boczek, Poland	C. E. Dyte, U.K.
E. J. Bond, Canada	Abdel H. M. Kamel, Egypt
M. Calderon, Israel	S. C. Saxena, India
Dana P. Childs, U.S.A. (Secretary)	T. Ajibola Taylor, Nigeria
Melville Connell, Australia	Syunro Utida, Japan
Robert Davis, U.S.A. (Chairman)	Peter Wheatley, U.K.
Horacio Dell'Orto Trivelli, Chile	Keith Whitney, U.S.A.

The Permanent Committee accepted a tentative invitation from Dr. T. Ajibola Taylor to hold the next Working Conference on Stored-Product Entomology in Nigeria, in 1978.

On October 11 the Conference participants passed the following resolution, entitled "Preservation of Staple Food Stocks Following Production":

"This Conference, being cognizant of the urgent need for action to provide and preserve a food supply to all mankind, confirms the great importance of losses during storage and transportation—representing wastage of human endeavor, natural resources and energy—which could be greatly reduced by implementation of methods currently known in our applied science."

Organizers

U. E. Brady	P. T. M. Lum
J. H. Brower	H. O. Lund
E. G. Jay	M. A. Mullen
P. E. Hunter	Robert Davis, Chairman

Submitted by Robert Davis, Stored-Product Insects Research and Development Laboratory, ARS, USDA, 3401 Edwin Street, Savannah, Georgia 31403

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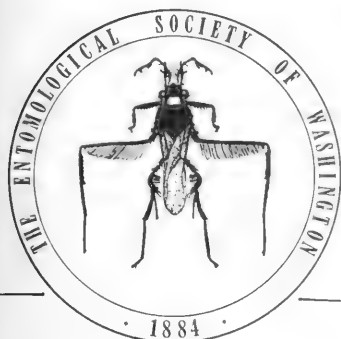
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SIXTEEN NEW NEOTROPICAL ANOBIIDAE WITH A NEW GENUS AND KEYS (COLEOPTERA)

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ABSTRACT—A new genus and 16 new species are described from Central and South America as follows: **Serranobium**, n. gen., S. **inerme**, *Ozognathus* **grossus**, *Euceratocerus* **argenteus**, *Priobium* **mexicanum**, P. **costaricense**, *Lasioderma* **badium**, L. **megalops**, L. **mexicanum**, L. **parvum**, *Stagetus* **convexus**, S. **minutus**, S. **paraguayensis**, S. **platyops**, *Striatheca* **rufescens**, *Neosothes* **abbreviatus**, N. **mexicanus**. Keys are presented for the American species of *Priobium*, *Stagetus*, and *Neosothes* and for the Central and South American species of *Lasioderma*.

Work on Central and South American Anobiidae recently sent to me has resulted in the following descriptions for a new genus and 16 new species.

Serranobium White, new genus

General: Body elongate cylindrical. Surface sculpture of fine, dense granulation. Pubescence very fine, short, appressed. Ground color brown.

Head: Eyes moderate in size, strongly bulging. Antenna 11 segmented, less than ½ as long as body, serrate from 3rd through 10th segments, last segment elongated. Last segments of maxillary and labial palpi triangular, each a little longer than wide.

Dorsal surface: Pronotum granulate throughout, vague elevations and depressions most distinct basally, with a complete, sharp lateral margin. Scutellum large, nearly quadrate, a little longer than wide. Elytra finely granulate throughout, lacking distinct striae, at side with weak striae.

Ventral surface: Prothorax excavated; prosternal length before coxae over ½ coxal diameter, prosternum slightly depressed medially; fore coxae moderately produced, separated by about ½ transverse coxal diameter; mesosternum short, flat; middle coxae separated by about ⅓ transverse coxal diameter; metasternum longitudinally grooved at center from before middle to apex; hind coxae separated, widest near middle. Abdomen granulate; first suture distinct throughout, produced posteriorly at middle, broadly V-shaped, 1st and 2nd segments nearly

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meeting in the same plane, remaining sutures distinct, straight, segments meeting in different planes; 1st segment longest, 2nd and 5th subequal, 3rd and 4th shortest and subequal.

This genus belongs in the subfamily Anobiinae and, among genera of this hemisphere, is most similar to *Colposternus* Fall, 1905, p. 190, but is readily distinguished by antennal, sternal, and abdominal characters. The antennae of *Serranobium* are strongly serrate with the width of each segment from 5 to 7 being greater than its length, and segments 9 and 10 distinctly serrate. The antennae of *Colposternus* are moderately to weakly serrate with the width of each segment from 5 to 7 not greater than its length and segments 9 and 10 feebly serrate. In *Colposternus* the pro- and mesosterna are conjointly depressed, and the middle coxae are separated by about the same distance as are the front coxae. The pro- and mesosterna of *Serranobium* are not conjointly depressed, and the middle coxae are much closer to one another than are the front coxae. Lastly, the 1st abdominal suture of *Colposternus* is nearly straight; that of *Serranobium* is broadly V-shaped.

I have examined specimens and descriptions of world genera of Anobiinae and find *Serranobium* most similar to the description of *Mimotrypopitys* Pic (1931, p. 6). Through the courtesy of F. Español I have examined the type of *Mimotrypopitys inaequalis* Pic (type-species by monotypy) and have found it not congeneric with *Serranobium*. In *Mimotrypopitys* the thorax is ventrally produced and hoodlike as in *Trypopitys*; in *Serranobium* the thorax is excavate ventrally much as in *Anobium* but is not hoodlike. In *Mimotrypopitys* the prosternum is reduced and strongly depressed, the fore coxae are separated and strongly produced, and the middle coxae are separated by about the coxal diameter; the antennae are received in the modified pro- and mesosterna. In *Serranobium* the prosternum is slightly depressed, the fore coxae are not strongly produced, and the middle coxae are narrowly separated. The dorsal surface of *Mimotrypopitys* is quite coarsely sculptured with elevations, depressions and coarse granules on pronotum, and tubercles, carinae, and coarse granules on elytra. In *Serranobium* there are vague depressions, elevations, and fine granules on pronotum, and very fine granules with no coarse sculpturing on elytra.

Serranobium is a neo-Latin name of neuter gender formed by combining anobium with serr- in reference to the serrate antennae.

Type-species: *Serranobium inerme*, new species.

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Serranobium inerme White, new species

fig. 14

</div>

General: Body nearly 2.6 times as long as wide; all body surfaces with small to minute granules; pubescence on all surfaces very short, completely appressed,

moderate in density, tan, with a slight sheen, hairs on elytra separated by less than length of a hair; ground color brown throughout.

Head: Eyes separated by 1.4 times vertical diameter of an eye; front nearly evenly convex, a little more rounded above antennal insertions, surface very finely, densely granulate; antenna with 1st segment long, arcuate, 2nd short, nearly oval, 3rd triangular, medially produced, width about ⅔ of length, 4th through 10th segments quite strongly serrate, process of 4th segment lateral, width of segment twice length, processes of following segments progressively more diagonal, shorter, segments 5 through 10 becoming a little longer, width of segment 8 about equal to length, segment 10 width a little less than length, 11th segment almost 4 times as long as wide; last segment of maxillary palpus triangular, nearly 2 times as long as wide, outer tip distinctly pointed, outer margin nearly straight; last segment of labial palpus subtriangular, a little longer than wide, distal angle less than a right angle, outer margin weakly, inwardly arcuate.

Dorsal surface: Pronotum with a medial, longitudinal ridge before base, with moderately distinct depression each side of elevation, surface with additional vague to very vague depressions, sculpture of small, fairly dense granulation on minutely granulate background. Elytron at base between humerus and suture with a vague longitudinal carina; disk with no evidence of striae, surface minutely, smoothly granulate throughout, with larger granules at base, at side with 2 traceable, weak, incomplete striae, a 3rd very weak stria above these.

Ventral surface: Metasternal surface finely granulate. Abdominal surface minutely granulate; 5th segment at apex somewhat produced. Tarsi about ⅔ to ¾ length of tibiae.

Length: 5.0 mm.

The holotype and only specimen (in CNC; female) bears the data "COLOM., 20km W Silvia, Cauca, VII. 15. 1970, 6,000' J. M. Campbell."

The specific name *inerme* means unarmed and refers to the smooth elytra that lack well-developed sculpturing and striae.

Ozognathus Leconte

Ozognathus Leconte, 1861, p. 205.

In attempting to identify members of *Ozognathus* sent to me, I have tried to apply names of described species with the following results.

The description of *Durangoum mexicanum* Pic (1903, p. 183) refers to densely punctate and non-striate elytra. This makes it likely that Pic correctly placed the species (*Durangoum* is a synonym of *Ozognathus*). I have seen a specimen of *Ozognathus* (a male bearing mandibular horns; in CNC) from W. Durango, Dgo., Mexico, that agrees fairly well with the color characters given by Pic. He describes the elytra as brown but with the suture and apex reddish, and the ventral surface as black. The specimen I have has the elytra brown, and the suture and apex orange, and the ventral surface dark brown, nearly black. The length is 2.0 mm, as compared with 2.6 mm for

mexicanus. I have labeled the specimen as possibly *mexicanus* (Pic). Madam A. Bons (Muséum National D'Histoire Naturelle, Paris) has not been able to find the type of *mexicanus* (Pic) and states in correspondence that it may have been destroyed.

I am unable to assign the Guatemalan *O. exiguus* (Gorham), 1883, p. 202, from its description. The size (1.0 to 1.5 mm) makes its minimum length less than that of any species of *Ozognathus* I have seen. The description below is for a species clearly distinct from described species.

Ozognathus grossus White, new species
fig. 13

General: Moderately elongate, body nearly 1.8 times as long as wide, elytral sides nearly parallel; ground color of dorsal surface black nearly throughout, margins of elytral apex and pronotum narrowly brown, ventral surface largely black, abdomen mostly brown medially, legs and antennae brown, club mostly dark brown; dorsal and ventral surfaces moderately shiny; pubescence grey, dense, with a feeble luster, that on dorsal surface semi-bristling; surfaces with very distinct punctation of 1 size.

Head: Punctation dense, distinct, punctures separated on an average by much less than a puncture diameter; front shallowly depressed near middle; eyes separated by 3 times vertical eye diameter; antennal length about ½ greater than pronotal length, antennal club nearly as long as all preceding segments united; (maxillary palpi missing); last segment of labial palpus about 1.5 times as long as wide, outer margin sinuate, outer angle bluntly pointed, inner angle broadly rounded.

Dorsal surface: Pronotum as wide as base of elytra; surface with dense, very distinct, coarse punctuation, at extreme side punctures separated on an average by ⅓ to ½ a puncture diameter; at middle before base with a short longitudinal, blunt carina; lateral margin distinct, evenly arcuate throughout. Elytra nonstriate; surfaces with distinct, dense, coarse punctation, on disk punctures separated on an average by a little less than diameter of a puncture, in addition to punctures, surfaces minutely irregular.

Ventral surface: Prosternal process between coxae wide, coxae separated by nearly ½ transverse coxal diameter; metasternum coarsely, densely punctate, anteriorly at side with punctures separated on an average by about ½ a puncture diameter, punctures smaller, sparser medially at apex. First abdominal suture clearly indicated laterally, at middle less distinct but traceable, 1st and 2nd segments meeting on same plane, remaining sutures quite strong throughout, segments meeting in different planes, with posterior margin of each segment overlapping following segment; abdomen densely punctate basally, less punctate apically, becoming finely granulate, 5th segment at middle with large granules in addition to fine granulation.

Length: 3.0 mm.

The holotype and only specimen (in CNC; female) bears the data "25 mi. E. El Salto, Dgo. MEX. VII.17 64, H. F. Howden."

This species can be distinguished from all other North American

members of the genus (*cornutus* Lec., *dubius* Fall, *floridanus* Lec., *exiguus* (Gorh.), and *mexicanus* Pic) by the following combination of characters: length 3.0 mm; pronotum as wide as base of elytra; ground color of dorsal surface black; and pubescence dense, grey, and semi-bristling. The length of the other species ranges from 1.2 to 2.8 mm; prothorax clearly narrower than elytral base to nearly as wide; ground color of dorsal surface light brown to medium brown at least in part, very infrequently black; and pubescence sparse to moderately dense, and orange, yellow or grey, and appressed.

Euceratocerus Lec.

Euceratocerus Leconte, 1874, p. 65.

The species following may deserve separate generic rank, but because the limits of *Euceratocerus* are not well known, it would be unwise to describe a new genus related to it. Contributing to the latter view are the characters of two species of *Euceratocerus* from South America (1 from Brazil, 1 from Paraguay) I have seen. Their elytra are vaguely carinate but not clearly striate as in described *Euceratocerus*; the 1st abdominal suture and the tarsi are typical for the genus. One or both of these species may have been named by Pic and placed in *Ptilinus* Müller, so I hesitate to describe them. Both species have the pronotal disk asperate; this could lead one who has examined them hastily to place them in *Ptilinus*.

Euceratocerus argenteus White, new species
fig. 15

General: Moderately elongate, body 2.6 times as long as wide, elytral sides nearly parallel; ground color of body and appendages orange brown clouded with brown, especially head and pronotum; dorsal surface weakly shiny, ventral surface slightly more shiny; pubescence light tan, moderately dense, appressed, obscuring surface, that on dorsal surface with numerous swirled to inclined patches, with a distinct sheen in bright light, surfaces appearing almost silvery, none-reflective pubescence at middle of pronotum making disk appear dark.

Head: With a very fine, dual system of granules; front evenly convex; vertex evidently not carinate (partially concealed); eyes of single specimen (male) separated by about 1.3 times vertical diameter of an eye. Antenna of male a little over ½ as long as body, segments 2 and 3 serrate, segments 4 through 8 pectinate, ramus of segment 5 about 2 times as long as segment, segments 6 through 8 similar, segments 9 and 10 more elongate than those preceding, ramus of segments 9 and 10 less than 2 times as long as segments, last segment about 5 times as long as wide. Last segment of maxillary palpus and labial palpus similar, elongate fusiform, each about 2.5 times as long as wide.

Dorsal surface: Pronotum as wide as base of elytra; lateral margin distinct, regular throughout, not serrate; surface of disk finely, densely granulate, at side granules smaller, less dense; surface at middle before base bluntly produced, surface at side broadly bulging. Elytra minutely granulate, surface weakly

undulate; not distinctly striate, at extreme side with feeble indication of punctures forming striae.

Ventral surface: Front and middle legs with outer margins concave, tarsi short, tibia about 1.7 times as long as tarsus. First abdominal suture posteriorly arcuate, as a consequence, 2nd segment 1.2 times as long at side as at middle.

Length: 6.0 mm.

The holotype and single specimen (CAS; male) bears the data "Venedio, Sinaloa, Mex. VI-16-1918; Van Dyke Collection."

This species differs from other described members of the genus (*hornii* Lec., *gibbifrons* White, *parvus* White, and *maculicollis* (Champ.)) in that the elytra lack distinct striae, the 1st abdominal suture is posteriorly arcuate, and the tarsi are short as compared with the length of the tibia.

The specific name refers to the nearly silvery appearance of the pubescence in bright light.

Priobium Motschulsky

Priobium Motschulsky, 1845, p. 35.

A specimen of *Priobium* in the USNM from 5 miles west of Portal, Arizona is possibly distinct from *punctatum* (Lec.), *sericeum* (Say), and the species described below. I have labeled the specimen as "*Priobium* evidently distinct from *sericeum* & *punctatum*." The abdominal sculpture is as that of *punctatum*, but the pubescence of the dorsal surface is about midway between the conditions in *punctatum* and *sericeum*, namely, the hairs are in part raised and arcuate, with the apices of each about parallel with the elytral surface. The pubescence of the dorsal surface of *punctatum* is clearly bristling in part; the pubescence of *sericeum* is almost completely appressed, with some hairs only a little elevated. Until a series of this form is available, its status remains uncertain.

Priobium mexicanum White, new species
fig. 2

General: Elongate-cylindrical, 2.5 times as long as wide, elytra vaguely widest behind middle; body and appendages red brown, pronotal sides and many body margins clouded with dark brown; pubescence dull yellow, with a slight sheen, moderately dense, not obscuring surface, mostly appressed, with some hairs arcuately raised.

Head: Surface with moderate-sized, smooth-topped granules, these separated on an average by about diameter of a granule, background finely granulate, weakly shiny; vertex very feebly, longitudinally grooved; with a distinct, broad groove adjacent to each eye; eyes separated by a little over 1.5 times vertical diameter of an eye. Antenna a little over 0.4 times as long as body, segments 2 through 8 serrate, last 3 segments a little longer than 4 preceding united. Last segment of maxillary palpus about 2 times as long as wide, bluntly pointed, basal margin

weaky arcuate, inner margin quite broadly arcuate, palpus widest at middle; last segment of labial palpus a little longer than wide, basal margin weakly arcuate, outer angle a little less than a right angle, outer margin nearly straight, diagonal, inner angle broadly arcuate.

Pronotum a little over 0.8 times as wide as elytra at base; disk with a weak, longitudinal groove anteriorly; entire surface with large, moderately dense granules on a finely granulate, weakly shiny background; lateral margin distinct at base only. Elytron with 10 distinct, complete striae of deep, nearly quadrate punctures, intervals nearly flat, finely granulate and scabrous, weakly shiny; elytral apex weakly truncate.

Ventral surface: Broad anterior depression of metasternum not clearly delimited posteriorly by a transverse carina; surface of metasternum confusedly, densely granulate, granules not clearly of 2 sizes. Abdomen weakly, longitudinally flattened at middle; sculpture of dual punctures, with large, ringlike punctures and small, pointlike punctures, larger punctures moderate in size and density, at middle separated by about diameter of a puncture, anterior portion of a large puncture weak or absent, surface at middle distinctly shiny.

Length: 5.4 mm.

The holotype and only specimen (in CNC; male) bears the data "3 mi. E.El Salto, Dgo.MEX.VII.12.64, H.F.Howden." For distinguishing characters see the key.

Priobium costaricense White, new species

General: Elongate-cylindrical, 2.6 times as long as wide, elytra slightly widest behind middle; body and appendages red brown throughout; pubescence dull yellow, with a slight sheen, moderate in density, not obscuring surface, mostly appressed, with some hairs bristling.

Head: Surface with moderate-sized, smooth-topped granules, these separated on an average by a little less than diameter of a granule, background obscurely, finely granulate, with a weak luster; vertex not grooved; with a distinct, broad groove adjacent to each eye; eyes separated by 1.7 times vertical diameter of an eye. Antenna nearly ½ as long as body, segments 2 through 8 serrate, last 3 segments a little longer than preceding 6 united. Last segment of maxillary palpus a little over 2 times as long as wide, tip distinctly pointed, basal margin nearly straight, inner margin broadly arcuate, widest at middle; last segment of labial palpus as wide as long, tip forming a right angle, outer margin nearly straight, inner margin very broadly arcuate.

Dorsal surface: Pronotum nearly 0.9 times as wide as elytral base; disk with a very weak longitudinal groove anteriorly; surface with large, moderately dense granules on a very finely granulate, weakly shiny background, at side large granules denser, each usually set in slight depression; lateral margin distinct at base only. Elytron with 10 distinct, complete striae of deep, nearly quadrate punctures, intervals nearly flat, very finely granulate, weakly shiny, elytral apex weakly truncate.

Ventral surface: Broad anterior depression of metasternum clearly delimited posteriorly by a short, transverse carina; surface of metasternum with large, smooth granules on a very finely granulate background. Abdomen at apex of 4th segment and base of 5th segment very weakly depressed; sculpture of dual punc-
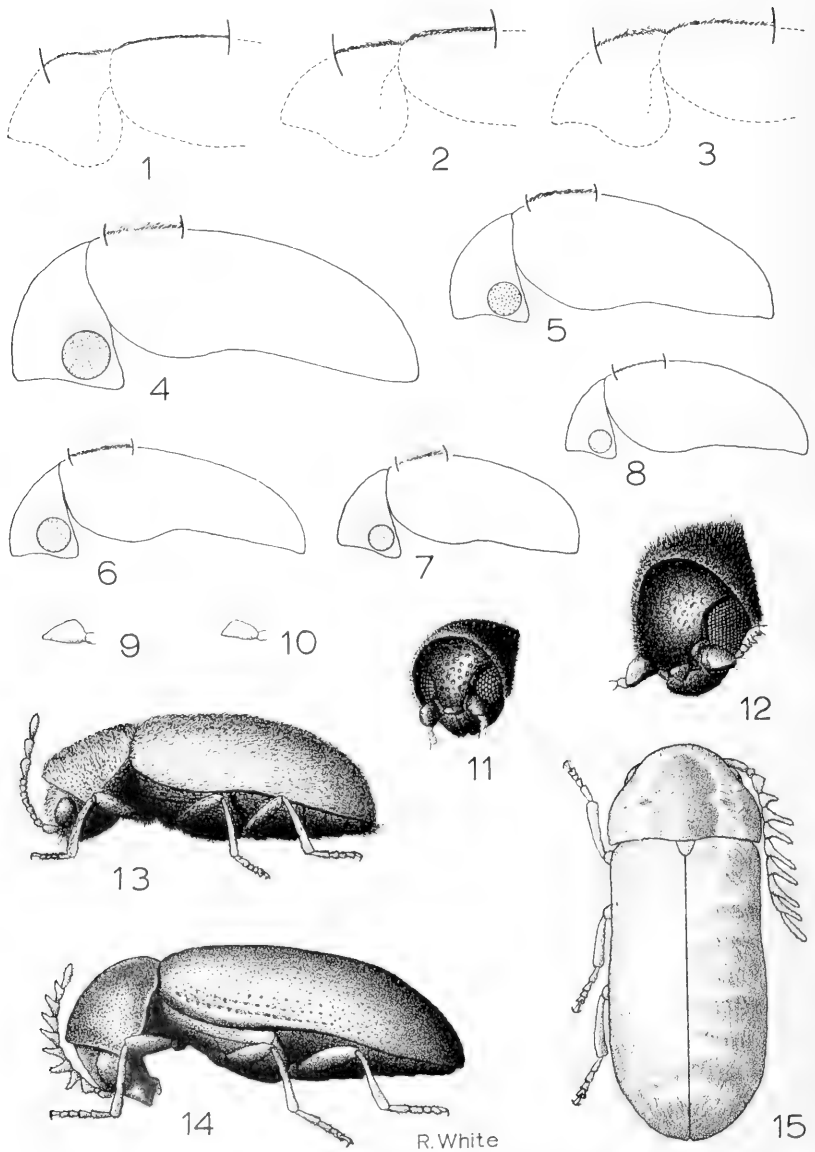
R. White

Fig. 1–3. *Priobium*, dorsal surface, partial, pubescence shown in circle segments. 1, *P. sericeum* (Say). 2, *P. mexicanum*, n. sp. 3, *P. punctatum* (Lec.). Fig. 4–8. *Lasioderma*, dorsal body in outline, punctures in circle, pubescence in circle segments. 4, *L. serricorne* (F.). 5, *L. badium*, n. sp. 6, *L. megalops*, n. sp. 7, *L. parvum*, n. sp. 8, *L. mexicanum*, n. sp. Fig. 9–10. *Stagetus*, last segment maxillary palpus. 9, *S. minutus*, n. sp. 10, *S. paraguayensis*, n. sp. Fig. 11–12. *Stagetus*, heads. 11, *S. paraguayensis*, n. sp. 12, *S. platyops*, n. sp. Fig. 13–15. Full views. 13, *Ozognathus grossus*, n. sp. 14, *Serranobium inerme*, n. sp. 15, *Euceratocerus argenteus*, n. sp.

tures, with large, ringlike punctures and small, pointlike punctures, larger punctures dense and distinctly impressed, at middle separated on an average by about ½ diameter of a puncture or a little less, surface shiny throughout except for densely granulate abdominal apex.

Length: 5.2 mm.

The holotype and only specimen (USNM no. 72662; male) bears the data "San Pedro, C.R., 28-VI-46, C. Sierra; in Quercus sp. 46-11326." Additional data from U. S. Dept. Agric. records are, "found alive in Quercus sp. logs." For diagnostic notes see the key.

Key to Central and North America Species of Priobium

1. Pubescence of dorsal surface erect in part (fig. 3); S. Dakota west to Arizona and California, also Costa Rica 2
— Pubescence of dorsal surface completely appressed (fig. 1) to arcuate in part (fig. 2); eastern North America west to Arizona, and Durango, Mexico 3

2(1). Large ring-shaped punctures at middle of abdomen dense and distinct, separated by no more than ½ diameter of a puncture; Costa Rica
.... *costaricense*, n. sp.
— Large ring-shaped punctures at middle of abdomen sparser, less distinct, separated on an average by no more than diameter of a puncture; S. Dakota west to California .... *punctatum* (Lec.)

3(1). Large ring-shaped punctures at middle of abdomen very large, distinct, center of punctures more shiny than surrounding surface; east U. S. to Arizona .... *sericeum* (Say)
— Large ring-shaped punctures at middle of abdomen smaller, weak, center of a puncture not more shiny than surrounding surface; Durango, Mexico .... *mexicanum*, n. sp.

Lasioderma Stephens

Lasioderma Stephens, 1835, p. 417.

Following are 4 new species of *Lasioderma*. In preparing the key to species I have not seen *L. puberulum* Gorham, from the Grenadines, West Indies. The species *L. dermestinum* Lec. actually belongs in *Neosothes* (paper in press) and is included in the key to *Neosothes* species.

Lasioderma badium White, new species
fig. 5

General: Body 1.6 times as long as wide, dorsal outline distinctly gibbous; pubescence fine, pale yellow to pale orange, nearly lusterless, much sparser but about as long, and bristling as in *serricorne*; body very dark red brown, some surfaces vaguely clouded with black, much darker than *serricorne*; dorsal surface about as shiny as that of *serricorne*; punctation of 1 size, punctures moderate in size.

Head: Eyes separated by 2.2 times vertical diameter of an eye; punctures of front large, separated on an average by less than diameter of a puncture, punctures much larger than those of *serricorne*; last segment of maxillary palpus a little over 2.0 times as long as wide, vaguely widest before apex, less elongate and tip less pointed than that of *serricorne*.

Dorsal surface: Pronotum with discal punctation moderate in size, punctures large, sparser than those of *serricorne*, surface at side shallowly concave front to back, punctures much larger than those of *serricorne*, separated on an average by about diameter of a puncture or a little more. Elytra with discal punctures much larger than those of *serricorne*, separated on an average by about diameter of a puncture or a little more.

Ventral surface: Metasternum with a strong, complete, arcuate carina bordering anterior declivity, at middle angulate and produced into a small tubercle, with a 2nd partial, moderately distinct carina each side behind anterior carina; surface punctate, at side punctate-granulate, granules not as distinct as those in *serricorne*; median process at apex distinctly notched; abdominal punctures larger than those of *serricorne*, at middle of 2nd segment with 9 to 11 punctures on a line from front to back (*serricorne* with 14 or 15).

Length: 1.9 to 2.1 mm.

The markedly similar holotype (USNM no. 72667; male) and paratype bear the data "Brasilien, Nova Teutonia, 27′11′B.52′23′L, Fritz Plaumann, 300–500m." In addition the holotype has "XII 1957" and the paratype has "XI 1957." The specific name refers to the red-brown color. For diagnostic characters see the key.

Lasioderma megalops White, new species

fig. 6

General: Body 1.6 times as long as wide; dorsal outline gibbous; pubescence fine, dull yellow, a little sparser than in *serricorne*, hairs but slightly raised, neither bristling nor closely appressed; body light orange brown, slightly darker than *serricorne*; dorsal surface slightly more shiny than that of *serricorne*; body punctation of 1 size, coarser than that of *serricorne*.

Head: Eyes large, separated by 1.2 times vertical diameter of an eye; punctures of front much larger than those of *serricorne*, fairly dense, separated on an average by a little less than diameter of a puncture; last segment of maxillary palpus broader, apex less pointed than that of *serricorne*, a little less than 2 times as long as wide, broadest before apex.

Dorsal surface: Pronotum with discal punctures clearly larger than those of *serricorne*, separated on an average by between 1 and 2 times diameter of a puncture, at side punctures larger, less dense than these in *serricorne*, separated on an average by about diameter of a puncture, surface at side shallowly concave front to back. Elytra with discal punctation a little larger and sparser than that of *serricorne*, punctures separated on an average by a little more than diameter of a puncture.

Ventral surface: Metasternum with a strong, complete, arcuate carina bordering anterior declivity, with a 2nd, distinct, partial carina each side behind anterior carina, (median metasternal process concealed); abdominal punctures

larger, sparser than those of *serricorne*, at middle of 2nd segment with about 6 punctures from front to back (*serricorne* with 14 or 15).

Length: 2.0 mm.

The holotype and only specimen (USNM type no. 72666; male) bears the data "Brasilien, Rondon, 24'38'B.54'07' L, Fritz Plaumann, X.1962, 500m."

The specific name refers to the large eyes. For diagnostic notes see the key.

Lasioderma mexicanum White, new species
fig. 8

General: Body nearly 1.8 times as long as wide; dorsal outline convex; pubescence very fine, weak orange yellow, much sparser than in *serricorne*, on dorsal surface entirely appressed; color orange brown, much as in *serricorne*; dorsal surface more shiny than that of *serricorne*; body punctation fine, of 1 size.

Head: Eyes separated by slightly over 3.0 times vertical diameter of an eye; punctures of front separated on an average by about 2 times diameter of a puncture, sparser than in *serricorne*; last segment of maxillary palpus more elongate, apex more pointed than that of *serricorne*, about 2.6 times as long as wide.

Dorsal surface: Pronotum with discal punctation fine, punctures larger, sparser than those of *serricorne*, punctation at extreme side about size of these in *serricorne* but sparser, punctures separated on an average by about diameter of a puncture (versus ½ in *serricorne*); surface at side clearly concave front to back. Elytron with discal punctation similar to but slightly sparser than that of *serricorne*, punctures separated on an average by nearly 2 times diameter of a puncture.

Ventral surface: Metasternum with a strong, complete, arcuate carina bordering anterior declivity, lacking a 2nd carina, surface punctate, not punctate-granulate as in *serricorne*, median process at apex distinctly notched; abdominal punctation larger, less dense than that of *serricorne*, at middle of 2nd segment with 7 or 8 punctures on a line front to back (*serricorne* with about 14 or 15).

Length: 1.8 mm.

The holotype and only specimen (in CNC; female) bears the data "15 mi. W. El Palmito, Sin. Mex. VII. 29. 64, H. F. Howden."

This species is most readily distinguished from *serricorne* by the pubescence of the dorsal surface being entirely recumbent; that of *serricorne* is semi-erect in part. Also, this species is 1.8 mm long, and *serricorne* is 1.8 to 3.0 mm long; very few of the latter are as small as the minimum length. The body shapes in lateral view of the 2 species differ; in *mexicanum* the body is more convex and is highest at about the middle of the body, whereas in *serricorne*, the body is less convex, and is highest above the humeri.

Comparing *mexicanum* with other North American species shows *L. falli* Pic to be most similar in size and many other characters, but it differs in color; it has the elytra and metasternum dark red brown, and the remainder dull red brown. Also, the eyes of the type of *falli* are separated by 4.0 times the vertical diameter of an eye. The color

of *mexicanum* is pale red brown throughout, and the eyes are separated by a little over 3.0 times the vertical diameter of an eye.

Lasioderma parvum White, new species

fig. 7

General: Body 1.56 times as long as wide; dorsal outline convex; pubescence coarse, dull yellow, sparser but longer and more bristling than in *serricorne*, in part slightly bristling, in part distinctly bristling; color orange brown more or less clouded with brown, darker than *serricorne*; dorsal surface slightly more shiny than that of *serricorne*; punctation of 1 size, coarser than that of *serricorne*.

Head: Eyes separated by a little over 2.0 times vertical diameter of an eye; punctures of front larger, less dense than those of *serricorne*, somewhat variable in size and density; last segment of maxillary palpus less elongate, tip less pointed than that of *serricorne*, nearly parallel-sided medially, about 2.0 times as long as wide.

Dorsal surface: Pronotum with discal punctures larger, less dense than those of *serricorne*, punctures separated by a little more than diameter of a puncture, at extreme side punctures distinctly larger than those of *serricorne*, separated on an average by less than diameter of a puncture, surface at side shallowly concave front to back. Elytra with discal punctation much larger than that of *serricorne*, punctures separated on an average by a little more than diameter of a puncture.

Ventral surface: Metasternum with a strong, complete, arcuate carina bordering anterior declivity, slightly undulate at middle, with a 2nd partial, distinct, even carina on each side behind anterior carina; surface punctate, not granulate as in *serricorne*, median process at apex not notched; abdominal punctation larger than that of *serricorne*, at middle of 2nd segment with about 9 punctures on a line from front to back (*serricorne* with 14 or 15).

Length: 1.7 mm.

Described from 2 nearly identical specimens with the data "Brasilien Rondon, 24′38′B.54′07′ L, Fritz Plaumann, X. 1962, 500 m." Both the holotype (no. 72665; female) and a paratype are in the USNM. The specific name refers to the small size.

KEY TO CENTRAL AND SOUTH AMERICAN SPECIES OF LASIODERMA

1.   Metasternum with 2 transverse carinae, 1st complete, 2nd present only
        at sides, absent medially; Brasil 2
—   Metasternum with 1 complete transverse carina, lacking a 2nd; various
        localities 4
2(1).   Color very dark red brown clouded with black; pubescence weakly
        bristling, fig. 5 .... *badium*, n. sp.
—   Color light orange brown to orange brown; pubescence either appressed
        or distinctly bristling 3
3(2).   Pubescence distinctly bristling, fig. 7; length 1.7 mm .... *parvum*, n. sp.
—   Pubescence appressed, fig. 6; length 2.0 mm .... *megalops*, n. sp.
4(1).   Pubescence bristling in part; pronotal punctation denser; body in out-
        line not convex, fig. 4; cosmopolitan .... *serricorne* (F.)

— Pubescence not bristling; pronotal punctation sparser; body in outline convex, fig. 8; Mexico .... *mexicanum*, n. sp.

Stagetus Wollaston

Stagetus Wollaston, 1861, p. 1.

The species of *Stagetus* are markedly similar in morphology. For the generic description below I present primarily those characters that are nearly or quite unvarying among species; this allows me to present for the species descriptions only those characters which vary among the species.

General: Body elongate robust, 1.9 to 2.0 times as long as wide, elytra widest near middle; pubescence grey to dull yellow, moderately dense, not or slightly obscuring surface sculpture, partly appressed, partly bristling; body color red brown to brown to nearly black.

Head: Surface punctate; strongly convex between eyes, grooved adjacent to eyes; eyes small to large; antenna of 11 segments, funicle (segments 3 through 8) of short, similar segments, with either medial segments widened or apical segments widened, segments 9, 10, and 11 elongated and enlarged, about as long as all preceding united; last segments of maxillary and labial palpi more or less distinctly triangular, that of former more elongate than that of latter.

Dorsal surface: Pronotum from dorsal view with sides moderately to quite distinctly tapering anteriorly, surface at side from front to back concave to distinctly concave; punctation on disk dual; lateral margin complete, distinct, sharp, produced, explanate, surface beneath lateral margin visible in retraction; sculpture at side usually of dual punctation. Scutellum small, distinct, a little longer than wide. Elytron with 10 distinct, regular, complete, quite strongly impressed striae; intervals at side convex, on disk more or less flat, surface often transversely wrinkled, usually punctate; humerus distinct; at side not indented for hind femur.

Ventral surface: Pro- and mesocoxae visible in repose, separated by an elongated, nearly cross-shaped mesosternal process; metasternum deeply, longitudinally grooved at middle, groove very deep anteriorly, surface of metasternum punctate; metepisternum very narrow. Abdomen with 1st segment short, largely concealed during retraction by hind legs, sutures distinct throughout, straight to weakly sinuate; surface punctate.

Length: 1.7 to 2.6 mm.

Below, alphabetically arranged, are 4 descriptions of new species followed by a key to American *Stagetus* species. Following the latter is discussion of a species name I have been unable to assign.

Stagetus convexus White, new species

General: Pubescence grey, bristling hairs of dorsal surface short, length of each hair about equal to width of a discal interval; body color brown, pronotum clouded with dark brown, margins often dark brown.

Head: Punctation dual, larger punctures distinct, deep, separated on an average by less than diameter of a puncture, small punctures obscure; eyes large, bulging, separated by about 1.6 times vertical eye diameter, anterolateral on head;

antennal funicle widest at 5th segment, latter about 2 times as long as wide, 4th and 6th segments widened to a lesser extent. Last segment of maxillary palpus nearly 1.5 times as long as wide, widest at middle.

Dorsal surface: Pronotum with larger punctures on disk distinct, separated on an average by less than diameter of a puncture, small punctures obscure, large punctures at side very large, dense, irregular in size, separated on an average by much less than diameter of a puncture, smaller punctures very obscure. Elytra with intervals at side convex, on disk nearly flat; surface obscurely granulate-punctate, not or vaguely transversely wrinkled.

Ventral surface: Metasternum with obscure dual punctation, large punctures anteriorly at side distinct, dense, separated on an average by much less than diameter of a puncture, small punctures obscure and sparse. Abdominal segments quite strongly convex front to back; punctation dual, at middle of 3rd segment large punctures distinct, separated on an average by a little less than diameter of a puncture.

Length: 2.3 mm.

The holotype (in CNC; male) bears the data "MEX., 19 mi.S. Matias Romero, Oax., VI-24-1969, D. Bright & J. M. Campbell."

The very strongly convex abdominal segments are distinctive for this species.

<div align="center">

Stagetus minutus White, new species

fig. 9
</div>

General: Pubescence dull yellow, bristling hairs of dorsal surface long, 1 hair about 1.5 times as long as width of a discal interval; body color dull red brown, surfaces, except abdomen, vaguely clouded with brown.

Head: Punctation dual, larger punctures quite distinct, varying in size, dense, separated on an average by less than diameter of a puncture, small punctation obscure; eyes large, bulging, anterolateral, separated by about 1.5 times vertical diameter of an eye; antennal funicle widest at 5th segment, latter about 2 times as wide as long, 4th and 6th segments widened to a lesser extent. Last segment of maxillary palpus about 1.5 times as long as wide, widest before middle.

Dorsal surface: Pronotum with large punctures on disk separated on an average by about 1.5 times a puncture diameter, these at side very large, dense, confused before base and above lateral margin, smaller near anterior margin, small punctures obscure. Elytra with intervals at side convex, those on disk weakly so, intervals weakly, transversely wrinkled and obscurely punctate.

Ventral surface: Metasternum with dual punctation, anteriorly at side with large, distinct, dense punctures, separated on an average by less than diameter of a puncture, smaller punctures very obscure. Abdominal segments weakly convex front to back; punctation dual, that at middle of 3rd segment with large punctures distinct, separated on an average by a little less than diameter of a puncture.

Length: 1.7 to 1.8 mm.

The holotype (USNM no. 72663; female) bears the data "Pedro Miguel, CZ Pan 17. 4.11; EASchwarz Collector;" the single paratype (also in USNM; a female) has the data "La Campana, Pan. vii–xi '38, JZetek 4278."

For diagnostic characters of this species see the key.

In the USNM is a single specimen from Kerrville, Texas, that I feel is distinct from *minutus*, but the differences are minor and subtle and I am unable to find a good character to distinguish the 2. It is possible that the Kerrville specimen agrees with the specimen referred to by Fall (1905, p. 224) in his revision of the Anobiidae. He felt that his specimen was distinct from S. *profundus* Lec. but was unwilling to describe it without seeing more than 1. The specimen I have is clearly distinct from *profundus*; the large punctures at the side of the pronotum in my specimen are circular, not decidedly crescent shaped as these are in *profundus*. I have labeled the Kerrville specimen as "Stageus sp. nr. minutus White."

<center>*Stagetus paraguayensis* White, new species</center>
<center>figs. 10, 11</center>

General: Pubescence grey, bristling hairs of dorsal surface long, a hair about 1.5 times as long as width of a discal interval; body dark brown, pronotum, head, and ventral surface vaguely clouded with red brown.

Head: Punctation dual, larger punctures quite distinct, varying in size, moderately dense, separated on an average by about a puncture diameter, small punctures distinct; eyes large, separated by about 1.5 times vertical diameter of an eye, eyes anterolateral on head; antennal funicle widest at 5th segment, latter about 2 times as wide as long, 4th and 6th segments widened to a lesser extent. Last segment of maxillary palpus about 2.0 times as long as wide, widest beyond middle.

Dorsal surface: Pronotum with larger punctures on disk separated on an average by about diameter of a puncture, at side larger punctures very large, dense, separated on an average by less than diameter of a puncture, smaller near anterior margin, small punctures obscure. Elytra with intervals at side convex, those on disk less distinctly so, intervals weakly, transversely wrinkled and indistinctly punctate.

Ventral surface: Metasternum with dual punctation, anteriorly at side with large, distinct, dense punctures, separated on an average by less than diameter of a puncture, smaller punctures very indistinct. Abdominal segments nearly flat front to back; punctation dual, that at middle of 3rd segment with large punctures distinct, separated on an average by a little less than diameter of a puncture.

Length: 1.8 mm.

The holotype (USNM no. 72664; female) bears the data "Paraguay, San Lorenzo, 8.IX.954, Daguerre; ARGENTINA, 1968 Colln. J. Daguerre." The 1st locality is the area of collection, the 2nd locality is part of a misleading U. S. National Museum label.

For distinguishing characters see the key.

<center>*Stagetus platyops* White, new species</center>
<center>fig. 12</center>

General: Pubescence grey with a weak yellow luster, bristling hairs of dorsal surface long, a hair about 1.5 times as long as width of a discal interval; body color dark brown, head, pronotum and metasternum nearly black.

Head: Punctation dual, larger punctures large, dense, very shallow, separated on an average by less than diameter of a puncture, small punctures distinct; vertex very shallowly, longitudinally depressed; eyes lateral on head, nearly flat, separated by about 2.0 times vertical diameter of an eye; antennal funicle widest at 5th segment, latter about 2 times as wide as long, 4th and 6th segments widened to a lesser extent. Last segment of maxillary palpus about 1.5 times as long as wide, widest just beyond middle.

Dorsal surface: Pronotum with larger punctures on disk separated on an average by a little less than diameter of a puncture, large punctures at side large, dense, irregular in size, separated on an average by less than diameter of a puncture, small punctures indistinct; anterior margin somewhat inflated, punctation there very distinct, dense, varying in size, not clearly dual. Elytra with intervals at side convex, those in disk flat; intervals obscurely, transversely wrinkled and obscurely punctate.

Ventral surface: Metasternum with dual punctation, anteriorly at side with large, distinct, dense punctures, separated on an average by less than diameter of a puncture, smaller punctures very obscure. Abdominal segments nearly flat front to back; punctation dual, that at middle of 3rd segment with large punctures distinct, separated on an average by a little less than diameter of a puncture.

Length: 2.6 mm.

The holotype (in CNC; female) bears the data "BRAZIL, DF, 1000m, Parque Nacional, III-11-1970, JM & BA Campbell."

The flattened eyes located laterally on the head distinguish this species from described American species.

KEY TO AMERICAN SPECIES OF STAGETUS

1.   Each abdominal segment distinctly convex front to back, appearing inflated; Mexico .... *convexus*, n. sp.
—   Abdominal segments not distinctly convex, nearly flat front to back; various localities 2
2(1).   Punctures at side of pronotum crescent shaped, with puncture rim nearest anterior margin of pronotum obsolete; U. S. .... *profundus* Lec.
—   Punctures at side of pronotum not as above; various localities 3
3(2).   Eyes lateral on head and nearly flat (fig. 9); Brazil .... *platyops*, n. sp.
—   Eyes anterolateral on head and strongly convex (fig. 8); various localities 4
4(3).   Last segment of maxillary palpus about 2 times as long as wide, widest beyond middle (fig. 7); Paraguay .... *paraguayensis*, n. sp.
—   Last segment of maxillary palpus about 1.5 times as long as wide, widest before middle (fig. 8); Panama .... *minutus*, n. sp.

INCERTAE SEDIS

I have examined the brief description of *Stagetus weiseri* (Pic) (1926, p. 1). The name cannot be assigned to a species on the basis of the description alone; however, mention of the thorax being greatly attenuate in front and the elytra strongly striate punctate is an indication that Pic was probably correct in his generic placement. Of the

preceding species, *paraguayensis* is the only one that could be identical with *weiseri*. Madam A. Bons (Muséum National d'Histoire Naturelle, Paris) is unable to locate the type of *weiseri* and feels that it may be lost.

Striatheca White

Striatheca White, 1973, p. 48.

Following is the 2nd species to be described in this genus.

Striatheca rufescens White, new species

General: Body 1.8 times as long as wide; elytral sides subparallel at basal ⅔. Pubescence dull yellow, sparse, bristling throughout, moderate in length, hairs separated by less than a hair length, hairs adjacent to elytral striae directed backward, others more or less irregular in direction. Body color dull dark orange red, pronotum slightly darker than rest.

Head: Front nearly evenly convex throughout; with a weak groove over eye; surface shiny, at middle with large punctures, these irregular in size, shape, and density, also with minute punctures, near eyes with smooth granules; eyes separated by 1.4 times vertical eye diameter. Antenna of 11 segments, segments 9 and 10 about as wide as long, 11th segment about 2 times as long as wide. Last segment of maxillary palpus subtriangular, about 2 times as long as wide, tip pointed, (labial palpus not seen).

Dorsal surface: Pronotum in lateral view nearly evenly convex throughout; disk densely, roughly punctate, punctures variable in size and shape, at side surface scabrous, shiny. Each elytron with 10 distinctly impressed, complete striae, plus a short scutellar and a short subhumeral stria, following striae uniting at apex, 1 and 10, 2 and 9, 3 and 4, 5 and 6, 7 and 8, intervals shiny, with transverse wrinkles and minute, sparse granules.

Ventral surface: Metasternum broadly, longitudinally grooved at middle, surface coarsely scabrous; with a slight depression anteriorly midway between middle and side. Abdominal sutures 2 and 3 more or less bisinuate, suture 4 arcuate; surface shiny, obscurely, sparsely punctate-granulate; 5th segment nearly flat front to back.

Length: 2.3 mm.

The holotype and only specimen (in CNC; male) bears the data "5 mi. N. Mazatlan, Sin. MEX. VII.24–29, 1964 H.F.Howden."

This species is very similar in most characters to S. *lineata* White, the only other member of the genus. The differences are as follows. The body color of *rufescens* is nearly uniformly dull orange red throughout with the pronotum and the extreme elytral apex slightly darker. The head and ventral surface of *lineata* are primarily dull orange red; both the head and the base of the abdomen are vaguely clouded with black. The pronotum of *lineata* is nearly black but with the margins infused with dull red; the elytra are black with the margins (especially near the apex) infused with dull red. Also the hairs of the elytral striae in *lineata* criss-cross over the intervals, whereas

those of *rufescens* are inclined backward or are irregular in direction. *Striatheca lineata* is known from Mississippi, Georgia, and Florida.

Neosothes White

Neosothes White, 1967, p. 43.

The following 2 new species bring the number of species in this genus to 5.

Neosothes abbreviatus White, new species

General: Body a little over 1.8 times as long as wide; pubescence very fine, dull yellow, with a luster in bright light; elytra brown, apex and sides red brown, remainder of body red brown and more or less clouded with brown; punctures of dorsal surface fine and dense, obscurely dual; pronotum and elytra shiny.

Head: Eyes separated by 2.0 times vertical diameter of an eye; last segment of maxillary palpus 1.5 times as long as wide, outer margin distinctly notched; last segment of labial palpus a little longer than wide, outer margin inwardly arcuate.

Dorsal surface: Pronotum at side nearly flat front to back; small punctures at side fine, dense, varying in distinctness, larger punctures obscure to very obscure; small punctures of elytra fine, dense, larger punctures fairly distinct, approaching size of small punctures.

Ventral surface: Metasternum finely, densely punctate, punctation obscurely dual, larger and smaller punctures intergrading in size; longitudinal groove at base bordered each side by a fine, sharp carina, carina obsolete beyond middle of metasternum, at base continuous with transverse carina which delimits inflexed portion, groove at base separated from inflexed portion by a fine, distinct, transverse carina, this continuous with transverse carina of each side of metasternum; metasternum apically at center terminating in a forked process attaining posterior limit of coxae; 1st abdominal suture nearly obsolete at center, more distinct at sides, other sutures strong throughout.

Length: 1.9 to 2.1 mm.

The holotype (in CNC; female) bears the data "JAMAICA, Try. Duncans, VIII. 19. 1966, Howden & Becker;" the two paratypes bear essentially the same data, except 1 was taken on August 8 (in CNC) and the other on August 14 (in USNM).

Diagnostic characters are presented in the key.

Neosothes mexicanus White, new species

General: Body nearly 1.8 times as long as wide; pubescence very fine, dull yellow, with a luster in bright light; metasternum brown, remainder of body red brown and more or less clouded with brown; punctures of dorsal surface fine, dense, very obscurely dual, pronotum and elytra shiny.

Head: Eyes separated by 1.8 to 1.9 times vertical diameter of an eye; last segment of maxillary palpus 1.5 times as long as wide, outer margin weakly, inwardly arcuate; last segment of labial palpus slightly longer than wide, outer margin distinctly inwardly arcuate.

Dorsal surface: Pronotum at side nearly flat front to back; small punctures at

side fine, dense, varying in distinctness, larger puncture obscure to very obscure; small punctures of elytra very fine, dense, larger punctures obscure to obsolete, more or less intergrading in size with small punctures.

Ventral surface: Metasternum finely, densely punctate, punctation obscurely dual; longitudinal groove at center bordered each side by sharp carina, latter distinct to apical metasternal process, and anteriorly continuous with carina which delimits inflexed portion, groove at base separated from inflexed portion by a fine, distinct transverse carina, this not continuous with transverse carina of each side of metasternum; metasternum apically at center terminating in a forked process attaining posterior limit of coxae; 1st abdominal suture weak at center, more distinct at sides, other sutures quite strong throughout.

Length: 2.2 to 2.3 mm.

The holotype (in CNC; female) bears the data "5 mi. N. Mazatlan, Sin. MEX. VII.24–29 1964 H. F. Howden"; the single paratype (in USNM) has the data "5 mi. N. Mazatlan, Sin. MEX. VII. 24. 64, H. F. Howden."

Diagnostic characters are given in the key.

I have recently transferred *Lasioderma dermestinum* Lec. to *Neosothes* and synonymized *N. bicarinatus* White with it (in press).

KEY TO SPECIES OF NEOSOTHES

1. Median longitudinal groove of metasternum with lateral margins evenly rounded, not carinate; Baja California .... *testaceus* White
—   Median longitudinal groove of metasternum with lateral margins carinate; various localities 2
2(1). Metasternal carinae distinct only at basal ⅓ to ½; Jamaica .... *abbreviatus*, n. sp.
—   Metasternal carinae distinct past middle of metasternum, usually attaining apex; various localities 3
3(2). Pronotum feebly shiny, less shiny than elytra; Cuba .... *granulatus* White
—   Pronotum as shiny as elytra; Mexico and Baja, California 4
4(3). Body 1.9 to 2.1 times as long as wide; metasternal carinae weak before metasternal apex; Baja California .... *dermestinus* (Lec.)
—   Body nearly 1.8 times as long as wide; metasternal carinae strong before metasternal apex; Sinaloa, Mexico .... *mexicanus*, n. sp.

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REVIEW OF THE GENUS SCHILDIA ALDRICH
(DIPTERA: LEPTOGASTRIDAE)

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ABSTRACT—Four new species in the unique genus *Schildia* Aldrich, S. **ocellata,** S. **guatemalae,** S. **alphus,** and S. **zonae,** extend the range of the genus from Costa Rica, Jamaica, and Brazil to Guatemala, Panama, and Peru.

Types of the new species described below are deposited in the U.S. National Museum (USNM), University of São Paulo (USP), and the Entomological Collections of the University of Utah (UUEM).

Genus *Schildia* Aldrich

Schildia Aldrich, 1923:4. Type-species, *microthorax* Aldrich (orig. desig.). Type, USNM. Type-locality: Costa Rica, San Mateo, Higuita.
Schildia: Hull, 1962:313.
Shannomyioleptus Carrera, 1944:87. Type-species, *fragilis* Carrera (orig. desig.). Type, USP. Type-locality: Brazil, Mato Grosso, Maracaju.
Schildia (*Shannomyioleptus*): Hull, 1962:314. Subgenus of *Schildia*.
Shannomyioleptus: Martin, 1965:11. Synonym of *Schildia*.

Generic characters. Aldrich's characters: Outer tarsal claw longer than inner claw; mesothorax cone-like apically, overhanging the pronotum; part or all the wing veins hairy dorsally.

The hair on the wing veins long and evenly spaced; patches of microchaetae in most cells. The end of longitudinal vein 3 (R_1) either in or below the apex of the wing. Antennal segment 3 more or less spatulate apically, style short to ¼ as long as segment 3; 4 long dorsocentral bristles. Halteres shorter than thorax. Abdominal segment 2 about twice as long as segment 3, very narrow, slightly flared posteriorly. Hind femora clavate, slightly longer than tibia; empodia either very short or lacking.

Leptogaster ferruginea Walker and *L. multicincta* Walker from Brazil have hairy wing veins, but the hair is closer set than in *Schildia*. The 2 species also lack other *Schildia* characteristics.

KEY TO THE SPECIES OF SCHILDIA ALDRICH

1. Thorax laterally with reddish maculae circled by dark reddish-brown rings, anteriorly median stripe outlined by yellowish spots (Brazil) .... *ocellata* Martin, new species
— Thorax without maculae and rings on dorsum 2
2. Anterior humeri yellowish or brownish 5
— Anterior humeri white 3

3. Anterior humeri and posterior pronotum white, dorsal areas mesad to
    humeri white to transparent, anteriorly dark median stripe outlined by
    reddish spots, posteriorly by narrow yellowish lines (Jamaica) ---------------
    -- *jamaicensis* Farr
—   Anterior humeri white, dorsal areas mesad to them reddish brown ----------- 4
4. View behind, occiput brownish black, grayish tomentose stripe from front
    to collar, expanded on upper angles of occiput, occipital bristles yellowish
    (Guatemala) --- *guatemalae* Martin, new species
—   View behind, occiput brownish, white tomentose stripe from front to
    collar, not expanded on upper occiput, gray to brownish-gray tomentose
    stripe around eye, occipital bristles brown (Brazil) ---------------------------------
    --- *alphus* Martin, new species
5. Median thoracic stripes extending on posterior declivity; pleura yellowish
    from spiracle 1 to halteres, below brown (Costa Rica; Panama; Peru) ----
    -- *microthorax* Aldrich
—   Posterior ⅔ or more of thorax without stripes -- 6
6. Face yellowish, front white to yellow, vertex yellow, occiput and pleura
    brown tomentose (w. cen. Brazil) ----------------------------------- *fragilis* (Carrera)
—   Face, front, vertex, gray --- 7
7. Abdominal segment 2 pale reddish-yellow brown, anterior and posterior
    margins blackish brown; pleura black, brown tomentose, above coxa 1
    and 3 white tomentose (Panama) ---------------------- *zonae* Martin, new species
—   Abdominal segment 2 reddish brown with a median yellow band; pleura
    red, thinly white tomentose, with a dark brown stripe from middle coxa
    to wing base (Pará, Brazil) --- *gracillima* Walker

Schildia alphus Martin, new species

Schildia alphus and S. *guatemalae* are closely related species. The
densely gray stripe from front to collar of S. *alphus* does not encroach
on the upper angles of the occiput but does encroach on S. *guatemalae*.

Female: Length 9 mm. Head black; face, front, vertex, and stripe to collar,
gray; from a rear view, occiput blackish brown, a gray to grayish-brown stripe
beginning at the first occipital bristles and extending completely around eye mar-
gin; antennae yellow, segment 3 brown on apical ⅔, 2 whitish mystax bristles,
occipital bristles long, brown, sparse.

Thorax slightly longer than wide; reddish-brown, anterior mid-stripe with pale
stripes beside it, posterior ⅔ without stripes, anterior humeri white, anterior and
posterior pronotum white tomentose, scutellum reddish, brown pollinose, no mar-
ginal bristles; pleura reddish, brownish yellow tomentose medially, above coxa
1 to wing base broadly grayish tomentose.

Abdomen reddish brown, tergite 2 dark reddish on anterior and on posterior
margins, yellow-banded medially, tergites 3 and 4 narrowly yellow-banded on
anterior margins, tergites 6 and 7 blackish.

Wings hyaline.

Hind femora reddish brown, yellow band on base of clavus, hind tibia reddish
brown, yellow band medially, middle femora yellow with 2 reddish bands, tiba
yellow with 3 reddish brown bands.

Male: Unknown.

Type-material: Holotype, female, Sit. B. Vista, Cascavel, Ceará, Brazil, December 1940 (O. C. Alves) (USP). Paratype, Cascavel, Ceará, Brazil, December 1940 (Shannon and Alves).

Schildia guatemalae Martin, new species

Schildia guatemalae closely resembles S. *alphus*. Depending on the angle of view, the occiput of S. *guatemalae* is more or less extensively gray pollinose.

Male: Length 11 mm. Head black; face, front, and stripe from ocellar tubercle to collar, white, behind ocellar tubercle white tomentum expanding on upper occipital angles, occiput blackish brown tomentose, at some angles of view upper occiput white tomentose; antennae yellowish, apical ⅔ of segment 3 brown; mystax of 2 yellowish bristles; upper occipital bristles long, sparse, pale yellowish.

Thorax dark reddish brown, on anterior ⅓ yellow stripes outlining median stripe, anterior humeri white, anterior and posterior pronotum white tomentose; scutellum dark brown, brown tomentose, no marginal bristles; pleura dark reddish, white tomentose above and anteriorly, brown tomentose below.

Wings hyaline.

Hind femora dark reddish brown, yellow band on base of clavus, hind tibia dark reddish brown with median yellow band.

Type-material: Holotype, male, Guazacápan, Guatemala, August 1952 (R. H. Painter) (USNM).

Schildia fragilis (Carrera)

Shannomyioleptus fragilis Carrera, 1944:87. Type, University of São Paulo. Type-locality: Brazil, Mato Grosso, Maracaju.
Schildia (*Schannomyioleptus*) *fragilis*; Hull, 1962:314.
Schildia fragilis; Martin, 1965:116.

Schildia gracillima (Walker)

Leptogaster gracillimus Walker, 1855:722. Type, British Museum (Natural History). Type-locality: Brazil, Pará (Belem).
Leptogaster gracillimus; Hull, 1962:299.
Schildia gracillimus; Martin, 1965:116.

Schildia jamaicensis Farr

Schildia jamaicensis Farr, 1962:191. Type, USNM. Type-locality: Jamaica, St. Andrew, Long Mountain.

Schildia microthorax Aldrich

Schildia microthorax Aldrich, 1923:4. Type, USNM. Type-locality: Costa Rica, San Mateo, Huiguita.

Schildia microthorax Aldrich is the only species of the genus with a median stripe, outlined by yellow stripes, extending on the posterior declivity but not reaching the scutellum. Comparison of specimens from Panama and Peru do not reveal any marked differences.

Distribution: Panama, Canal Zone, Barro Colorado Island, May 18–23, 1967 (Rodger D. Akre). Peru, Tingo Maria, December 23, 1957 (Schlinger and Ross).

Schildia ocellata Martin, new species

Schildia ocellata is the only species of *Schildia* with lateral thoracic yellowish-brown maculae encircled by darker reddish-brown circles.

Male: Length 12 mm. Face, front, vertex, black, thinly dark brown pollinose, occiput black, at 1 angle of view thinly dark brown tomentose, at another view grayish brown; antennal segments 1 and 2 yellowish brown (segment 3 missing); proboscis dark brown.

Thoracic median stripe dark reddish brown, outlined on anterior half by paler yellowish-red stripes expanding anteriorly, laterally large yellowish-red spots surrounded by reddish-brown circles broader latero-anteriorly than mesally, about medially the rings coalesce with the median stripe, the yellowish color of posterior humeri expanding to outline the gradually narrowing reddish brown of the dorsal region; scutellum yellowish, darker anteriorly; pleura yellowish, darker below, thinly white tomentose; halteres, black knobs, yellow stalks.

Abdomen dark reddish brown, segment 1 pale yellow, tergite 2 with a yellow band about ⅔ of distance from base, tergites 3 and 4 anteriorly with narrow yellow bands; hypandrium rises above basistyli, a thin dark line marking the coalescence of basistyli and epandrium, epandrium truncate, not as long as apex of basistyli and appendages, 3 long yellowish bristles on corner of truncation, epandrium without a visible lateral slit between apex and base.

Wings hyaline.

Hind femora slightly longer than abdominal segment 2, reddish brown, yellow band covering basal half of clavus; without empodium, 1 tarsal claw shorter than the other.

Female: Unknown.

Type-material: Holotype, male, Brazil, Territory Amapá, Rio Ampari (J. Lane). (USP).

Schildia zonae Martin, new species

Schildia zonae with yellow humeri, thorax blackish except on anterior ⅓ where reddish spots outline the short median stripe.

Female: Length 9 mm. Head black; face gray tomentose, occiput brown tomentose, narrowly gray along eyes, densely gray tomentose stripe from front to collar; antennae yellowish, segment 3 brown dorsoapically, style short; a pair of yellowish mystax bristles, occipital bristles sparse, long, yellow.

Thorax blackish, apical cone reddish, outlining a dark reddish median stripe, posterior pronotal lobes and below anterior humeri densely white tomentose, posterior humeri yellowish, brown tomentose above scutellum; sparse bristles on apical cone of thorax; scutellum brown, brown tomentose, without marginal bristles; pleura dark reddish, white tomentose above coxa 1 and 3, medially thinly brown tomentose.

Abdominal segment 2 pale reddish-yellow brown, tergites 2 and 3 with anterior and posterior margins blackish reddish-brown.

Wings clear.

Hind leg, a pale yellow ring between the broadly blackish apex and reddish-yellow base; outside tarsal claw longer than inside claw.

Type-material: Holotype, female, Piña area, Canal Zone, Panama, 18 November 1957 (W. J. Hansen) (UUEM). Allotype, male, same data as holotype.

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THE GENUS PALUMBIA RONDANI (DIPTERA: SYRPHIDAE)

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ABSTRACT—The genus *Palumbia* Rondani is reviewed and placed in the tribe Milesiini of Milesiinae. *Korinchia* Edwards is combined with *Palumbia* as a subgenus. Keys to the subgenera and species of *Palumbia* are presented. The species of the subgenus *Palumbia* are redescribed and 2 new species of the subgenus *Korinchia* are described from Malaya, *K.* **tenax** and *K.* **vivax**.

Palumbia Rondani (Diptera: Syrphidae) is a small genus of flies which in the past has been considered to belong to either the Eristalini or Milesiini. Rondani (1865) thought his genus was related to *Eristalis* Latrielle as did Sack (1931) and Hull (1949), but Bigot (1860) and Portschinsky (1864) described their species of *Palumbia* in *Milesia* Latreille (= *Sphixea* Rondani). Paramonov (1927) at first thought the group belonged with the Eristalines, but later when he discovered that his species, *Palumbia flavipes*, was the same as Portschinsky's *Milesia eristaloides*, he concluded that *Palumbia* was a milesiine. *Korinchia* Edwards, which is here combined with *Palumbia* as a subgenus, was also placed in with the eristalines (Edwards, 1919; Brunetti, 1923; Hervé-Bazin, 1926; and Shiraki, 1930), although some of its species were originally described in *Milesia*. The confusion over the placement of *Palumbia* (and *Korinchia*) results from the fact that the traditional character on which the taxon, Eristalini (or Eristalinae), was based, the looped third vein, is now known to have also developed independently in the Milesiini (= Xylotinae, *auctores*). All eristaline taxa have pilose metasterna but many milesiine taxa have bare metasterna. *Palumbia* has bare metasterna and thus is placed in the tribe Milesiini.

Genus *Palumbia* Rondani

Head: Higher than long; face concave in female, variable in male, bare, extensively pale pollinose; cheeks broad, about as broad as long; facial grooves short, extending along lower ¼ of eye margins and only half way to bases of antennae; facial stripes distinct, narrow, pilose; frontal prominence low, at middle of head; frontal triangle of male short, about as long as vertical triangle, bare; vertical triangle of male short, about 1⅓ as long as broad at occiput; front of female broad, with sides convergent above, bare on lower 3rd; ocellar triangle clearly before posterior margin of eyes, equilateral; eyes bare, holoptic and touching for distance equal to ½ of vertical triangle in males. Antennae short, about ½ as long as face; 3rd segment orbicular; arista bare, long, about twice as long as antennae.

Thorax: Distinctly longer than broad, with long bristles above wings, on postalar calli, along margin of scutellum and on posterior edge of mesopleurae; anterior mesopleurae bare; sternopleurae with broadly separated dorsal and ventral pile patches; metasterna intermediate in development, bare; postmetacoxal bridge incomplete; metathoracic spiracle small; metathoracic pleurae bare; scutellum with apical emarginate rim, with a well developed ventral pile fringe consisting of a couple of rows of hairs; legs simple; hind femora not swollen, with numerous ventral spines, without distinct basoventral setal patches. Wings: Marginal cell petiolate, apical cell petiolate, 3rd vein strongly looped into apical cell; anterior crossvein beyond middle of discal cell, at outer fourth of discal cell, oblique; anal cell with a long and slightly curved apical petiole. Apical and posterior crossveins continuous; apical and discal cells without spurs at their apicoposterior corners.

Abdomen: Elongate-oval, weakly emarginate: 1st abdominal spiracle embedded in metathoracic epimeron. Male genitalia: Cerci simple, small, pilose; 9th tergum simple, bare; surstyli pilose, approximately triangular in profile, slightly asymmetric; 9th sternum with ventral membranous areas, with left membranous area about twice as large as right; lingula absent; superior lobes fused to 9th sternum, pilose on basal half, produced into a curved prong, with a large basoventral tooth, with ventral portion of apical prong usually membranous; aedeagus with large earlike lateral lobes, with apical process short and stout; aedeagal apodeme short, broad; ejaculatory apodeme triangular, with apical portion usually extended like a umbrella.

Discussion: *Palumbia* is very closely related to *Pterallastes* Loew, as is indicated by the following synapomorphic characters: a looped third vein (R 4 + 5), bare metasterna, long bristlelike hairs above the wings and on postalar calli, and virtually identical aedeagi. *Palumbia* differs from *Pterallastes* in having the marginal cell petiolate, an apomorphic condition found elsewhere among the Milesiini only in *Milesia*. *Milesia* differs from *Palumbia* in having developed (apomorphic) but pilose (plesio-) metasterna, an angulate anal cell petiole (apo-), and pilose face (plesio-). Thus the presence of a petiolate marginal cell in *Milesia* and *Palumbia* undoubtedly represents convergence, not synapomorphy. The sister group to *Palumbia* is *Pterallastes* Loew; the relationships between these two genera and other milesiine syrphids have been previously discussed by Thompson (1974).

Key to Subgenera of Palumbia Rondani

1. Apical cell (R 4 + 5) with long petiole, longer than humeral crossvein (fig. 1); face concave in both sexes (fig. 5); front of female completely pollinose; arista shorter than maximal facial width (western Palaearctic) .... *Palumbia* Rondani

— Apical cell with short petiole, less than ½ as long as humeral crossvein (fig. 12); face tuberculate in male (fig. 9, 11), concave in females (fig. 10); front of female shiny on lower ⅓; arista longer than maximal facial width (Oriental, eastern Palaearctic) .... *Korinchia* Edwards

Subgenus *Palumbia* Rondani

Palumbia Rondani, 1865:129. Type-species, *Palumbia sicula* Rondani by present designation (first of two originally included species, *vide infra*) = *bellieri* Bigot. Subsequent references: Kertész, 1910:266 (catalog citation); Paramonov, 1929:180 (placement in Milesiinae, quotation of original description); Stackelberg, 1930:233 (key reference, place in Milesiinae); Sack, 1931:252 (descript., placed in Eristalinae); Hull, 1949:400 (descript., placed in Eristalinae); Thompson, 1972:203 (descript. notes, placed in Milesinae-Milesini-*Milesia* group).

Head: Face concave in both sexes, completely yellow pollinose; front of female broad, only about ¼ longer than broad at base of frontal prominence, about ⅓ longer than face, with sides convergent above, about ⅔ as broad at ocellar triangle as at base of frontal prominence, completely pollinose; arista long, slightly shorter than maximal facial width.

Thorax: With long yellow bristles; mesonotum yellow pilose, densely yellow pollinose; pleurae grayish white pollinose, yellowish to white pilose; posterior pteropleurae bare; hypopleurae including barrettes bare; scutellum with indistinct apical emarginate rim; mesocoxae bare on posterior surface. Wings: Marginal cell with petiole about as long as humeral crossvein; apical cell with petiole longer than humeral crossvein.

Abdomen: Male genitalia: Surstyli approximately triangular in profile, with ventroapical margin concave and apex drawn straight out, slightly asymmetric; 9th sternum with 2 ventral submedial membranous areas, with left membranous area about twice as large as right; superior lobes with dorsal membranous area near base of apical prong; aedeagal apodeme with subapical ventral keel.

Discussion: *Palumbia* is very similar to *Korinchia*, the principal differences between the two being listed in the above key, with the other differences included in the subgeneric descriptions. These differences are the only ones found after a study of the 2 known species of *Palumbia* and five of the 12 known species of *Korinchia*. The geographical vicariance of *Palumbia* and *Korinchia* along with the minor dissimilarities between them strongly suggests that these 2 groups are relatively recent in origin. Thus I have combined *Palumbia* and *Korinchia* as a single genus. Further, since the sister group to *Palumbia* and *Korinchia*, is the genus *Pterallastes* (Thompson, 1974) it is logical to consider the combination, *Palumbia* + *Korinchia*, as equal in age and rank. Hull (1949) gave S*phixae bellieri* Bigot as the type-species of *Palumbia* but this can not be accepted as a valid type designation since *bellieri* was not among the originally included species. Since I have been unable to locate any other type-species designation for *Palumbia*, I have made the above type-species designation.

KEY TO SPECIES OF THE SUBGENUS PALUMBIA RONDANI

1. Wing with medial brown spot; abdomen tawny with large triangular brown spots on 2nd, 3rd and 4th terga .... *inflata* (Macquart) (Nearctic?)

— Wing without medial brown spot, hyaline except for a slight grayish tinge on apical half; abdomen black, with large rectangular yellow to orange spots on 2nd tergum, and small and narrow lateral triangular yellow spots on 3rd and 4th terga (Palearctic) 2

2. Legs mainly dark brownish black, yellow on tips of femora, basal ⅓ or less of front and hind tibiae, all of middle tibiae and hind tarsi; apical margin of last abdominal tergum (4th in males, 5th in females) black .... *bellieri* (Bigot) (Sicily)

— Legs mainly orange, black only on apical ⅔ of front tibiae and all front tarsi; apical margin of last abdominal tergum orange .... *eristaloides* (Portschinsky) (Caucasia)

Palumbia bellieri (Bigot)

Sphixea bellieri Bigot, 1860:776. Type-locality: Sicily, "Monts Madonie" (14° 05′E, 37° 53′N). Types ♂ ♀ BM(NH).
Palumbia bellieri: Rondani, 1868:23 (synonymy); Kertész, 1910:266 (catalog citation, 3 references); Sack 1931:252 (descript. distr.).
Palumbia sicula Rondani, 1864:130. Type-locality: Sicily, "Agro Panormitano" [= country around Palermo]. Types ♂ ♀ Zool. Mus. Univ. Bologna. Synonymy by Rondani, 1868:23.

Head: Face black except yellow laterally, yellowish white pollinose; cheeks black, sparsely whitish pollinose; frontal triangle black, yellow pollinose, bare; front black, yellow pollinose, short yellow pilose on upper ⅔; vertical triangle black, whitish pollinose on anterior half, yellow pilose; vertex shiny black, yellow pilose; occiput black, white pollinose and pilose below becoming yellow above. Antennae brownish orange, orange pilose, 3rd segment orbicular, about as large as metathoracic spiracle; arista brownish orange.

Thorax: Black; pleurae densely grayish white pollinose, yellow pilose; mesonotum densely yellow pollinose and pilose; plumulae white to yellow; squamae white with orange margin and fringe; halters yellow. Legs: Coxae black, whitish gray pollinose, white pilose; trochanters and femora brownish black except yellow tips of femora, densely whitish gray pollinose, yellow pilose except black ventral spines on middle and hind femora; femoral spines very sparsely on middle femora and on only apical ⅔ or less of hind femora; anterior tibiae yellow on basal ⅓ or less, brownish black on apical ⅔ or more yellow pilose except brownish pilose on ventral surface; middle tibiae orange, yellow pilose except for a few black hairs ventromedially; hind tibiae yellow on basal ⅓, orange to brownish orange on apical ⅔, yellow pilose except for black pile on ventromedial ⅔ and intermixed on apicolateral ⅔; anterior tarsi black, black pilose; middle and hind tarsi orange, orange pilose with a few black hairs intermixed. Wings: With a very slight grayish tinge, microtrichose except for bare streak in middle of 2nd basal cell and along anterior edge of anal cell.

Abdomen: Black with yellow markings; 1st segment all black, grayish pollinose, long white pilose; 2nd sternum mainly yellow, slightly darker medially, short appressed yellow pilose except for a few longer apicomedial yellow hairs; 3rd sternum black except yellow laterally, with pile same as sternum; 4th and 5th sterna black, short appressed black pilose, with a few longer yellow hairs intermixed and on apical margins; 2nd tergum with 2 large basolateral quadrate yellow
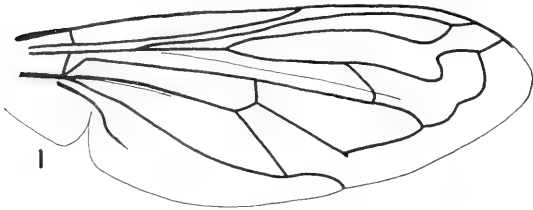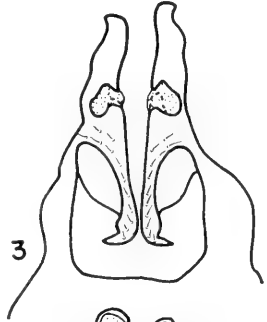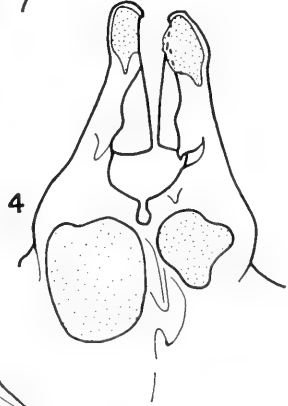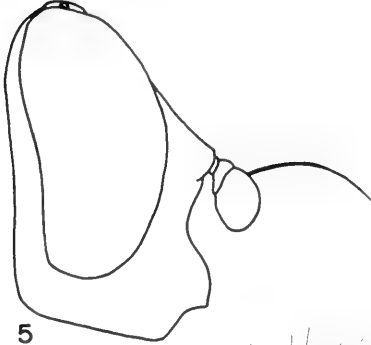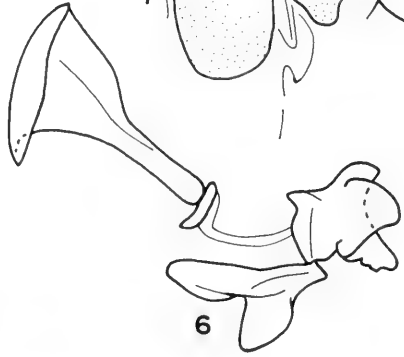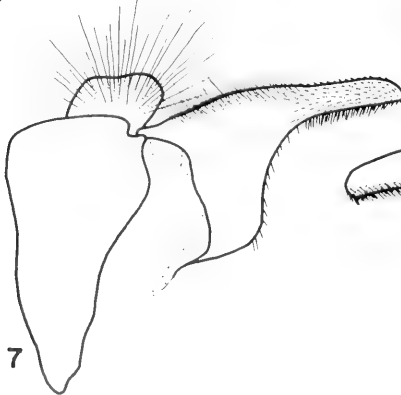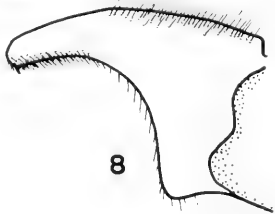
spots, with black area restricted to a medial inverted T-shaped spot, long yellow pilose laterally, short yellow pilose medially, with black pile restricted to a small apicomedial triangular area; 3rd and 4th terga black with sides yellow, long yellow pilose laterally, short yellow pilose on most of 3rd and on basolateral corners of 4th, short appressed black pilose in form of a large apicomedial triangle on 3rd and on all of 4th except sides and basolateral corners; 5th tergum black except narrowly yellow on lateral margins, long yellow pilose laterally, short yellow pilose on basolateral corners, black pilose elsewhere.

Material examined: 1 ♂ 1 ♀ cotypes of *Sphixea bellieri* Bigot (BM(NH)).

Palumbia eristaloides (Portschinsky)

Milesia eristaloides Portschinsky, 1887:187, pl. 4, fig. 4 (wing). Type-locality: "Transcaucasus (Daratschitschach)" Types ♂ ♀ Zool. Mus., Leningrad. Subsequent references: Kertész, 1910:470 (catalog citation).

Palumbia eristaloides: Paramonov, 1929:180 (synonymy); Zimina, 1960:663 (distr. rec. (Transcaucasus), flower records); Stackelberg & Richter, 1968:272, fig. 4 (habitus) (distr. recs. (Caucasus), notes).

Palumbia flavipes Paramonov, 1927:11. Type-locality: Armenia, "Berg Karny-Jarych [= Gora Arailer, 40°24′N, 44°26′E] (Bez. Etschiadzin)" [= Echmiadzin]. Type ♂ "author collection." Subsequent references: Sack, 1931:253 (descript., distr.). Synonymy by Paramonov, 1929:180.

Male: Head: Face yellow, yellow pollinose; cheeks mostly shiny black and bare, yellow pollinose and pilose on posterior edge; frontal triangle black, densely yellow to white pollinose, bare; front black, yellow pollinose, short yellow pilose on upper ⅔; vertical triangle black, whitish pollinose on anterior ½, yellow pilose; occiput black, yellow to whitish pollinose, yellow pilose. Antennae orange, orange pilose; 3rd segment orbicular, as large or larger than metathoracic spiracle; arista orange.

Thorax: Black; pleurae densely grayish white pollinose, yellow pilose; mesonotum densely yellow pollinose and pilose; plumulae white, squamae white with orange margin and fringe; halters yellow. Legs: Mainly orange and short orange pilose; coxae black, grayish white pollinose, long yellow pilose; anterior tibiae black on anteroapical ⅔ and posteroapical ¼ or less; black pilose on black areas; anterior tarsi all black, black pilose; middle femora sparsely black pilose on ventral surface, middle tibiae sparsely black pilose on apicoventral ⅓; hind trochanter sparsely black pilose; hind femora densely covered black spinelike hairs on ventral surface; hind tibiae black pilose on medial ⅓; all femora sparsely whitish pollinose. Wings: With very slight grayish tinge, microtrichose except for bare streak in middle of 2nd basal cell and along anterior edge of anal cell.

Abdomen: Black with yellow markings; 1st segment all black, grayish pollinose, long white pilose; 2nd sternum black except yellow laterally, appressed short yellow pilose except for a few long apicomedial yellow hairs; 2nd tergum with 2

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Fig. 1–8. Features of *Palumbia eristaloides* (Portschinsky), male, all lateral view except fig. 1 and 3 dorsal and 4 ventral. 1, wing. 2, 9th sternum. 3 and 4, apical portion of 9th sternum. 5, head. 6, axial system. 7, 9th tergum and associated structures. 8, left surstyle.

large basolateral quadrate yellow spots, with black area restricted to a medial inverted T-shaped spot, long yellow pilose laterally, short appressed yellow pilose on yellow areas, short appressed black pilose on black areas; 3rd thru 4th or 5th sterna black, except reddish orange on apical ⅓ on apical sternum (4th in males, 5th in females), short yellow pilose except longer apically; 3rd and 4th terga, black except narrowly yellow laterally and reddish yellow on apical margin of 4th tergum, slightly yellow pollinose laterally, long yellow pilose laterally, short appressed yellow pilose broadly on basolateral corners and apical margin of 4th tergum, short appressed black pilose elsewhere; 5th tergum black on basal half, yellow laterally, reddish yellow on apical half, yellow pilose with pile longer on sides; genitalia reddish orange, yellow pilose.

Material examined: USSR, ARMENIAN SSR: Azizbekovskiy Region, Gerger, 16 June 1957, V. Richter, 1 ♂ (BM(NH)); Vedinskiy Region, Forest near Khosrov (39° 57′N, 44° 50′E), 18 July 1969, V. Richter, 1 ♀ (FCT). USSR, AZERBAIJAN SSR: Ordubadskiy Region, Forest near Khurs (39° 12′N, 45° 54′E), 31 July 1970, 1 ♂ (FCT). TURKEY, Erzurum, 5,000 ft., 22 July 1960, Guichard and Harvey, 1 ♂ (BM(NH)).

Discussion: *Palumbia bellieri* and *eristaloides* are very closely related, apparently differing only in the color of the legs and apical margin of the last abdominal tergum (see key). The genitalia of the 2 species are identical. Thus, this similarity strongly suggests that these 2 "species" may represent only geographical races. However, until more is known about the distribution and geographic variation in *Palumbia* (*Palumbia*) I prefer to accept *bellieri* and *eristaloides* as valid species.

Palumbia inflata (Macquart)

Eristalis inflatus Macquart, 1834:507. Type-locality: "De l'Amerique septentrionale" Type(s)? lost. Subsequent references: Osten Sacken, 1878:133 (could not find the type either at Lille or Paris); Williston, 1887:178 (included as unrecognized species); Kertész, 1910:222 (catalog citation, 4 references); Wirth, et al., 1965:624 (included as unrecognized species).

Palumbia inflata: Rondani, 1865:130 (transfer to *Palumbia*).

"Face without a tubercle, grayish white, as is the front. Antennae tawny, not inserted on a prominence. Thorax blackish, yellow pilose; scutellum brown. Abdomen short, rounded-off apically, tawny; second, third and fourth segments with large triangular brown spots. Legs blackish; anterior tibiae half white; hind femora tawny, with tip black. Wings with a brown spot in the middle." Translation of Macquart's original description.

Discussion: Apparently this species has not been recognized since its original description. As noted above, the types of *inflata* are probably lost. Rondani, on the basis of Macquart's description, merely transferred *inflata* to his new genus *Palumbia*. While no subsequent author has followed Rondani's inclusion of *inflata* in *Palumbia*, I can see no reason to doubt his placement. On the basis of Macquart's description this species has bare eyes and aristae, simple hind femora,
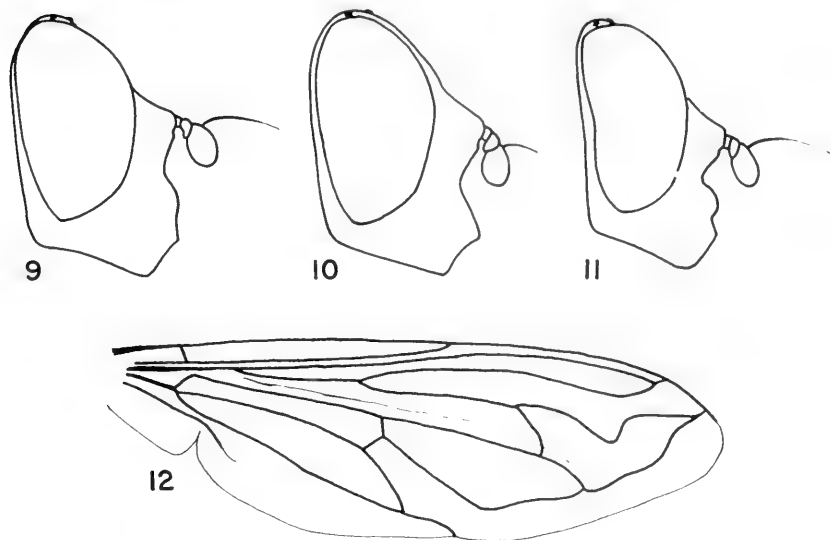
Fig. 9–11. Heads of *Palumbia* (*Korinchia*) species, lateral view. 9, *P. vivax* Thompson, male. 10, *P. vivax* Thompson, female. 11, *P. pendleburyi* (Curran), male. Fig. 12. Wing of *Palumbia* (*Korinchia*) *tenax* Thompson.

no facial tubercle, petiolate marginal and apical cells, and a looped third vein (R 4 + 5). These characteristics can apply *only* to a species of *Palumbia* (*Palumbia*). Having arrived at the conclusion that *inflata* does belong to *Palumbia s.s.* the question of what species does the name apply to remains. Macquart stated that his species was from North America and if this is accurate, then his species is either now extinct or extremely rare since no one has ever collected a *Palumbia* species in the New World. Another alternative is to assume that type-locality is in error and perhaps the species was from the Palearctic Region where *Palumbia* is known to occur. However, even if this was so, Macquart's original description does not readily fit either of the 2 known *Palumbia* (*Palumbia*) species. To make Macquart's description fit a known species would require assuming that Macquart made additional errors in his work and, if we are going to do this, we might then even question the accuracy of Macquart's statements on which the placement in *Palumbia s.s.* rests. Thus, taking Macquart's description of *inflata* as it is, I conclude it is best to leave *inflata* as an unrecognized species of *Palumbia* (*Palumbia*).

Subgenus *Korinchia* Edwards

Korinchia Edwards, 1919:39 (as a genus). Type-species *Korinchia klossi* Edwards by designation of Brunetti, 1923:224. Subsequent References: Brunetti, 1923:224, 415 (descript., type-species design., placed in Eristalinae); de

Meijere, 1924:201 (diff. from *Milesia*); Curran, 1928:150 (key reference); Shiraki, 1930:153 (descript., key to spp., placed in Eristalinae, related to *Meromacrus*); Hull, 1949:362 (descript., transfer to Xylotinae); Thompson, 1972:83, 84 & 203 (descript. notes, placed in Milesinae-Milesini-*Milesia* group).

Head: Face concave in female, tuberculate in male; front of female broad, about as long as broad at base of frontal prominence, about as long as face, with sides convergent above, about ⅓ to ½ as broad at ocellar triangle as at base of frontal prominence; arista long, much longer than maximal facial width.

Thorax: With variable pleural pile, with or without pile on posterior pteropleurae, hypopleurae, barrettes; mesocoxae bare or pilose on posterior surface; scutellum with distinct apical emarginate rim. Wings: Marginal cell with petiole shorter than (usually ½ or less) humeral crossvein; apical cell with petiole shorter than (usually ½ or less) humeral crossvein.

Abdomen: Male genitalia: Ninth sternum with a single ventral membranous area, asymmetric in shape; superior lobes without a dorsobasal membranous area.

Discussion: The subgenus *Korinchia* displays more interspecific variation in pleural pile patterns than any other syrphid genus known to me. The posterior pteropleurae, barrettes, and hypopleurae in front of metathoracic spiracle may be pilose or bare in *Korinchia* species. Also, the presence or absence of hairs in front of the metathoracic spiracle may vary within a single species or a single individual. This variation in pleural pile possibly could be used to divide the subgenus into species groups. On the basis of the species I have studied, the following groups are suggested: 1) *simulans* and *vivax*, both have the posterior pteropleurae and barrettes pilose, as well as having very similar male genitalia; 2) *pendleburyi* has the posterior pteropleurae and barrettes bare, but the posterior surface of the mesocoxae is pilose; 3) *sinensis* and *tenax*, both have the posterior pteropleurae, barrettes and posterior surface of mesocoxae bare. Phylogenetically, I would suggest that the *simulans* + *vivax* group to be the plesiomorphic to the other two and the *pendleburyi* group to be plesiomorphic in respects to *sinensis* + *tenax*. Despite this apparent diversity in pleural pile species of *Korinchia* are fairly uniform in appearance and other structural characters.

KEY TO THE SPECIES OF THE SUBGENUS KORINCHIA EDWARDS
(ADAPTED FROM CURRAN, 1931:372)

1. Scutellum black in ground color, frequently with margin broadly yellow or brown _____ 2
— Scutellum wholly reddish in ground color _____
_____ *rufa* Hervé-Bazin (1922a:122, India)
2. Scutellum with normal erect pile _____ 3
— Scutellum with dense appressed tomentose golden pile, with long brown bristles on margin .... *aurata* Hervé-Bazin (1922b:213, Java; 1926:87, Laos)
3. Front tarsi wholly or mostly black _____ 5
— Front tarsi wholly reddish yellow or light brownish _____ 4

4. Face grayish white pollinose except for shiny black medial vitta; meso-
notum and scutellum yellow pilose with grayish-yellow bristles; abdomen
all black, with bronze lateral spots on 2nd thru 4th terga _____
_____ *potanini* Stackelberg (1963:5, China)

— Face golden yellow pollinose, without black medial vitta, with mouthedge
and lateral vittae yellow brown; mesonotum mainly black pilose, with only
a few reddish-yellow bristles on sides; abdomen mostly dark brown, with
reddish-brown apical bands on terga; 4th tergum with large orangish-
yellow medial spot _____ *apicalis* Shiraki (1930:157, Formosa)

5. Second abdominal tergum with large reddish or yellow lateral spots _____
_____ *formosana* Shiraki (1930:154, Formosa)

— Second tergum with at most small reddish spots on anterior corners _____ 6

6. Posterior alar calli yellow pilose on outersides _____ 7

— Posterior calli wholly black pilose _____ 9

7. Scutellar pile largely blackish _____ 8

— Scutellar pile mostly yellowish _____ 10

8. Fourth abdominal tergum with large yellowish-gray lateral patches _____
_____ *klossi* Edwards (1919:40, Sumatra)

— Fourth tergum without such grayish patches _____
_____ *robinsoni* Edwards (1919:41, Sumatra)

9. Mesonotum with yellowish-brown bristles above wings _____
_____ *simulans* (de Meijere) (1914:144, Java)

— Mesonotum with black bristles above wings _____
_____ *minor* (de Meijere) (1919:21, Sumatra)

10. Posterior pteropleurae, barrettes and usually in front of metathoracic
spiracle pilose _____ *vivax* new species

— Posterior thoracic pleurae bare _____ 11

11. Frontal triangle (♂) and front (♀) black _____ 12

— Frontal triangle (♂) and front (♀) yellow _____ *tenax* new species

12. Second and 3rd abdominal terga all orange pilose; mesocoxae with pos-
terior surface bare; 3rd antennal segment with a large semicircular sen-
sory pit (fig. 17) _____ *sinensis* Curran (1929:503, China)

— Second and 3rd abdominal terga black pilose medially; mesocoxae with
posterior surface pilose; 3rd antennal segment with a short straight sensory
pit (fig. 16) _____ *pendleburyi* Curran (1931:373, Borneo)

Palumbia (*Korinchia*) *vivax* Thompson, new species

Head: Face longer and produce downward more than *tenax* with tubercle
low, yellowish gold, completely yellow pollinose; cheeks shiny brown on anterior
half, yellow and yellow pollinose and pilose on posterior half; frontal triangle
yellowish gold, shiny above antennal bases, yellow pollinose elsewhere; vertical
triangle brownish black, yellow pollinose in front of ocellar triangle; ocellar
triangle brownish pollinose, yellow pilose; occiput bright yellow, yellow pollinose
and pilose except narrowly dark brown pollinose behind eyes on upper ¼ and
with a few short black cilia on upper ¼. Antennae orange, orange pilose; 3rd
segment with a short straight sensory pit; arista orange.

Thorax: Light brown; mesonotum mainly dark brown pollinose, with tawny
yellow pollinose bands along anterior edge and transverse sutures, with band
along transverse sutures broadly interrupted medially, with a semicircular tawny-
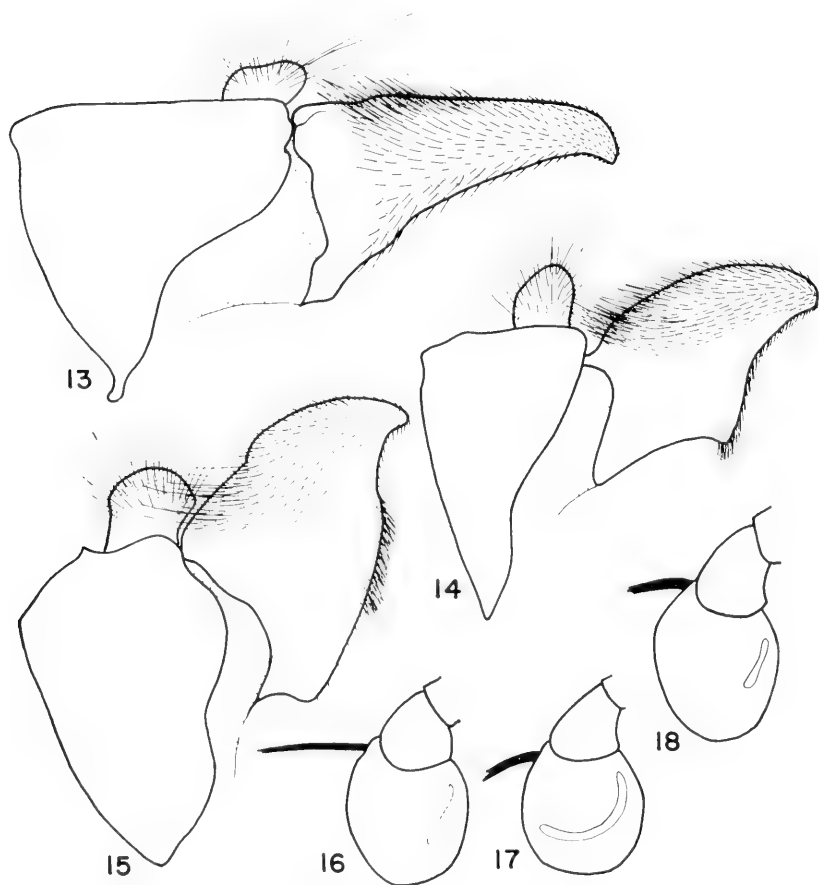
Fig. 13–15.   Ninth tergum and associated structures of male genitalia, lateral view. 13, *Palumbia vivax* Thompson. 14, *P. pendleburyi* (Curran). 15, *P. tenax* Thompson. Fig. 16–18. Antennae of *Palumbia* (*Korinchia*) species, inner side in lateral view. 16, *P. pendleburyi* (Curran). 17, *P. sinensis* (Curran). 18, *P. vivax* Thompson.

yellow pollinose spot in front of scutellum, tawny pilose on light areas and dark brown pilose on dark areas, with long orange bristles above wings and on postalar calli; postalar calli dark brown on inner part; mesonotal pile longer and with more tawny pile intermixed than in *tenax*; pleurae yellow pilose, grayish white pollinose except densely yellow pollinose on upper sternopleurae, posterior mesopleurae and anterior pteropleurae, with a very few black hairs intermixed on upper posterior corner of posterior mesopleurae; posterior pteropleurae pilose, barrettes pilose medially; meropleurae pilose in front of metathoracic spiracles; mesocoxae with posterior surfaces pilose; scutellum dark brownish black except tawny-yellow mar-

gin, tawny pilose, with a few black hairs intermixed; plumulae white; squamae dirty white with brown margin and fringe. Wings: Hyaline except brownish apex, completely microtrichose; epaulets black pilose. Legs: Coxae orange, white pollinose, orange pilose; front trochanters and femora orange and orange pilose; front tibiae orange and orange pilose on base on posterior ⅔, black and black pilose on anterior ⅓; front tarsi black except orange apical tarsomere, black pilose; middle leg orange, orange pilose except for a few short black hairs on apicoventral margin and posterior apicolateral edge of femora; hind leg orange, with femora slightly darker than tibiae and tarsi, with only a small patch of black setae on trochanters and femora black pilose ventrally.

Abdomen: Dorsum mainly orange pilose, with a medial patch of black pile on 3rd tergum and bright yellow pilose on posterior margins of all terga; 1st tergum mostly orange and yellow pollinose; 2nd tergum brown with posterior ¼ orange, dull except bright yellow pollinose on posterior ¼; 3rd tergum orange except for a large medial black spot, dull except bright yellow pollinose on basolateral edges and posterior ⅓; 4th tergum orange except for a small faint dark brown basomedial spot, dull except bright yellow pollinose on basolateral edges and posterior half; venter brown except yellowish white on posterior margins of sterna, sparsely grayish white pollinose, long yellow pilose except short yellow pilose medially on 4th sternum with a few black hairs intermixed. Male genitalia: Brown, long golden pilose, with a very few short black hairs intermixed; surstyli elongate, narrowly triangular, with tip recurved, extensively pilose; 9th sternum elongate, with a small irregularly shaped ventral membranous area on right side; superior lobe with long curved apical prong ending in a short hook, with a large sharp subbasal tooth, with a small basolateral patch of hairs; aedeagus with lateral lobes greatly enlarged dorsally into an acute cone with a subbasal anteriorly directed tooth; aedeagel apodeme with subapical ventral keel.

Female: Similar to male except as follows: front shiny above antennae, with medial ⅓ yellow pollinose and upper ⅓ brownish black pollinose, with upper ⅔ yellow pilose; legs with only a few ventral black hairs setae and with no black setae on hind trochanters; abdomen without dark spot on 3rd and 4th terga, with 5th tergum all orange and subshiny, completely orange pilose.

Material examined: MALAYA, Pahang, Fraser's Hill, 4,000 ft.; H. M. Pendlebury; 29 January 1929 (holotype ♂), 26 January 1929 (allotype ♀), 8 June 1941 (paratype ♂). Tho holotype and allotype are deposited in the British Museum (Natural History); the paratype is deposited in the author's collection.

Discussion: *Palumbia vivax* is very similar to both *P. pendleburyi* and *tenax* but is quite different in respect to its pleural pile pattern and male genitalia as noted above. Also the head is produced downwards much more than in either *P. pendleburyi* or *tenax* (fig. 9–11). *Palumbia vivax* can be contrasted with *P. pendleburyi* as follows: 1) front is yellow, not black; 2) cheeks are brown, not yellow; 3) mesonotal bristles are reddish orange, not bright yellow; 4) mesonotal pile is long and mostly yellow, not long and mainly black; 5) abdominal terga are almost completely orange pilose, only with a small medial patch of black pile on 3rd tergum in male, not extensively black pilose medially on all terga; and 6) male terminalia is long golden pilose, not short black pilose. *Palumbia vivax* is very similar to *P. tenax* in

color characteristics, differing only in the dark brownish orange cheeks which are yellow in *tenax.*

Palumbia (*Korinchia*) *tenax* Thompson, new species

Head: Face short, with tubercle prominent, yellowish gold, completely yellow pollinose; cheeks yellow, shiny on anterior half, yellow pollinose and pilose on posterior half; frontal triangle yellowish gold, shiny above antennal bases, yellow pollinose elsewhere; vertical triangle brownish black, yellow pollinose in front of ocellar triangle; ocellar triangle brownish pollinose, yellow pilose; occiput bright yellow, yellow pollinose and pilose except narrowly dark brown pollinose behind eyes on upper ¼ and with a few short black cilia on upper ¼. Antennae (3rd segment missing) orange, black pilose except orange pilose on sides of 2nd segment.

Thorax: Light brown; mesonotum mainly dark brown pollinose, with tawny yellow pollinose bands along anterior edge and transverse sutures, with band along transverse sutures broadly interrupted medially, with a semicircular tawny-yellow pollinose spot in front of scutellum, tawny pilose on light areas and dark brown pilose on dark areas, with long orange bristles above wings and on postalar calli; postalar calli dark brown pilose on inner part; pleurae yellow pilose, grayish white pollinose except densely yellow pollinose on upper sternopleurae, posterior mesopleurae and anterior pteropleurae; posterior pteropleurae, hypopleurae and barrettes bare; mesocoxae with posterior surface bare; scutellum dark brownish black except tawny-yellow margin, tawny pilose with a few black hairs intermixed; plumulae dirty white; squamae dirty white with brown margin and fringe. Wings: Hyaline except brownish apex, completely microtrichose; epaulets black pilose. Legs: Coxae orange, white pollinose, orange pilose except for a very few short black apical setae; front trochanters and femora orange and orange pilose; front tibiae orange and orange pilose on base and posterior half, black and black pilose on anterior half; front tarsi black and black pilose; middle leg orange, orange pilose except for a few short black hairs on apicoventral margin and posterior apicolateral edge of femora; hind leg orange, with femora slightly darker than tibiae and tarsi, with trochanters covered with black setae and femora black pilose ventrally.

Abdomen: Dorsum completely orange pilose except bright yellow pilose on posterior margins of terga; 1st tergum brown, dull except yellow pollinose on basal corners and posterior margins; 2nd tergum brown with posterior ¼ orange, dull except bright yellow pollinose on posterior ¼; 3rd tergum orange except for a faint medial brown spot on anterior ½, dull except bright yellow pollinose on posterior ⅓; 4th tergum orange, dull except bright yellow pollinose on posterior ½; venter brown except yellowish white on posterior margins, sparsely grayish-white pollinose, long yellow pilose except short black pilose on posterior margin of 4th sternum. Male genitalia: Brown, short black and golden pilose; surstyli short and broadly triangular, with apical portion slightly curved, pilose on dorsal ½ and along ventral margin; 9th sternum short, with a large medial ventral membranous area, almost symmetrical in shape, with apical prong short and almost straight, with subbasal tooth large and sharply pointed, pilose uniformly except bare on apical prong and subbasal tooth; aedeagus with lateral lobes small and triangular; aedeagal apodeme without subbasal ventral keel.

Material examined: MALAYA, Pahang, Cameron's Highlands, Simgai Pareng Path, 4850 ft.; 25 May, 1931; H. M. Pendlebury (1 ♂, Holotype). The type is deposited in the British Museum (Natural History).

Discussion: *Palumbia tenax* is very similar to *P. pendleburyi* but can be contrasted as follows: 1) front is yellow, not black; 2) meso-notal bristles are reddish orange, not bright yellow; 3) mesonotal pile is short and mostly brownish yellow, not long and mainly black; 4) abdominal terga are all orange pilose, not extensively black pilose medially; 5) 3rd and 4th abdominal terga are orange, not brownish black; and 6) male terminalia has both long golden pile and shorter black pile intermixed, not just short black pile.

Palumbia (*Korinchia*) *pendleburyi* (Curran)

Korinchia pendleburyi Curran, 1931:373. Type-locality: North Borneo, Mt. Kinabalu, Kamborangah, 7,200 ft. Type-depository: ♂ HT BM(NH). NEW COMBINATION.

I have studied a paratype male of this species (in AMNH). The following characters were noticed in addition to those described by Curran in his original description.

Antennae black pilose except orange on inner side of 2nd segment; 3rd segment with a short inner sensory pit; mesocoxae with posterior surface pilose; posterior pteropleurae, barrettes and in front of metathoracic spiracle bare; wings completely microtrichose, with epaulets black pilose. Male genitalia: Surstyli short, slightly quadrate in shape due to a triangular production on ventral margin, pilose on dorsal ½ and along apical part of ventral margin; 9th sternum short, with a small submedial ventral membranous area, with membranous area irregular in shape, with apical prong short and narrow and strongly recurved, with subbasal tooth broad and blunt and with serrated edge, pilose on subbasal tooth and base of apical prong; aedeagus with lateral lobes small and triangular; aedeagal apodeme with subbasal ventral keel.

Palumbia (*Korinchia*) *sinensis* (Curran)

Korinchia sinensis (Curran), 1929:503. Type-locality: China, Sechuen, Suifu. Type-depository: HT ♀ U.S. Natn. Mus. NEW COMBINATION.

I have studied a paratype female of this species (in AMNH). The following characters were noticed in addition to those described by Curran in his original description.

Antennae completely black pilose; 3rd antennal segment with a long semi-circular inner sensory pit; mesocoxae with posterior surface bare; posterior ptero-pleurae, barrette, and in front of metathoracic spiracle bare; wings completely microtrichose; epaulets black pilose.
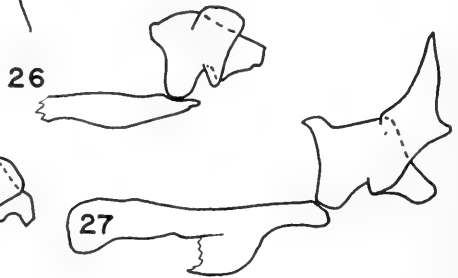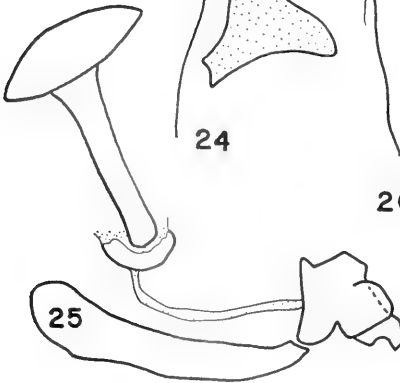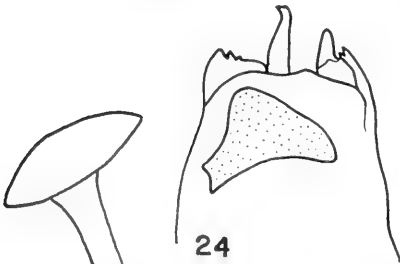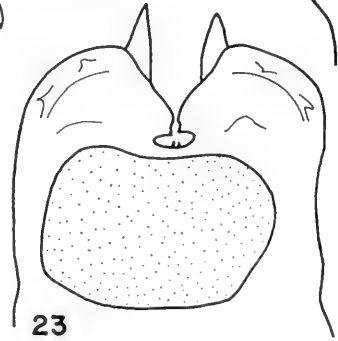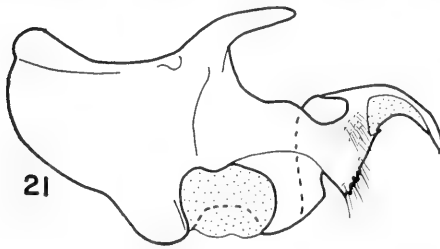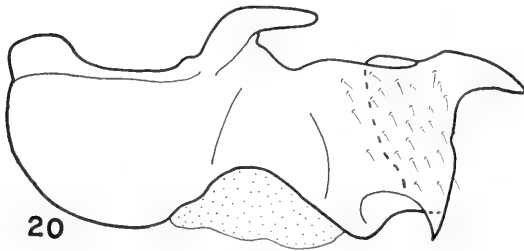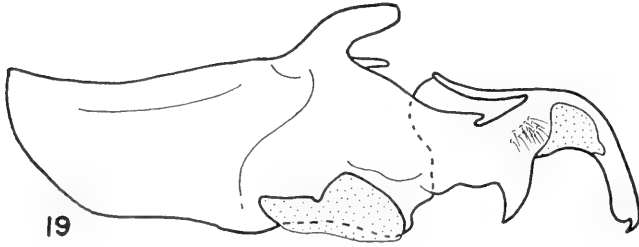
Palumbia (*Korinchia*) *simulans* (de Meijere)

Milesia simulans de Meijere, 1914:144. Type-localities: JAVA, Gunung Ungaran and Gunung Gedeh. Type-depository: 3 ♀ 1 ♂ syntypes, Zool. Mus., Amsterdam. Subsequent references: de Meijere, 1919:28 (distr. recs. (Sumatra)); 1924:201 (synonymy, transfer to *Korinchia*). NEW COMBINATION.

De Meijere (1924:201) gave *Korinchia aurata* Hervé-Bazin as a synonym of his *Milesia simulans*. However, a comparison of the original descriptions of the 2 suggests that both are distinct, the main differences being in the color and type of pile on the scutellum. *Simulans* is stated to have black pile on the scutellum and as its name implies, *aurata* has bright golden appressed pile on the scutellum. I have studied a male from Java (Mt. Gede, Tjibodas; in AMNH) which agrees well with de Meijere's original description of *simulans*. The following characters were noted in addition to those mentioned by de Meijere in his original descriptions.

Antennae orange pilose except for 2 or 3 long ventral brown hairs on 2nd segment; 3rd antennal segment with a short inner sensory pit; mesocoxae with posterior surface pilose; posterior pteropleurae pilose; barrettes pilose medially, meropleurae with a few hairs in front of metathoracic spiracle; wings completely microtrichose; epalets black pilose; male genitalia almost virtually identical to those described above for *vivax* Thompson.

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Fig. 19–27. Male genitalia of *Palumbia* (*Korinchia*) species, lateral view except fig. 22–24 ventral view. Fig. 19–21. Ninth sternum and superior lobe. 19, *P. vivax* Thompson. 20, *P. tenax* Thompson. 21, *P. pendleburyi* (Curran). Fig. 22–24. Apical portion of 9th sternum and superior lobes. 22, *P. vivax* Thompson. 23, *P. tenax* Thompson. 24, *P. pendleburyi* (Curran). Fig. 25–27. Aedeagus and aedeagal apodeme (fig. 25 including ejaculatory apodeme also), lateral view. 25, *P. tenax* Thompson. 26, *P. pendleburyi* (Curran). 27, *P. vivax* Thompson.

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THE NORTH AMERICAN SPECIES OF PIOPHILA SUBGENUS ALLOPIOPHILA WITH BLACK FORECOXA (DIPTERA: PIOPHILIDAE)

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ABSTRACT—A lectotype of *Piophila nitidissima* Melander and Spuler is designated; its postabdomen (♂) is figured; its distribution cited; and a key to the 3 species of the group is given.

Three species of the subgenus *Allopiophila* known from North America are distinguished by having black rather than yellowish forecoxa. One of them, *P. penicillata* Steyskal (1964) was described and its male postabdomen figured in comparison with another 1 of the group, *P. atrifrons* Melander and Spuler. The postabdomen of the 3rd species, *P. nitidissima* Melander and Spuler, is similarly figured at this time and the following key for separation of the 3 species is presented.

1(2). Mid- and hindlegs wholly yellowish; front usually a little reddish anteriorly; last preabdominal sternum with 2 small tufts of setae at posterior margin (fig. 1) _____ *P. nitidissima* M. & S.
2(1). At least femora of mid- and hindlegs largely black; front wholly black; last preabdominal sternum with or without single median tuft of setae
3(4). Femora of mid- and hindlegs yellow at tip for distance at least equal to diameter at apical ⅓ of femur; sterna without setal tuft (Steyskal, 1964, fig. 1) _____ *P. atrifons* M. & S.
4(3). Femora of mid- and hindlegs yellow at tip for distance less than diameter at apical ⅓ of femur; last preabdominal sternum with single median tuft of setae (Steyskal, 1964, fig. 2) _____ *P. penicillata* Stey.

Piophila nitidissima was described (Melander and Spuler, 1917:66) from a syntypic series of 2 males and 10 females; the male from Coeur d'Alene, Idaho, 24 August 1916 (A. L. Melander), now in U.S. National Museum, is here designated lectotype. Other specimens have been seen from Idaho (Coeur d'Alene and Moscow Mt., paralectotypes); Washington (Lake Chelan, Lucerne; Paradise Park, Mt. Rainier; Valley Ford); California (Yosemite, paralectotypes); Montana (Cold Creek; Gardiner); Wyoming (Yellowstone National Park); and Colorado (36 km W Fort Collins). Paralectotypes from Moores Lake. Idaho and Pullman, Washington have not been seen.

The conspicuous tip of 1 of the 2 pairs of gonites (fig. 1, g) seen in macerated specimens is subject to considerable variation (fig. 1, A–D), but other details of this rather complex and characteristic set of structures appear very uniform.

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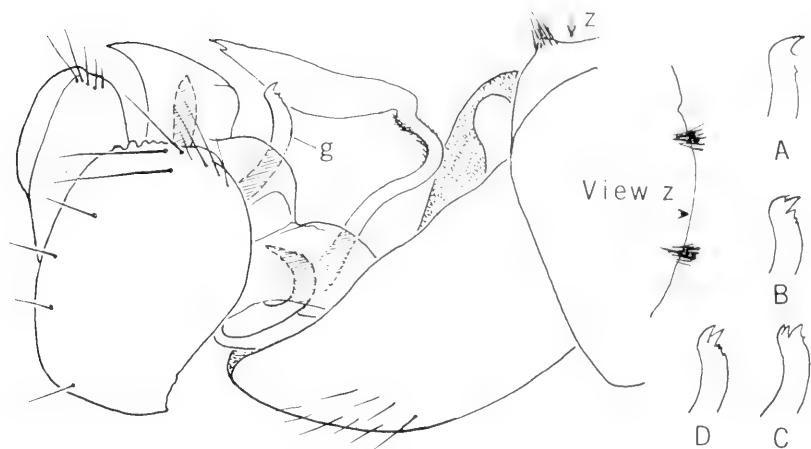
Fig. 1. *Piophila nitidissima* M. & S., postabdomen of lectotype male. A–D, enlarged views of tip of gonites (g) of lectotype (A), and specimens from Cold Creek, Montana (B), 36 km W Fort Collins, Colorado (C), and Yellowstone Park, Wyoming (D).

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NEW RECORDS OF MITES ASSOCIATED WITH CERATOPOGONIDS
(DIPTERA: CERATOPOGONIDAE)

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ABSTRACT—Larval mites, *Tyrrellia* sp. (Limnesiidae) are first recorded from the ceratopogonids: *Atrichopogon fusculus* (Coquillett), *Dasyhelea oppressa* Thomsen, *Culicoides furens* (Poey), and *Bezzia setulosa* (Loew). Adult mites, *Amblyseius* sp. (Phytoseiidae) are first recorded from *Culicoides schultzei* (Enderlein).

A literature search has revealed few records of mites associated with ceratopogonids. Vercammen-Grandjean (1957) described *Evansiella culicoides* (Trombidiidae) as a new genus and species. The host for this new mite was *Culicoides pulicaris* (Linnaeus). Whitsel and Shoeppner (1967) reported *Valgobothrium* (Trombidiidae) on *Dasyhelea mutabilis* (Coquillett) and *Culicoides* sp. Both of the above references are cases of association by larval mites.

On 12 June 1973, the authors collected ceratopogonids by light trap at Irish Grove Wildlife Sanctuary, near Marion, Somerset County, Maryland. Among the material, the following ceratopogonids were found to have mites attached to them: 1 female *Atrichopogon fusculus* (Coquillett), 1 female *Dasyhelea oppressa* Thomsen, 19 female and 2 male *Culicoides furens* (Poey), and 3 female *Bezzia setulosa* (Loew). The specimens were preserved in 70% ethyl alcohol and later mounted along with their associated mites on microscope slides in Hoyer's solution to facilitate identification of the mites. The mites were sent to David R. Cook, who has tentatively identified them as larval *Tyrrellia* sp. (Limnesiidae). This is apparently the 1st record of this mite family associated with ceratopogonids. Cook (1974, pers. comm.) indicates that the genus *Tyrrellia* occurs in aquatic or moist habitats. If this is the case, the larval mites probably attach to the host fly soon after emergence from the pupal skin as suggested by Whitsel and Schoeppner (1967). One female *C. furens* had 4 mites attached to it (fig. 1), 2 *C. furens* had 2 mites, while all the other specimens had a single mite attached usually to the pleural membrane of the anterior ⅓ of the abdomen. All of the above specimens are presently in the collection at the University of Maryland.

Two female specimens of *Culicoides schultzei* (Enderlein) in the National Museum of Natural History (USNM) collected October, 1958, by J. Maldonado from Katmandu, Nepal, have mites mounted with them in phenol-balsam on microscope slides. These specimens were sent to Robert L. Smiley who identified the mites as *Amblyseius*

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Fig. 1.   Larval mites, *Tyrrellia* sp., attached to the abdomen of female *Culicoides furens* (Poey).

sp. (Phytoseiidae). One of the *Culicoides* apparently had 2 mites attached to it. These mites are adults, and this is apparently the 1st record of adult mites associated with ceratopogonids as well as the 1st record for the order Parasitiformes on this group of flies. Smiley (1974, pers. comm.) indicates the possibility that these mites may have been phoretic on these flies.

We would like to thank Robert L. Smiley and David R. Cook for identifying the mites. Thanks are also extended to William V. Horvath, whose photograph appears within.

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ADDITIONAL RECORDS OF MYIOPHTHIRIA (BRACHYPTEROMYIA)
FROM SWIFTS AND A DESCRIPTION OF THE FEMALE OF
M. (B.) NEOTROPICA (BEQUAERT)
(DIPTERA: HIPPOBOSCIDAE)

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ABSTRACT—A female of *Myiophthiria* (*Brachypteromyia*) *neotropica* (Bequaert), collected from *Aeronautes montivagus* (d'Orbigny and Lafresnaye) in Venezuela, is reported for the first time. Characters distinguishing it from the male are presented. A brief summary of the louse-flies of this subgenus (Diptera: Hippoboscidae: *Myiophthiria* (*Brachypteromyia*)) from swifts (Aves: Apodidae) is given with an additional record of *M.* (*B.*) *fimbriata* (Waterhouse) collected from *Aeronautes saxatilis* Woodhouse in New Mexico.

As a part of continuing studies of the ecology of Neotropical swifts (Aves: Apodidae) by the 2nd author, ectoparasites have been collected from numerous individuals of several species. In addition to lice of the genera *Dennyus* and *Eureum*, and feather mites, a single parasitic fly has been collected. This specimen, collected from the under-tail coverts of a Mountain Swift, *Aeronautes montivagus* (d'Orbigny and Lafresnaye) proved to be the 3rd known specimen of *Myiophthiria* (*Brachypteromyia*) *neotropica* (Bequaert) and the 1st female reported for the species.

All 3 specimens of *M.* (*B.*) *neotropica* were collected in Venezuela from the same host species. Bequaert (1942) originally described this fly from a single male specimen from Galipán (2,000 m. elev.) which is close to Pico Avila in the State of Miranda and in the "immediate neighborhood of Caracas" (Beebe, 1949). The 2nd and 3rd specimens were taken approximately 100 km west of this location near the crest of the coastal cordillera at an elevation of approximately 1100 m. The 2nd specimen, also a male, was collected by William Beebe from a swift that flew into the Estación Biológica de Rancho Grande in dense fog or "neblina" on 23 April 1948 (Beebe, 1949). The 3rd and latest specimen was collected by the 2nd author from a Mountain Swift netted in Portachuelo Pass on 10 November 1966. Portachuelo Pass is located approximately 0.25 km from the Estación Biológica de Rancho Grande and approximately 20 km by road north of Maracay in the State of Aragua. A detailed description of the ecology of the Portachuelo Pass Rancho Grande area is presented by Beebe and Crane (1947) and bird-netting operations in Portachuelo

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Pass have been described by Collins (1967). A detailed study of the host species *A. montivagus* is in preparation. (Collins, in prep.)

The female specimen is very much like the male described by Bequaert (1942, 1954). The female differs from the male as follows: The 1st antennal segment of the male bears 3 to 6 long setae on the inner anterior corner, whereas in the female there are 4 moderately long recurved setae; 2 are coarse and long and 2 are fine and shorter. On the thorax there is an oblique patch of bristles on the humeral callosity which, in the male, extends uninterrupted to beyond the spiracle. In the female this patch of bristles is narrowly interrupted at either side of the middle to leave an isolated patch of about 36 bristles at the middle. The abdomen of the male in dried condition is narrower than the thorax at its widest point and shorter than the combined length of head and thorax. The abdomen of the female, in alcohol, is longer than the head and thorax, and $1.6 \times$ wider than the thorax at its widest point. The total length of the male, in dried condition is 9 mm; the female, in alcohol, is 12.5 mm long. The length from the tips of the apical arms of the frons to the hind margin of the scutellum in the male is 5.6 mm, in the female, 5.5 mm.

The distribution records for *M.* (*B.*) *neotropica* (Bequaert) can be summarized as follows: Venezuela: Est. Miranda, Galipán, 2,000 m; Est. Aragua, Estación Biológica de Rancho Grande; Est. Aragua, Portachuelo Pass, 1100 m. The holotype is deposited in the collections of the Museum of Comparative Zoology, Harvard University. Beebe's specimen (given the number 48375, presumably in the collections of the Department of Tropical Research of the New York Zoological Society), has not been located. The recently taken female specimen will be housed with the type at the Museum of Comparative Zoology.

The only other species in the subgenus *Brachypteromyia* is *M.* (*B.*) *fimbriata* (Waterhouse). This fly has been collected from 3 host species of birds in Western North America. These hosts include 2 swifts, the White-throated Swift, *Aeronautes saxatilis saxatilis*, and the Black Swift, *Cypseloides niger borealis*, and 1 swallow, the Violet Green Swallow, *Tachycineta thalassina lepida*. Although all 3 host species migrate into Mexico and possibly Central America during the winter months the flies have only been recovered from specimens collected in western United States. Localities of collections include the States of Nebraska, Colorado, Wyoming, Utah, New Mexico and Arizona (Bequaert, 1953).

To the localities mentioned above we can add 1 more. On 3 August 1971, Rex Funk obtained 3 female specimens of *M.* (*B.*) *fimbriata* from 1 White-throated Swift collected 5 miles north of Canyon, Sandoval Co., New Mexico. These specimens will be housed at the Museum of Comparative Zoology, Harvard.

These flies are unquestionably uncommon on swifts. To date the 2nd author has handled 64 *Aeronautes saxatilis* and 62 *Aeronautes montivagus* and found only the 1 specimen of *neotropica* and none of *fimbriata*. However, it should be noted that the size of these flies relative to the body size of the host species is much greater than for

most parasitic hippoboscids. The single specimen of *neotropica* en-
countered by Collins had, by its presence and large size, greatly
modified the normal resting position of the feathers of the under
tail region.

All other members of the genus *Myiophthiria* are known only from
swifts. This includes, in addition to the 2 species in the subgenus
Brachypteromyia already discussed, 2 other species: *M. reduvioides*
Rondani from *Collocalia troglodytes*, *C. spodiopygia*, and *C. vani-
korensis* in the Malaysian Subregion; and *M. lygaeoides* Rondani
found only on *Collocalia brevirostris unicolor* in the Wallacean Sub-
region. The only other genus of Hippoboscidae known to parasitize
swifts is *Crataerina*, 8 species of which are found on 9 species of
Apus in the Old World (Bequaert, 1953).

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A NEW SPECIES OF PSOCULUS FROM KENYA WITH NOTES ON RELATIONSHIPS OF THE PSOCULIDAE (PSOCOPTERA)

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ABSTRACT—*Psoculus* **ricei** n. sp. is described from Kenya. It is the 2nd species of its genus and family, and the 1st in which males are known. Male morphology tends to confirm Roesler's (1954) conclusion that the Psoculidae are most closely related to the Mesopsocidae.

In October 1966, I collected psocids at several localities in Kenya. While collecting on the eastern shore of Lake Naivasha, I found representatives of a small species with wingless females and winged males. These insects were living under webs about 2 cm in greatest dimension on trunks of fever trees (*Acacia xanthophloea*). Later microscopic examination proved them to be a species of *Psoculus*, different from the type, *P. neglectus* (Roesler). The latter species was hitherto the only one known for its genus and family. It was first recorded in the Mecklenburg area of Germany (Roesler, 1935), and was later found in France (Roesler, 1954). It is exclusively parthenogenetic (Roesler, 1954), males being totally unknown. My find, then, of a second species which was bisexual and African was of considerable interest.

In this paper I describe the new species and discuss systematic relationships of *Psoculus*.

Materials and Methods

The material consists of 3 males, 12 females, and 4 nymphs of the new species. I have not obtained specimens of *P. neglectus*, and comparisons are here made with published descriptions of that species.

Measurements (Table I) were taken only on specimens permanently slide-mounted (1 male and 2 females). The measurements are in microns and have an error of $\pm 0.27 \mu$. Abbreviations for measurements are as follows: A = antennal length; Fw = forewing length; T = posterior tibial length; t_1, t_2 = length of 1st and 2nd posterior tarsomeres; IO/D = least distance between compound eyes in dorsal view divided by greatest antero-posterior diameter of compound eye in same view; PO = greatest transverse diameter of compound eye in dorsal view divided by greatest antero-posterior diameter of compound eye in same view.

Psoculus ricei Mockford, new species

Diagnosis: Female differing from *P. neglectus* as follows: 1) pigmented area of subgenital plate with anterior margin decidedly concave; 2) posterior projection of subgenital plate bearing few setae; 3) 1st valvula with its distal protuberance more elongate, slender,
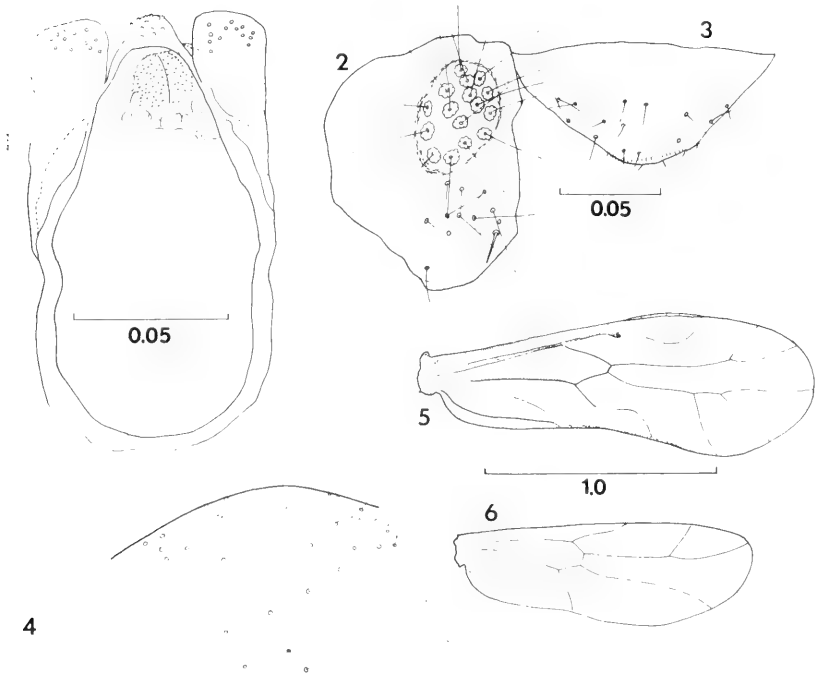
Fig. 1–6.   *Psoculus ricei* n. sp. ♂. Scales in mm. 1, Phallosome. 2, Left para-proct. 3, Epiproct. 4, Hypandrium (scale of fig. 2 and 3). 5, Forewing. 6, Hindwing.

and tapering toward tip; 4) 2nd valvula with its distal protuberance tapering toward tip; 5) distal end of 2nd valvula extending decidedly beyond protuberance; 6) 3rd valvula more rounded.

Male: Measurements (Table I).

Morphology: Macropterous. Ocelli present, well separated. Median ecdysial line present from posterior margin of vertex nearly but not quite to ocellar interval, its lateral arms absent. Compound eyes relatively larger and with more facets

Table I.   Measurements and Head Ratios of *Psoculus ricei* n. sp.

	A	Fw	T	t_1	t_2	IO/D	PO
♂ (holotype)	728	1649	407	96	75	2.21	0.58
♀ (allotype)	561	—	329	79	77	3.57	0.46
♀ (paratype)	567	—	331	77	77	—	—
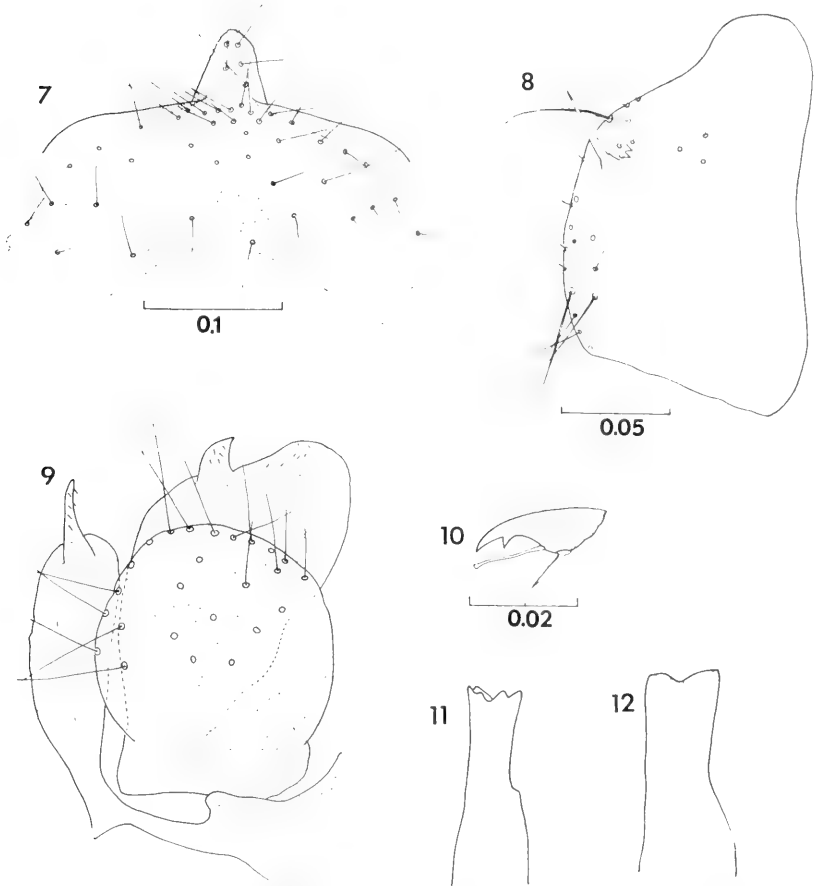
Fig. 7–12. *Psoculus ricei* n. sp. ♂ and ♀. 7, Subgenital plate (♀). 8, Left Paraproct (♀). 9, Gonapophyses (♀, scale of fig. 8). 10, Pretarsal claw (♂). 11, Lacinial tip (♂, scale of fig. 10). 12, Lacinial tip (♀, scale of fig. 10).

than in female. Lacinial tip (fig. 11) with raised median and lateral edges, 2 denticles near median edge and 1 near lateral edge. Labrum with a pair of short stylets anteriorly toward lateral margins. Thorax of normal macropterous form. Legs relatively short. Rasp of Pearman's organ present on hind coxa but mirror absent. Pretarsal claws as in fig. 10. Wings unciliated. Forewing (fig. 5) with free cubital loop; pterostigma rounded posteriorly and with a heavy anterior margin. Rs and M in both forewing and hindwing (fig. 6) joined by a crossvein. Phallosome (fig. 1) with external parameres broad, blunt apically; aedeagal arch wide in middle, bearing minute tubercles; endophallus bearing numerous minute denticles, the mass apparently divided medially. Hypandrium (fig. 4) rounded distally with numerous minute setae on inner surface near distal margin; notched

laterally, external surface sparsely setose. Paraproct (fig. 2) with a well defined sense cushion bearing 16 trichobothria in specimen examined. Epiproct (fig. 3) sparsely setose, with a row of minute denticles on distal margin.

Color (in alcohol): Compound eyes black. A large purple spot around each ocellus, the spots not convergent. Head, thorax, and appendages yellowish brown. Wings clear, unmarked, the veins yellowish brown. Preclunial abdominal segments white, faintly ringed with purple. Clunium, subgenital plate, epiproct, and paraprocts yellowish brown.

Female: Measurements (Table I).

Morphology: Apterous and otherwise neotenic. Lacinial tip (fig. 12) cleft medially, without denticles. Subgenital plate (fig. 7) and gonapophyses (fig. 9) as described in diagnosis. Paraproct (fig. 8) completely lacking sense cushion; sparsely ciliated on and near posterior margin, bearing a long spine and a minute duplex spine near posterior margin. Epiproct broad, rounded posteriorly.

Color (in alcohol): Compound eyes black. Head, sclerotized portions of thorax, legs, terminal abdominal segments and their appendages medium reddish brown, the abdominal segments paler ventrally than dorsally. Membranous portions of thorax dull creamy white. Intersegmental membranes of abdomen narrowly indicated by broken creamy-white lines.

Nymphs: Resembling adults in body form. Late instar male nymphs with rounded wing pads and ocelli indicated by 3 black spots on vertex. Nymphs of both sexes with compound eyes black, body and appendages dull creamy white. Female nymphs with slight indication of reddish brown on preclunial abdominal segments.

Type-locality.—Kenya: Rift Valley District: Naivasha, 10 Oct. 1966, on trunks of fever trees, holotype ♂, allotype ♀, 2 ♂, and 11 ♀ paratypes and 4 nymphs. Types are in my collection.

This species is named for my long-time friend Mr. Dale W. Rice, who was with me when this species was taken and who made most of the arrangements for our East African journey. Mr. Rice is best known for his scientific contributions in marine mammalogy.

DISCUSSION

Psoculus was erected by Roesler (1954) for a species which he had earlier (1935) called *Reuterella neglecta*. Later, that author realized that the species was not closely related to *Reuterella* and (1954) he concluded that it is most closely related to the Mesopsocidae but shows similarities to the Philotarsidae and Peripsocidae. He placed it in a family of its own.

In considering the systematic relationships of Psoculidae, I follow the classification of Badonnel (1951) modified by restriction of Peripsocidae to include only the genera *Peripsocus* and *Kaestneriella*.

Characters available for determining the systematic relationships of Psoculidae consist at present only of external morphological features. Female characters affected by neoteny (absence of wings, ocelli, and paraproctal sense cushions; retention of duplex paraproctal

Table II. Comparison of characters in Psoculidae, Peripsocidae, Mesopsocidae, Philotarsidae, and Elipsocidae. Positive and negative signs mean presence or absence of the stated character.

	Psoculidae	Peripsocidae	Mesop-socidae	Philo-tarsidae	Elipsocidae
Lacinial tip shape	Flattened, denticulate or not	Bicuspid	Bicuspid	Bicuspid	Variable
Wing ciliation	−	±	−	+	±
R–M junction (forewing)	crossvein	fused	fused, point, crossvein	fused	fused
Cu₁ₐ present	+	−	+	+	±
Hypandrium notched laterally	+	−	+	±	+
Pore-bearing parameres external	+	−	+	+	+
Aedeagal arch tuberculate	+	−	±	−	−
Endophallus with large sclerites	−	+	−	±	−
Distal process on first valvula	+	−	+	−	−
Subapical process on second valvula	+	−	+	−	−
Female paraproct broader than long	+	−	+	−	−

spines) may help to mark out the group as a distinct phylogenetic line, but they cannot be used to show affinity. Presence of only 2 tarso-meres in Psoculidae may be also neotenic, although it is expressed in both sexes. Characters shared with all or nearly all other families of Suborder Psocomorpha are of no value.

In Table II, Psoculidae and 4 families which have been thought to be related to it are compared in 11 characters which seem to be of taxonomic value. The similarity in these characters between Psocu-lidae and Mesopsocidae is far greater than between Psoculidae and any of the other families.

Unique features of the Psoculidae which mark them as distinct from the Mesopsocidae include the following: 1) tarsi 2-segmented; extreme neoteny of the female (no wing pads, no sense cushions of paraproct, stout distal spine and duplex spine persistent on paraproct); 2) well-developed r-m crossvein in both forewing and hindwing of male; 3) external parameres broad, not narrowing at their tips; 4) pigmented area of female subgenital plate broad antero-posteriorly.

If the Psoculids prove to be primarily African there will be a bio-geographic basis as well as a morphological one for the conclusion that they are most closely related to the Mesopsocidae, because the early evolution of the Mesopsocids appears to have been African. Of the 3 living genera, 2 (*Hexacyrtoma* and *Labocoria*) are known only from Africa, while *Mesopsocus* appears to have its greatest diversity in Africa. The Psoculids are probably an early branch from a stem shared only with the Mesopsocids.

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A NEW SYNONYM IN *POTAMANTHUS*
(EPHEMEROPTERA: POTAMANTHIDAE)

A. H. Morgan (1913, Ann. Entomol. Soc. Amer. 6:412) was first to refer the name *Potamanthus bettini* (only as figure captions) to figures of a whole dorsal view and the mandibles of a larval specimen of *Potamanthus*. This desig-nation is interpreted to conform to the meaning of "indication" as referred to in Article 12 and delineated in Article 16 (a) (vii) of the International Code of Zoological Nomenclature (1964), and therefore, the name cannot be con-sidered a nomen nudum. All other criteria for availability, as established in the "Code," have been met. There is reasonable circumstantial evidence to believe that the species name was intended to be patronymic for Cornelius Betten (thus, a possible incorrect spelling). Such cannot be proven, however.

J. G. Needham (1920, Bull. Bur. Fish. 36:287) and F. P. Ide (1935, Can. Entomol. 77:119) suggested that Morgan's (1913) published figures actually referred to *Potamanthus flaveola* (Walsh). J. H. McDunnough (1926, Can. Entomol. 58:185) synonymized *P. flaveola* with *Potamanthus verticis* (Say), and *P. verticis* has been almost unanimously recognized by workers as the senior synonym since that time.

Comparative study of the larvae of North American *Potamanthus* species has indicated that Morgan's figures do indeed refer to *P. verticis*, and I therefore formally designate *P. bettini* to be a junior synonym of *P. verticis*: *Potamanthus bettini* Morgan [= *Potamanthus verticis* (Say)], NEW SYNONYM.

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A NEW GENUS OF PIMPLINI FROM JAMAICA
(HYMENOPTERA: ICHNEUMONIDAE)

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ABSTRACT—A new genus, **Jamaicapimpla**, (type-species: *Ephialtes nigro-aeneus* Cushman) occurs in the cloud forest of Jamaica. It differs from *Pimpla* (= *Coccygomimus*) in having strong, complete, notauli with an anterior transverse ridge.

Among material collected in the cloud forest zone of the Blue Mountains of Jamaica in Malaise traps is a new genus of Pimplini (Ephialtini *sensu* Townes, 1969). It most resembles *Pimpla* (= *Coccygomimus*) and will run to *Coccygomimus* in the key of Townes (1969), but it differs in having deep, almost percurrent notauli closed anteriorly by a strong transverse ridge.

Jamaicapimpla Mason, new genus

Type-species: *Ephialtes nigroaeneus* Cushman.

Resembles *Pimpla* (= *Coccygomimus*) in all features except that the mesonotum bears strong notauli almost reaching the scutellum but not touching one another. They are connected by a median depression a little behind the center of the mesonotum so that altogether a W-shaped area is impressed on the mesoscutum. In all but the most dwarfed specimens a median, 3rd groove runs forward from the central depression to the anterior declivity of the mesonotum.

Jamaicapimpla nigroaenea (Cushman)

Ephialtes nigroaeneus Cushman 1927. Proc. U.S. Natl. Mus. 72, art. 13:10–11.
Coccygomimus nigroaeneus (Cushman): Townes 1966. Mem. Amer. Entomol. Inst. 8:26.

Female: Forewing length 4.5–8.0 mm. Face mostly smooth and hairless, small area below antennae coarsely punctate; sides and center of face bulging, with intervening shallow vertical grooves. Thorax smooth and extremely sparsely and finely punctate, almost glabrous. Propodeum ecarinate; horizontal part and sides finely, transversely aciculate; posterior declivity smooth, laterally bounded by a pair of large rounded apophyses descending in a sharp ridge to sides of abdominal foramen; spiracles subcircular. Abdomen predominantly smooth but with fine transverse reticulations and sparse, fine and shallow punctures, the few hairs separated by 2–4 times their own lengths. Length/width ratios of laterotergites II–IV: 1.2, 1.0, 1.0. Only temples, propleuron, antenna, front leg and hind tibia and tarsus have normally dense hair. Tarsal claws without basal lobes or spatulate hairs. Ovipositor straight, sheath about as long as hind femur.

Color black with strong metallic reflections; thorax, head and coxae gun-metal blue; abdomen, antenna and legs mostly purplish, but bronzy in places. Hind femur, except the apical 0.1, and usually hind distritrochanter, bright red; anterior femur and tarsus with small fulvous suffusions on occlusor surface; hind coxa sometimes rufescent basally; antenna brown apically. Wings almost black but with bright green or blue to bronze reflections.

Male: With appearance of a normal holarctic pimpline, mainly because it largely lacks metallic coloration, being black with fulvous-red legs. The males resemble the females morphologically except as follows: length of forewing 3.5–6.5 mm, face generally punctate; notauli and median groove on mesonotum less strongly developed, especially in smaller specimens—most depauperate individuals with no more than a suggestion of a median groove and with notauli shortened to about 0.6 of length of mesonotum; propodeum lacking transverse aciculations too, being thus uniformly smooth except for a pair of short strong ridges that run cephalad from sides of abdominal fovea; length/width ratios of laterotergites II–IV: 1.8, 1.8, 1.5; body pubescence, although still sparse, yet much denser than that of females, the hairs mostly separated by about their own lengths. Color black with scape, coxae and legs reddish fulvous; hind tibia and tarsus black with subbasal whitish band on tibia, base of tibia black to fulvous; metallic reflections lacking in thorax of all but large specimens, abdomen purplish in all but smallest; terga usually apically testaceous; palpi, tegula, anterior coxa and trochanters whitish; wings hyaline in small individuals, moderately fulvous apically in large ones.

Specimens seen: *Jamaica* Hardwar Gap, Portland, 4000 ft., 23 ♂ ♂, 8 ♀ ♀, taken in a Malaise trap operated by H. F. and A. T. Howden 6–29 July, 1966, and by T. H. Farr, Aug. to Nov. 1967 (C.N.C. and Jamaica National Collection); Cinchona, [Blue Mts., 4200 ft.]. 1 ♀ taken by C. C. Gowdey, 5 Aug. 1926, the type (U.S. National Museum).

The genus differs from *Pimpla* only by the strongly developed notauli with transverse anterior ridge and by a median groove on the mesonotum. I regard the deep and fully extended notauli as an important plesiomorphic character, because of their universal occurrence in sawflies and their presence in various degrees of reduction in many parts of the Ichneumonidae, as well as in other Apocrita. It follows that *Jamaicapimpla* can be regarded as a plesiomorphic sister group to the genera *Pimpla*, *Apechthis*, *Ephialtes* and *Strongylopsis*, which are closely related but differ from the former genus chiefly by reduction of notauli. *Jamaicapimpla*, being plesiomorphic and being confined to the cloud forest belt of a single tropical island shows clearly a relic distribution. Two other genera of Pimplini, *Lissopimpla* and *Xanthopimpla* also have strong and fully extended notauli but they, together with *Echthromorpha*, share a strongly apomorphic feature, the division of the clypeus by a flexible articulation into proximal and distal parts. I think these 3 genera form an apomorphic sister group to the rest of the Pimplini. The strong notauli should be regarded as a symplesiomorphic condition retained in *Jamaicapimpla* on one hand, and in *Xanthopimpla* and *Lissopimpla* on the other.

REFERENCE

Townes, H. K. 1969. The genera of Ichneumonidae, Part I. Mem. Amer. Entomol. Inst. 11, 300 pp.

ANISODACTYLUS INCERTUS CASEY, 1914, AND A. SERICATUS CASEY, 1914, NEW JUNIOR SYNONYMS OF A. SIMILIS LECONTE, 1851 (COLEOPTERA: CARABIDAE)

Terry L. Erwin recently noted (in litt.) that neither Lindroth (1968, Opusc. Entomol. Suppl. 33:649–944) nor I (1973, Quaest. Entomol. 9:266–480) mentioned the names *Anisodactylus incertus* Casey, 1914 and *A. sericatus* Casey, 1914, suggested that I clarify the status of these names, and loaned me representatives of the type-series to which these names were applied.

Casey (1914, Memoirs on the Coleoptera. 5:45–305) applied the name *A. incertus* to a single female specimen. This specimen is therefore a holotype and is labeled: "Sta Clara Co Cal," "Casey bequest 1925," "TYPE USNM 47916," "incertus Csy." The type-locality of this form is Santa Clara County, California, as given both in the original description and on the locality label.

The name *A. sericatus* was applied to more than 1 specimen by Casey (1914) as indicated by the statement of ranges for length and width of the specimens measured. A ♀ symbol was used to denote the sex of the specimens measured. However, the 1st specimen in the type-series is a male which agrees well with the description provided by Casey. The 2nd and only other type-specimen of *A. sericatus* is a female (T. L. Erwin, in litt.) which Buchanan, when curating the Casey collection, numbered "2" and labeled with a paratype label. The ♂ symbol was no doubt accidentally omitted from the species description. I here designate the male or 1st specimen as the lectotype of *A. sericatus*. The lectotype is labeled: "C. al.," "Casey bequest 1925," "TYPE USNM 47915," "sericatus Csy." An additional label has been added stating LECTOTYPE *Anisodactylus sericatus* Casey By G. R. Noonan." The type-locality of *A. sericatus* is San Francisco Bay, California, as given in the original description.

The holotype of *A. incertus* and the lectotype of *A. sericatus* both key to *A. similis* LeConte, 1851 in Lindroth (1968) and agree well with the description provided by Lindroth for *A. similis*.

Therefore, I propose here that the names *A. incertus* Casey, 1914, and *A. sericatus* LeConte, 1914, be treated as junior synonyms of the name *A. similis* LeConte, 1851.

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DESCRIPTION OF ADULT AND LARVAL STAGES OF A NEW SPECIES
OF CRYPTORHOPALUM FROM ARIZONA AND MEXICO
(COLEOPTERA: DERMESTIDAE)

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ABSTRACT—Larval and adult stages of a new species of dermestid beetle from Arizona, and Mexico, *Cryptorhopalum* **poorei**, are described. Characters distinguishing larvae of the genus from larvae of other genera of Anthreninae are discussed.

Adults of species of *Cryptorhopalum* are often taken in abundance on flowers throughout most of the United States. Nevertheless, habitats of the larvae have not previously been known and no description has been given for larvae of any Nearctic species. Rees (1943) described the larva of the Neotropical *Cryptorhopalum dubium* Sharp, but the description seems inadequate for distinguishing larvae of the genus from those of related genera. Probably larvae of a number of species have been taken and are present in collections together with useful biological notes, but because they superficially resemble larvae of *Anthrenus*, their identity has gone unnoticed. It is hoped that the following description and discussion of larval characters will provide a basis for further investigations into the biology of this common but little known group.

Cryptorhopalum poorei Beal, new species[1]

Adult male: Dorsal facies as illustrated (fig. 1A). Dorsal pubescence recumbent, consisting of brownish-black and yellowish-white to white hairs distributed as shown; hairs on lateral margins of pronotum about as long as length of scutellum; hairs on elytra ⅗ to ⅘ as long as length of scutellum. Head with integument black; frons and vertex with shallow punctures about as wide as twice width of facet of eye and separated by ¼ to ½ diameter of puncture. Antennal club entirely black; ratio of width to length of 10th segment 1 : 1.22; ratio of length of 11th segment to 10th segment 1 : 1.23. Pronotum with integument black; punctures of disc minute, slightly less wide than width of facet of eye and separated by 3 to 5 times width of puncture. Integument of elytra black at base becoming mahogany brown posteriad with nebulous light reddish-brown maculae beneath areas of light colored pubescence. Ventral surfaces with recumbent white hairs except for dark golden-brown hairs on lateral margins of abdominal segments and apex of last (visible) abdominal segment. Antennal fossa at lateroposterior margin reaching posterior margin of hypomeron. Metasternum without diagonal striae. First (visible) abdominal sternum with 2 fine striae on each side extending diagonally from inner margin of coxae half way to posterior

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[1] Named for Henry W. Poore, M. D., of Flagstaff, Arizona, in recognition of the time and effort he has given through the Explorer program of the Boy Scouts of America to the biomedical education of youth of the community.

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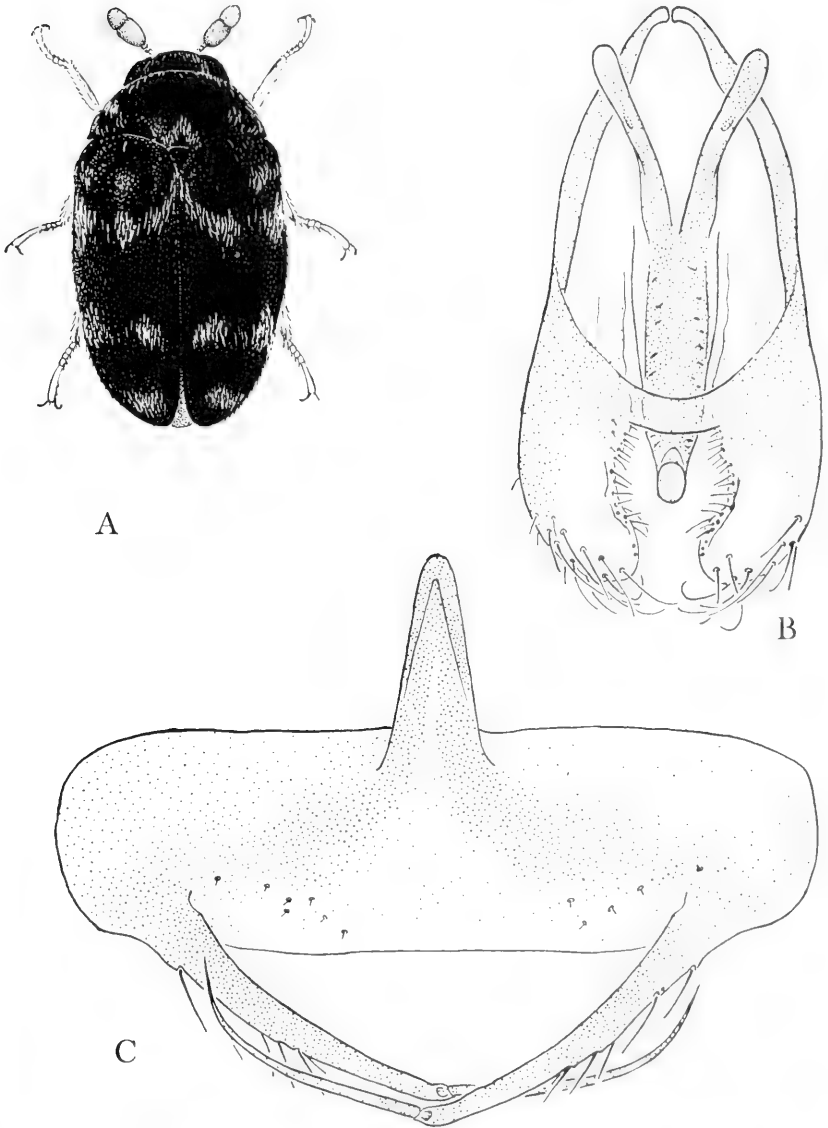
Fig. 1. *Cryptorhopalum poorei.* A, adult male. B, aedeagus and lateral lobes. C, eighth (morphological) sternum.

margin of segment. Front tibia not expanded at apex. Eighth (morphological) sternum as illustrated (fig. 1C). Aedeagus and lateral lobes as illustrated (fig. 1B). Length of pronotum and elytra combined: 2.8 mm ratio of width (across humeri) to length: 1 : 1.70.
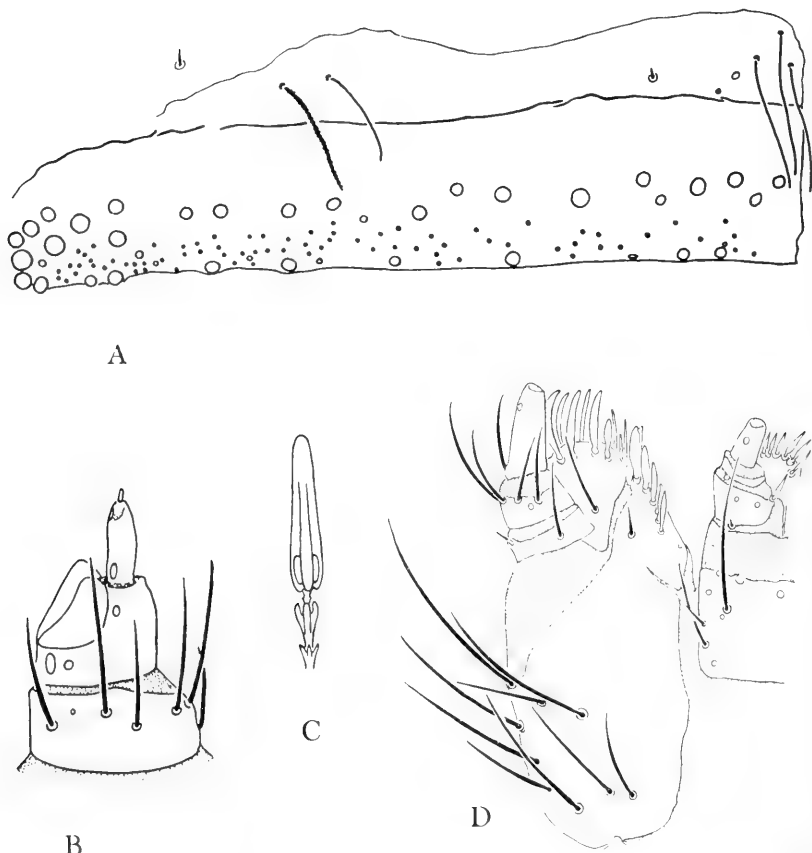
Fig. 2.   Larval structures of *C. poorei*. A, left half of first abdominal segment, mostly denuded.   Open circles represent sockets of spicisetae, size of socket roughly proportional to size of seta; dots represent points of insertion of hastisetae; acrotergite shown with position and lengths of fine spicisetae.   B, antenna.   C, head of hastiseta from first abdominal segment. D, ventral aspect of maxilla and labium.

Adult female: Similar to male except as follows: antennal club dark brown, ³⁄₁₄ as long as lateral margin of pronotum.   Antennal fossa ³⁄₇ as long as lateral margin of pronotum.   Integument of dorsal surfaces entirely mahogany brown except for elytral maculae.   Fifth (visible) abdominal sternum with 2 minutely and densely punctate, subcircular, glabrous spots, each in diameter about ⅔ length of sternum.   Length: 3.3 mm.   Ratio of width (across humeri) to length: 1 : 1.79.

Range of observed variations: Dorsal integument entirely black without maculae to dark brown with ochreous maculae.   Ratio of width to length of male antennal segment 10 varying from 1 : 1.15 to 1 : 1.30; ratio of length of segment 10 to length of segment 11 varying from 1 : 1.23 to 1 : 1.34.   Color of female

antennal club varying from dark brown to black. Length of males varying from 2.5 mm to 3.0 mm.

Mature larva: Integument of head, nota, and terga fuscous, sterna hyaline, coxae fuscous, femora and tibiae yellowish. All setae light golden-brown; hasti-setae (spear-headed setae) with shape of head as illustrated (fig. 2C); shaft of longest hastiseta about 0.84 times as long as length of pronotum. Length of longest terminal spiciseta (rat-tailed or spinulate setae) about 7½ times as long as length of pronotum. Middle setal series of labro-epipharyngeal margin with slender setae only; outer setae subequal in width to inner setae. Epipharynx with 6 distal sensory papillae in single, compact, sharply defined group, a median pair of sensory cups, and a proximal transverse series of 12 to 16 sensory cups; epi-pharyngeal rods narrow and slightly curved. Frons without median tubercle. Antenna as illustrated (fig. 2B). Ventral side of maxilla and labium as illustrated (fig. 2D); dorsal (inner) side of galea of maxilla with numerous recurved setae at apex. Setal patterns of 1st abdominal tergum as illustrated (fig. 2A). Dense brush of hastisetae inserted on membrane behind 7th tergum; in resting position membrane withdrawn beneath tergum so that brush of hastisetae directed pos-teriad; no hastisetae inserted on intersegmental membranes behind other terga. Antecostal suture present on 7th tergum, absent on 8th. Ninth tergum reduced to small, crescent-shaped, vertically positioned plate bearing caudal brush of spici-setae. Ratio of length of mesosternal femur to width of pronotum 1 : 2.69. Ratio of length of tibia to length of femur 1 : 1.16. Anterior pretarsal seta on each leg ½ as long as pretarsus; posterior pretarsal seta ⅘ as long as anterior pretarsal seta.

Holotype male: 23 miles north of Flagstaff, Arizona, collected as larva March 16, 1968, and emerged as adult April 8, 1968, R. S. Beal; deposited in the col-lection of the California Academy of Sciences.

Allotype female: Santa Catalina Mts., Arizona, June 10, 1938, O. Bryant; de-posited in the collection of the California Academy of Sciences.

Paratypes: ARIZONA: T. 19 N., R. 5 E., Coconino Co., as larvae Dec. 21, 1969, reared April and June, 1970, 2 males, R. S. Beal; Schultz Pass, San Francisco Mts., Coconino Co., 8,200 ft. elev., as larva Nov. 25, 1971, R. S. Beal; Hart Prairie, San Francisco Mts., Coconino Co., 8,600 ft. elev., 2 skin casts, R. S. Beal; "Graham Mts." (Pinaleno Mts.), Graham Co., July 6, 1955, one female, Ordway and Statham; Chiricahua Mts., Cochise Co., June 23, 1933, one female (tentatively assigned here; specimen badly abraded), O. Bryant; Santa Catalina Mts., Pima Co., 7,000 ft. elev., June 11, 1961, one male, R. S. Beal. MEXICO: (vicinity of) Durango, 9,300 ft. elev., June 3–5, 1937, Juan Manuel (Van Dyke Collection) (Parts of label illegible). Paratypes in collections of the California Academy of Sciences, the U. S. National Museum, the American Museum of Natural History, and the author.

DIAGNOSIS

The species seems to be most closely associated with a group that includes *C. haemorrhoidale* (LeConte) and *C. balteatum* LeConte. Each member of this group has 2 appendage-like projections on the 8th (morphological) sternum of the adult male. A large seta inserted at the apex of each projection creates the appearance of a jointed appendage (fig. 1C). The 8th segment forms part of the genital

tube and is recessed within the abdomen except during copulation. Males of the group have in common a broad rather than narrow "bridge" on the lateral lobes (fig. 1B). Females of the group have 2, round, glabrous areas on the 5th (visible) sternum. *Cryptorhopalum poorei* is distinguished from members within the group by the sub-cylindrical shape of the antennal club of the male. The other Nearctic members of the group have an ovate instead of subcylindrical antennal club. The antennal club of *C. poorei* is somewhat similar to the form found in *C. triste* LeConte, *C. uteanum* Casey, and *C. apicale* Manner-heim. However, the pattern of dorsal pubescence readily distinguishes it from these 3 species. These and other species of *Cryptorhopalum* with a similar subcylindrical antennal club either have entirely black dorsal pubescence or lack 3 distinct bands of light-colored pubescence on the elytra. The light-colored pubescence on the elytra of *C. poorei* forms 3 rather distinct bands, but there are usually no light-colored hairs at the base. One specimen collected has a few light-colored hairs along the base, but these do not form a distinct band, whereas there is a strongly pronounced band at the basal 3rd.

Larvae of *Cryptorhopalum* can be distinguished from larvae of most other Nearctic genera within the Anthreninae by the presence of a dense brush of hastisetae arising from the membrane behind the 7th abdominal tergum but the absence of a similar brush of hastisetae on the membrane behind the tergum of any other segment. In con-trast to this, *Trogoderma*, *Reesa*, *Megatoma*, *Pseudohadrotoma*, and the Palearctic *Globicornis* have no hastisetae inserted on the mem-brane behind any of the terga; all of the hastisetal tufts are inserted on the sclerotized tergites. A different condition is found in *Anthrenus*, which has tufts of hastisetae inserted on the membrane behind the terga of the 5th and 6th abdominal segments as well as the 7th. *Ctesias* has tufts of hastisetae inserted on the membrane behind the terga on abdominal segments 4–7 (Rees, 1943). Among known larvae of Nearctic genera, only *Thaumaglossa* has tufts of hastisetae inserted on the membrane behind the 7th abdominal tergum only, as in *Cryptorhopalum*. Larvae of *Cryptorhopalum* are easily distinguished from those of *Thaumaglossa* in that the spicisetae near the middle of each notum and tergum of *Cryptorhopalum* are relatively short, seldom longer than ⅛ the total width of the tergum or notum. The spicisetae near the middle of each notum and tergum of *Thaumaglossa* are exceptionally long, some longer than ½ the width of the segment. Further, the accessory papilla on the 2nd antennal segment of *Cryp-torhopalum* is broad and extends from below the middle of the seg-ment to the apex (fig. 2B). The accessory papilla on the 2nd antennal segment of *Thaumaglossa* is peglike, about ½ the diameter of the 3rd segment, and situated entirely at the apex of the segment. The larva of the Hawaiian *Labrocerus* also has a tuft of hastisetae inserted on

the membrane behind the 7th abdominal segment only, as in *Cryptor-hopalum*. Larvae of *C. poorei* differ from the 3 species of *Labrocerus* studied in having fine spicisetae inserted on the acrotergites of the abdominal segments and in having the 2 pretarsal setae subequal. In *Labrocerus* there are no spicisetae inserted on the acrotergites and 1 of the pretarsal setae is less than ½ as long as the other.

The larva of an unidentified species of *Cryptorhopalum* from Pan-ama is the only 1 that has been available for comparison with *C. poorei* with respect to characters at the specific level. Apparently the pattern of setation of the pronotum, the number of setae on different seg-ments of the maxilla, and the color of the integument are useful in distinguishing the species.

BIOLOGY

The species occurs in montane areas of the Southwest at elevations of 7,000 feet or higher, occurs in the state of Durango, Mexico, and probably will be found at higher elevations along the entire Sierra Madre Occidental. The larvae have been found under moderately loose bark of standing dead *Pinus ponderosa*. Efforts to find the larvae under bark of fallen trees and under the bark of other trees have proved fruitless. In each instance except one, the larvae were associated with spider webbing under the bark, and in that one in-stance they were found under bark about 6 inches from spider webbing. One cast skin was found within a spider egg case. However, a partially eaten cast skin of *Megatoma cylindrica* was also found within the case, indicating that the *C. poorei* larva was not the 1st intruder. Invariably the larvae were found only under bark where there was enough moisture present to support Collembola in moderate abundance. No information is available on the habits of the adults.

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STUDIES ON THE GENUS APHODIUS OF THE UNITED STATES AND CANADA (COLEOPTERA: SCARABAEIDAE) III. APHODIUS ASSOCIATED WITH DEER DUNG IN THE WESTERN UNITED STATES

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ABSTRACT—Six species of *Aphodius* from the western United States (*conspersus* Horn, *pectoralis* LeConte, *aleutus* Eschscholtz, *nevadensis* Horn, **schuhi**, new species, and *opacus* LeConte) are recorded as being associated with deer dung. *Aphodius schuhi* is described for the first time and *conspersus* and *Aphodius davisi* Fall are newly recorded from the Pacific Northwest.

Deer droppings are the ecological niche used by most native species of *Aphodius* inhabiting the forested areas of the eastern United States and Canada. Nearly all of the several species of *Aphodius* commonly found in cow dung are European introductions that rarely utilize deer dung. In the western United States and Canada, deer droppings usually do not have specimens of *Aphodius* associated with them, or at least there is a lack of information to that effect. This is understandable in warm, arid regions where the droppings would dry too quickly to be of use to the beetles, but I have long felt that the association of *Aphodius* with deer dung should occur in moist, forested regions such as parts of the Pacific Northwest. Jerath (1960) listed *Aphodius opacus* LeConte, *pectoralis* LeConte and *aleutus* Eschscholtz as occurring in deer dung in Oregon, and I have collected both *pectoralis* and *aleutus* in large numbers in deer droppings in the vicinity of Corvallis, Oregon. A collection containing several species of *Aphodius* was recently received from Joe Schuh, Klamath Falls, Oregon, taken in deer dung in Jackson Co., Oregon, in oak forest at Shady Cove, March 28, 1972. The species represented were: *A. conspersus* Horn (the 1st record of the species from the Pacific Northwest)[2], *nevadensis* Horn (this species taken also in Klamath Co., Algoma) and *schuhi*, new species (described below). *Aphodius conspersus* in particular was present in large numbers. A check of specimens in the USNM collection revealed a series of 4 specimens of *conspersus* from the San Bernardino Mts., Mill Creek Canyon, California, collected from deer dung. It is likely that both *conspersus* and *schuhi* are restricted to deer dung, but *nevadensis* has been found in a variety of habitats including the burrows of the rodent *Spermophilus beldingi.*
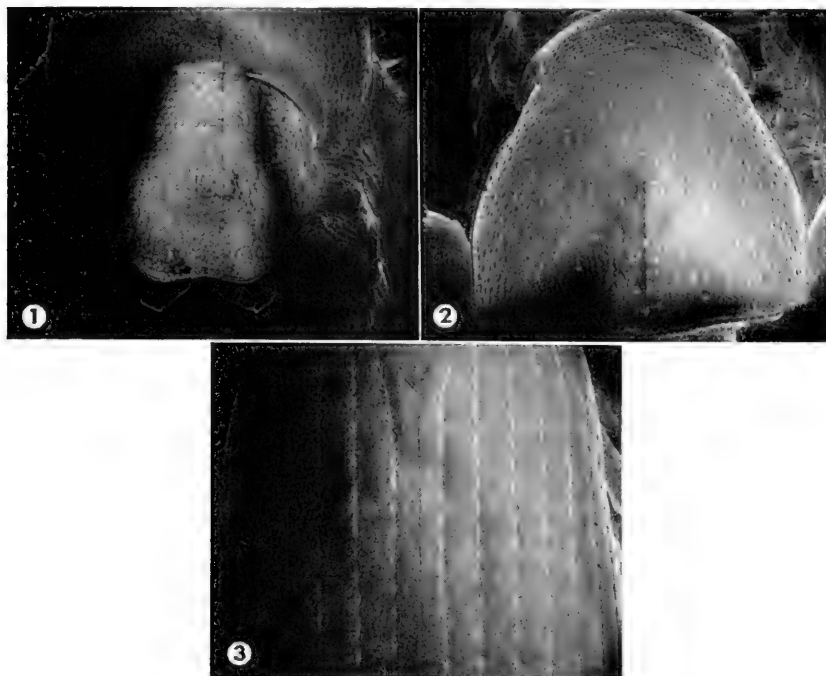
Fig. 1–3. *Aphodius schuhi*, new species. 1, head. 2, pronotum. 3, elytron (center line on head and pronotum and the dark areas are artifacts caused by specimen charging with electrons).

Aphodius opacus LeConte has also been taken under deer droppings by W. H. Tyson at Big Basin State Park, Santa Cruz Co., California, May 2, 1970, but it has also been recorded from human dung and horse dung.

The specimen photographed for the illustrations herein presented was not coated and some buildup of electrons has occurred. The center line and dark areas on the photographs are artifacts caused by this "charging." 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.

Aphodius schuhi Gordon, new species

Holotype: Female, length 4.6 mm, greatest width 2.1 mm. Form elongate, widest at middle of elytra. Color dark reddish brown; elytron brownish yellow. Head shiny, surface distinctly alutaceous, punctures fine, dense, separated by less than diameter of a puncture; clypeus feebly emarginate medially, anterolateral angle smoothly rounded (fig. 1). Pronotum shiny, not alutaceous, with irregular,
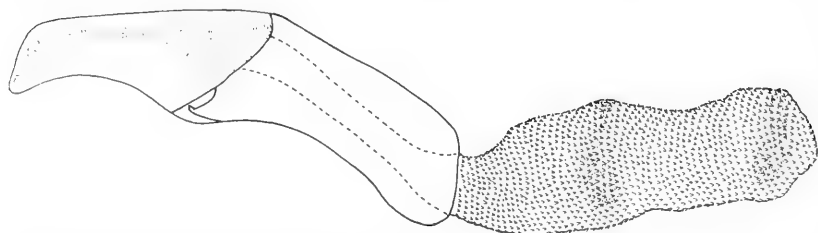
Fig. 4.   *Aphodius schuhi,* new species, lateral view of male genitalia.

intermixed coarse and fine punctures (fig. 2), coarse punctures separated by less than to 3 times the diameter of a puncture, fine punctures scattered among coarse punctures; anterolateral angle rounded with small depression inside angle, lateral margin feebly explanate, strongly beaded, posterolateral angle rounded, posterior margin strongly beaded. Elytron smooth, shiny, striae definitely impressed with equally spaced, coarse, scale-bearing punctures (fig. 3), 1st interval raised, with scattered, minute punctures, intervals 2–9 feebly convex with minute, scattered punctures, lateral ridge of elytron curved upward at humerus ending with small tooth. Ventral surface mostly dull, opaque, strongly alutaceous except legs and apex of last abdominal sternum shiny; metasternum flattened, alutaceous, with coarse, dense punctures; meso- and metafemora coarsely, densely punctured. Anterior tibia with apical spur short, tapered to sharp point, curved downward in lateral view; apex of mesotibia fringed with short, unequal spines and 2 spurs, outer spur very short, ⅓ as long as inner spur, bent upward at apex, inner spur nearly as long as 1st tarsal segment, slender, sinuate; apex of metatibia fringed with short, unequal spines and 2 spurs, spurs slender, acute apically, outer spur slightly shorter than inner. Anterior tarsus with segments 1–4 short, subequal, 5th segment nearly as long as 3 and 4 combined; middle and hind tarsi with basal segment nearly as long as 2–5 combined, segments 2–4 approximately equal, 5th segment nearly as long as 3 and 4 combined.

Allotype: Male, length 8.3 mm, greatest width 2.0 mm. Similar to holotype except genitalia as in fig. 4.

Type-material.—Holotype (USNM 73039) and allotype (J. Schuh collection), Oregon, Jackson Co., Shady Cove, deer manure, 3–28–72, oak forest, Joe Schuh collector.

Remarks.—In superficial appearance, the only described species from the Pacific Northwest resembling *schuhi* is *A. suspectus* Mannerheim, but *suspectus* has pubescence on the elytron, narrow elytral intervals and a slender, straight, outer spur on the middle tibia. In addition, *suspectus* occurs in ant nests, and the 2 types of *schuhi* were taken in deer droppings. The presence of a short, scalelike seta in each of the strial punctures is very unusual in species of *Aphodius* as is the extremely short, bent spur at the apex of the middle tibia. These characters readily separate *schuhi* from *congregatus* Mannerheim to which *schuhi* goes in Horn's key (1887), *Aphodius schuhi* doesn't fit satisfactorily into any of the subgenera used by Schmidt (1922),

apparently being closest to *Volinus* Motschulsky but also having characteristics of *Agoliinus* Schmidt and *Platyderides* Schmidt.

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A CASE OF LONGEVITY OF THE BROWN PRIONID, ORTHOSOMA BRUNNEUM (FORSTER) (CERAMBYCIDAE: COLEOPTERA)

Reports of longevity of wood boring beetles have been numerous since the 1800's. The present case is not unusual in its time span but is presented as an aid to property owners.

A local resident brought 2 pupae and 2 undamaged larvae to my attention early in 1974 and explained their source as the pine foundation beams in his house adjacent to a patio. During construction in late 1964, the surface of this patio was sloped incorrectly and surface water drained against the foundation. Wood decay in the untreated beams was inevitable and while replacing these beams, the owner discovered these insects.

My identification of the specimens as *Orthosoma brunneum* (Forster) was confirmed by D. M. Anderson (Systematic Entomology Laboratory, USDA). Craighead (1950, USDA Misc. Publ. 657, p. 258) implies reinfestation of wooden timbers in contact with ground, but in the present case, the beams were not touching the soil. Careful examination of the untreated, infested wood, the larval galleries, and adjacent uninfested wood showed no evidence of more than the present generation. Inasmuch as this species is not known to infest finished lumber, field infestation of the logs from which these beams were sawed is theorized to have occurred from adult flights during the summer or fall of 1964. The excessive moisture in the wood caused by improper drainage from the patio apparently kept the moisture content in these beams sufficiently high to enable these insects to continue their development on into 1974. Normally they would have died some years earlier as the moisture content of the wood lowered naturally.

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A NEW SPECIES OF ACROBASIS ZELLER ON RIVER BIRCH
(LEPIDOPTERA: PYRALIDAE: PHYCITINAE)[1]

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ABSTRACT—The adult, larva and pupa of Acrobasis **betulivorella**, are described. This species apparently is restricted to Betula nigra L. in the southeastern United States. Information is also included on the behavior of the larval stage.

The birch tube maker (*Acrobasis betulella* Hulst) is a common species on birch in the northern United States. Its host plants include gray birch (*Betula populifolia* Marshall), canoe birch (*Betula papyrifera* Marshall), and possibly other northern species of birch (Neunzig, 1972).
Recently, a species of *Acrobasis* was found on river birch (*Betula nigra* L.), a primarily southern tree. A study of the immature stages and adults of this phycitine shows it to be a previously undescribed species.

Acrobasis betulivorella Neunzig, new species

Adult
fig. 1–5

Wing Expanse: 19–21 mm.
Head: Gray to pale brown. Labial palpi black, usually with a few white tipped scales distally and on inner surface. Basal segment of antenna black anteriorly, white posteriorly.
Thorax: Collar mostly same color as head, sometimes slightly darker. Dorsum of thorax fuscous to black, at times with scales lightly tipped with white or gray. No sex-scaling on thorax.
Primaries: Fuscous to black, very lightly irrorate with white; antemedial line obscure anteriorly but usually distinct and broad in posterior half of wing (distinct posterior part, at times, followed by obscure small white patch); raised-scale ridge black; area between ridge and antemedial line black; discal spots absent; subterminal line relatively distinct, sometimes more evident posteriorly; undersurface of male with sex-scaling consisting of white to yellowish white streak along costa, and very short black basal patch below costa.
Secondaries: Pale smoky fuscous; no sex-scaling.
Male genitalia: Gnathos terminating in a trifurcate hook; transtilla with posterior terminal margin broadly concave and lateral elements with expanded irregularly obtrigonal bases; aedeagus simple.
Female genitalia: Ductus bursae elongate, membranous, and scobinate near union with corpus; corpus bursae with distinct band of scobinations spreading out from signum which consists of dense cluster of scobinations.
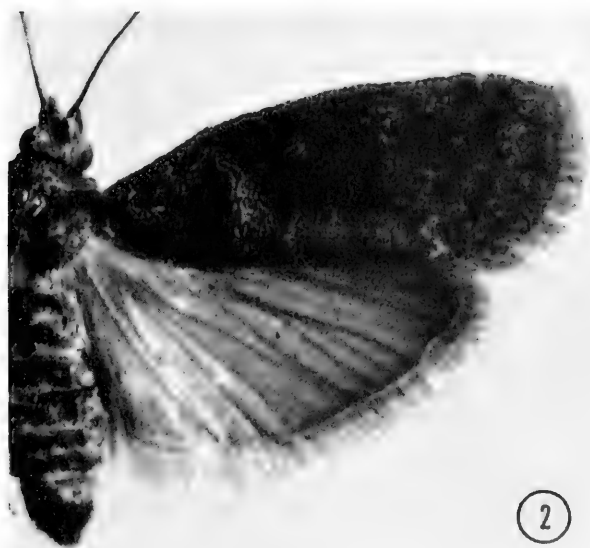
Fig. 1, 2.   *Acrobasis betulivorella.* 1, male (holotype). 2, female.
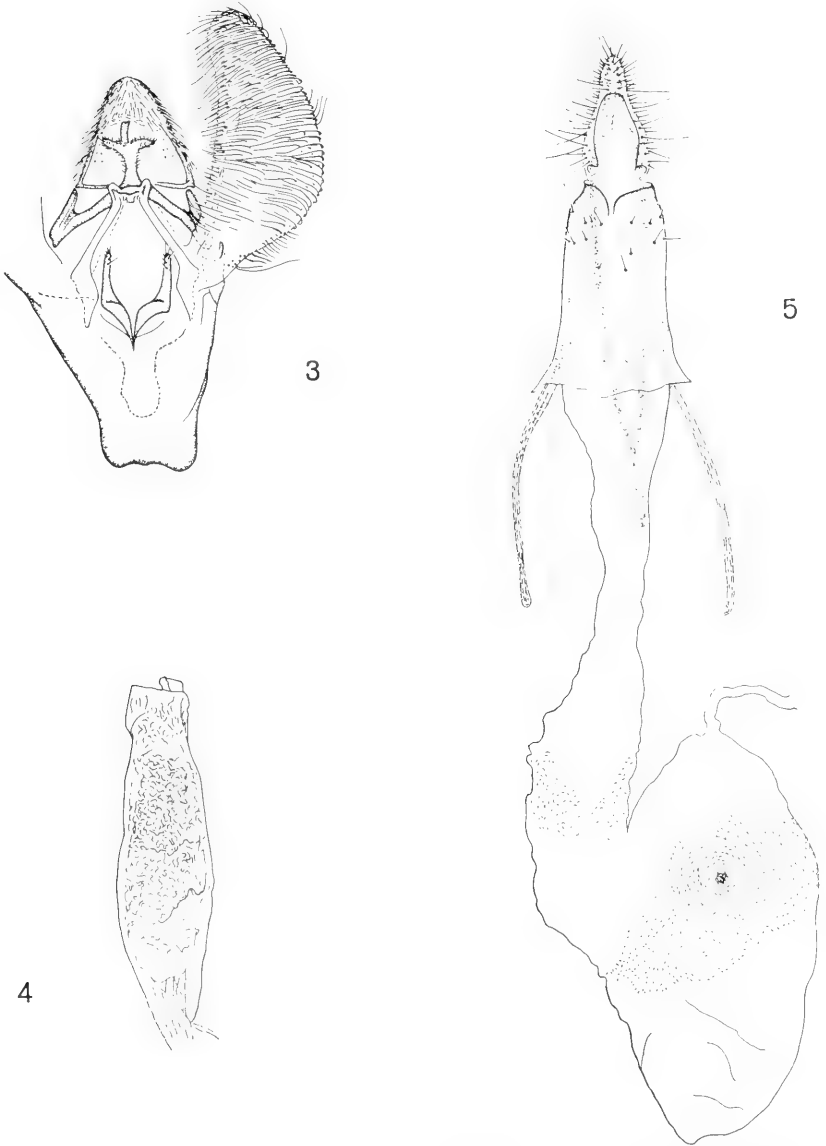
Fig. 3-5. Genitalia of *Acrobasis betulivorella*. 3, 4, male. 5, female.

Holotype: Elizabethtown, North Carolina, ♂, reared from larva collected 25–IV–73, *Betula nigra*, Coll. H. H. Neunzig. USNM type no. 73084, ♂ genitalia slide 244; in the National Museum of Natural History (USNM).

Paratypes: NORTH CAROLINA: Elizabethtown, 7 ♀, reared from larvae collected 5–V–72, *Betula nigra*, Coll. H. H. N.; 2 ♂, 3 ♀, reared from larvae collected 25–IV–73, *Betula nigra*. Coll. H. H. N.

The paratypes collected as larvae 5–V–72 and 1 of the ♂ paratypes collected as a larva 25–IV–73 have been placed in the National Museum of Natural History (USNM). The remaining paratypes are in the North Carolina State University Museum.

Last-stage Larva
fig. 6, 8, 10

General: Length 17.0–17.5 mm. Width 2.5–2.8 mm. Head yellowish brown to reddish brown with pale brown to distinct dark brown bands of muscle attachments; pale orange area within ocelli. Dorsum of body usually purplish gray with a few white patches on thorax; thorax along meson not paler than surrounding integument, at times slightly darker; pale whitish lateral patches on thorax followed by more distinct, larger whitish area, composed of numerous irregular pale patches below spiracles on abdomen; venter of thorax light purplish gray with few small white spots; venter of abdomen paler; whitish patches below spiracles extending to venter. Thoracic shield and prespiracular plate brown with dark brown muscle attachments; region anterior to shield whitish. Thoracic legs dark brown. Mesothoracic SD1 ring dark brown, white within. Eighth abdominal segment SD1 ring brown. Pinacula small, pale brown to brown. Anal shield brownish yellow with brown maculation. Muscle attachments same color as surrounding integument (in some specimens, 1 to 2 brown muscle attachments on abdominal segments 3–6).

Head: Width, 1.45–1.65 mm; length, 1.16–1.32 mm; reticulate rugose; epicranial index about 1.3; labrum moderately emarginate; mandible with large dentiform retinaculum; spinneret 4–5 times as long as median breadth.

Prothorax: Shield and prespiracular plate separate, usually slightly rugose; dorsal surface of shield irregular from anterior to posterior margin, usually with distinct transverse gibbosity near posterior margin; distance between D1 setae usually distinctly less than distance between XD1 setae; distance between SD1 and SD2 usually distinctly greater than distance between SD1 and XD2; distance between XD1 and XD2 about 1.8 times greater than distance between SD1 and XD2; distance between D1 and D2 about 1.5 times greater than distance between D1 and XD1.

Mesothorax: SD1 1.40–1.75 mm long; SD1 ring narrow, closed anteriorly, becoming very broad posteriorly.

Metathorax: D1 and D2 on same pinaculum; SD1 and SD2 on separate pinacula.

Abdomen: D2 setae of anterior segments about ⅓ as large as diameter of segments; distance between D2 setae on segment 1 slightly greater than distance between D1 setae; distance between D2 setae on segment 6 less than distance between D1 setae; D2 on segment 1 about 4 times as long as D1; D2 on segment 8 about 3 times as long as D1; distance between D1 and SD1 on segment 1 dis-
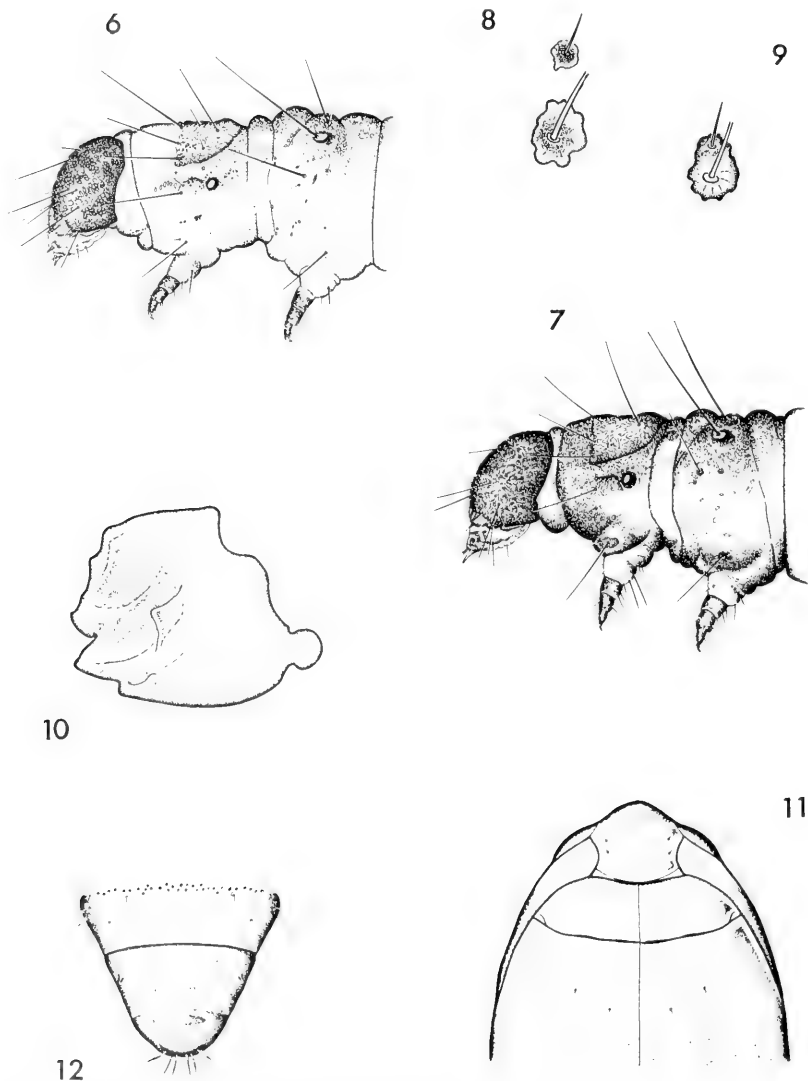
Fig. 6–12.   Larvae and pupae of *Acrobasis* spp. 6, lateral view of head, pro-
thorax and mesothorax of last-stage larva of *A. betulivorella.* 7, lateral view of
head, prothorax, and mesothorax of last-stage larva of *A. betulella.* 8, SD1, SD2
and pinacula of metathorax of last-stage larva of *A. betulivorella.* 9, SD1, SD2
and pinaculum of metathorax of last-stage larva of *A. betulella.* 10, dorsal or inner
aspect of right mandible of last-stage larva of *A. betulivorella.* 11, dorsal aspect
of cephalic segments of pupa of *A. betulivorella.* 12, dorsal aspect of caudal
segments of pupa of *A. betulivorella.*

tinctly greater than distance between D1 and D2; distance between D1 and SD1 on segment 8 less than distance between D1 and D2; crochets biordinal, arranged in a circle, number on prolegs of segments 3, 4, 5, 6, and anal segment 49–50, 48–53, 48–56, 50–52, and 41–44, respectively; diameter of spiracle on segment 6 about ½ as large as basal ring of SD1 on segment 8; diameter of spiracle on segment 7 about ½ as large as diameter of spiracle on segment 8; SD1 on segment 8, 1.32–1.49 mm long; ring at base of SD1 complete, broadly developed except narrow posteriorly; 2 SV setae on each side of segments 8 and 9; D1, D2 and SD1 on segment 9 on separate pinacula; L3 usually present on segment 9.

Pupa
fig. 11, 12

General: Midbody segments distinctly broadened, caudal segments usually elevated. Length 7.88–8.75 mm. Width 2.63–2.75 mm. Mostly yellowish brown with a broad, dorsal reddish-brown longitudinal streak.

Head: Smooth to very slightly wrinkled; distal region broadly rounded.

Thorax: Prothorax smooth to very slightly wrinkled; dorsum of metathorax with 2 groups of about 16 punctures each that do not reach meson.

Abdomen: Cephalic ⅓ to ½ of dorsum of segments 1–4 punctate; punctures, for most part, confined to broad dorsal reddish-brown longitudinal streak, those on all segments far removed from spiracles; punctures on segments 5–7 not encircling segments; D1 and L2 usually present on segment 8; a few setae also present on segment 9; gibba low, only slightly darker than surrounding integument, about 2.5 to 3.5 times as long as wide; cremaster very weakly developed; cremastral "spines" consisting of 6, similar, slender, straight "spines."

Immatures Examined: NORTH CAROLINA: Elizabethtown, 1 last-stage larva, reared from larva collected 25–IV–73, *Betula nigra*, Coll. H.H.N.; 2 last-stage larvae, collected 5–V–72, *Betula nigra*, Coll. H.H.N.; 2 pupae, reared from larvae collected 25–IV–73, *Betula nigra*, Coll. H.H.N. The larva and pupae reared from immatures collected 25–IV–73 have been deposited in the National Museum of Natural History (USNM). The remaining larvae are in the North Carolina State University Museum.

Distribution: *Acrobasis betulivorella* has been collected only in North Carolina. However, its host, river birch, is common at relatively low elevations in swamps and flood plain forests throughout the southeastern United States, and therefore this phycitine probably has a much broader range than presently known.

Biology: Overwintering occurs as small larvae in hibernacula on the twigs of the host plant. Early in the spring (late March to early April in eastern North Carolina) the larvae leave their hibernacula and resume feeding. The exact location on the plant selected by the small larvae is not known, but it seems likely that initially some boring is done into the unfolding buds and the base of the expanding shoot. Eventually the larvae move, usually to the terminal leaves, on the shoot. Margins of the leaves are eaten and a tube is made of silk and frass (fig. 13). Larvae frequently do not complete their development at a single site on the terminal, but move and construct a new tube
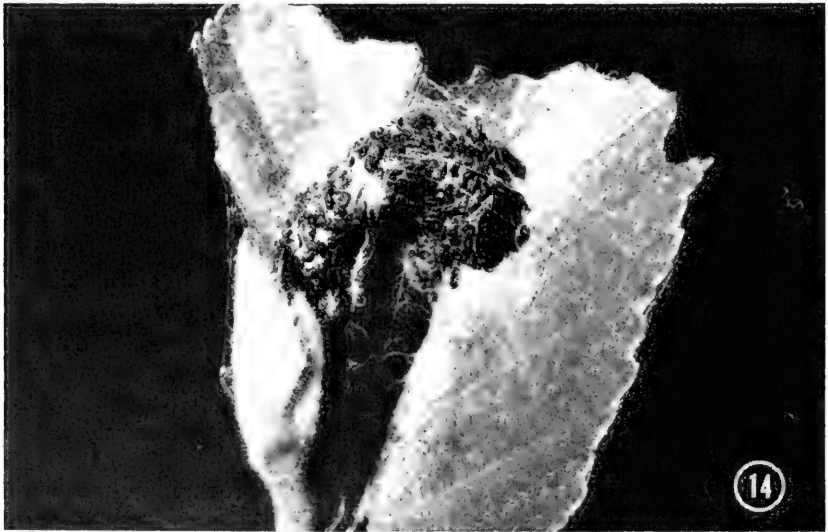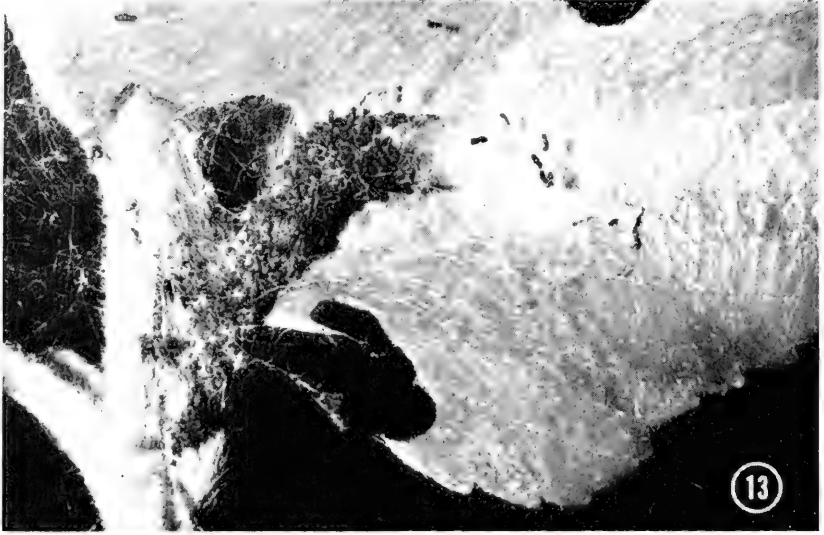
Fig. 13.   Frass tube and feeding injury made by ⅓ to ½ grown larva of *Acrobasis betulivorella* on *Betula nigra*.   Fig. 14. Frass tube and feeding injury made by last-stage larva of *Acrobasis betulivorella* on *Betula nigra*.

at another location (fig. 14).   As the insect approaches the completion of larval development a pupal chamber is constructed at the end of the frass tube.

The completed pupal chamber is subovoid to ovoid, usually whitish

gray with a brown or black frass plug distally, becoming gray and brown or black basally. The length of the chamber is 9.8–12.5 mm, and its maximum diameter is 5.3–6.0 mm.

The larvae pupate about mid- to late May and adults probably occur in the field mostly during June. It is not known if this species is univoltine or multivoltine.

Acrobasis betulivorella has always been collected approximately 2 meters or higher (up to about 8 meters) on host trees. No larvae have been seen on the lower branches of the host. Natural stands of river birch grow only in bottom land and are subject to flooding several times during the year, including at least once early in the growing season when the larvae are feeding. Selective feeding by *A. betulivorella* in the higher branches of trees, apparently dictated by oviposition preference of the females, possibly is an example of adaptive behavior that avoids destruction of the species by drowning.

Discussion

On the basis of general appearance of the adults, habits of the larvae, appearance of the pupae, pupal chamber formation, and host, *Acrobasis betulivorella* appears to be most closely related to *A. betulella*. The pupae of the 2 species are very similar morphologically. However, the following diagnostic features easily separate the adults and larvae of *A. betulivorella* and *A. betulella*.

Adults: *Acrobasis betulivorella*, in general, is darker in this stage; for example, the bases of the labial palpi are gray or white in *A. betulella*, and black in *A. betulivorella*; also, discal spots are distinct in *A. betulella*, contrasting with the surrounding white scales, but this area of the wing is very dark in *A. betulivorella* and discal spots are absent. Males of the 2 species are readily separated in that *A. betulivorella* has wing sex-scaling and *A. betulella* lacks sex-scaling. The genitalia of the 2 species are relatively similar. In males, the uncus of *A. betulivorella* is less elongate posteriorly and the posterior terminal margin of the transtilla is less concave than in *A. betulella*. The bands of scobinations on the genitalia of females, particularly near the union of corpus and ductus bursae, is narrower in *A. betulivorella* than in *A. betulella*.

Larvae: The larva of *A. betulivorella*, in general, is lighter in color than *A. betulella* (fig. 6, 7). This is very apparent in comparing the venter of the 2 species. The venter of *A. betulella* is usually darkly pigmented, being purple or greenish purple. The venter of *A. betulivorella* is a much lighter pale purplish gray or grayish white that distinctly contrasts with the more darkly pigmented dorsum. The larvae of *A. betulivorella* have SD1 and SD2 of the metathorax on separate pinacula (fig. 8). SD1 and SD2 of the metathorax of *A. betulella* are on a single pinaculum (fig. 9).

Reference

Neunzig, H. H. 1972. Taxonomy of Acrobasis larvae and pupae in eastern North America (Lepidoptera: Pyralidae). USDA Tech. Bull. 1457. 158 pp.

BIOLOGY AND IMMATURE STAGES OF TRITOXA INCURVA
(DIPTERA: OTITIDAE)[1]

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ABSTRACT—The life cycle and larval feeding habits of *Tritoxa incurva* Loew were studied for 2 years in northeastern Ohio. The larval stages have as their natural host the bulbs of wild garlic, *Allium canadense* L., but can develop in the laboratory also on bulbs of the commercial onion, *A. cepa* L. There is 1 generation a year. Adults emerge in late spring and early summer and oviposit in mid to late summer. Eggs go into diapause and overwinter, with hatching being delayed until April. Larval development requires 25–52 days and is completed in May or June, with pupation taking place in soil. The pupal period lasts 21–28 days.

The eggs, 3 larval stages, and puparia are described and illustrated. The life cycles of *T. incurva* and *T. flexa* (Wiedemann), the black onion fly, are compared and contrasted. It is concluded that little or no competition exists between the 2 species, because the larval feeding stages are largely separated in time. It is further concluded that *T. incurva* has little potential as a pest of commercial onions due to the fact that this species attacks onion bulbs only during the spring months.

The strictly Nearctic genus *Tritoxa* currently contains 5 species of rather sizeable, reddish-brown to blackish flies that have distinctly patterned wings. Keys to the species are available in Harriot (1942) and Steyskal (1967). *Tritoxa cuneata* Loew is a western species, having been reported from Alberta and Nebraska south to California and New Mexico; *T. flexa* (Wiedemann) has a somewhat broader range and is fairly common in the eastern and midwestern states; *T. incurva* Loew is largely Eastern, ranging from Connecticut to Alberta and south to Florida and Texas; *T. pollinosa* Cole has been recorded only from Oregon, Washington, and Colorado; and *T. ra* Harriot apparently is restricted to California (Steyskal, 1965).

Biological information has been published for only *T. flexa* (Banks, 1912; Chittenden, 1927; Manis, 1941), a species that is known in the economic literature as the black onion fly and which is of some minor importance to growers of commercial onions (Chittenden, 1927; Merrill, 1951; Merrill and Hutson, 1953).

Our discovery that the larvae of *T. incurva* feed on bulbs of wild garlic (*Allium canadense* L.) (fig. 19) suggests that all 5 species of the genus may be associated with various species of onions. The present paper, based on a study of the life history of *T. incurva*

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conducted in northeastern Ohio, elucidates the life cycle, discusses the larval feeding habits, and describes the egg, 3 larval instars, and puparium. A few comparative comments concerning this species and *T. flexa* are also given.

<center>LIFE HISTORY</center>

Figure 18 illustrates the geographic distributions of *T. incurva* and its only known natural host plant, *Allium canadense*. The ranges of the 2 species coincide rather well except that the host plant appears to occur farther north and south than does the fly and the fly ranges farther west than does the host plant. More intensive collecting undoubtedly will reduce these apparent discrepancies in ranges considerably. According to Ownby and Aase (1956, 1959), 10 other species of *Allium* are rather closely related to *A. canadense*, and it is probable that one or more of these genetically similar species also serve as hosts for larvae of *T. incurva*. In laboratory rearings, larvae fed readily on *A. cepa* L., the commercial onion, but failed to develop on *A. tricoccum* Aiton, wild leek. Blanton (1938) failed to find larvae of this species in Narcissus bulbs.

Adults of *T. incurva* (fig. 20) were found most frequently in poorly drained fields, thickets, and open woodlands, habitats where large populations of *A. canadense* also occurred. The first adults of the season were observed in early July, and the adult population had disappeared by mid-October. Populations in nature were largest in late July and early August. Wild caught adults held in breeding jars lived only 16 to 46 days, but laboratory reared flies commonly remained alive 60 to 100 days.

In nature, flies usually were seen on low herbaceous vegetation or on the ground. They moved slowly, rarely flew, and constantly waved their dark-banded wings in a to-and-fro motion similar to that of many Tephritidae. This wing-waving probably played a role in the courtship ritual as did the frequent expansion of an orange-colored membrane from the mouth. Both sexes engaged in the wing-waving and bubble-blowing activities, with the latter being particularly noticeable during the early afternoon hours. Mating usually occurred in the breeding jars between 4 and 7 p.m. No mating was observed in nature.

Preliminary observations and experiments indicate that mating is induced by short photoperiods. Two females which were obtained from larvae that were reared under continuous light never mated and laid a few unpigmented, non-viable eggs 50 days after emerging. Another female that emerged on March 5 was exposed to the natural and artificial lighting of the laboratory. She also never mated and laid only 2 non-viable eggs. Two other females that emerged on February 27 and April 4 laid a few non-viable eggs on March 31 and
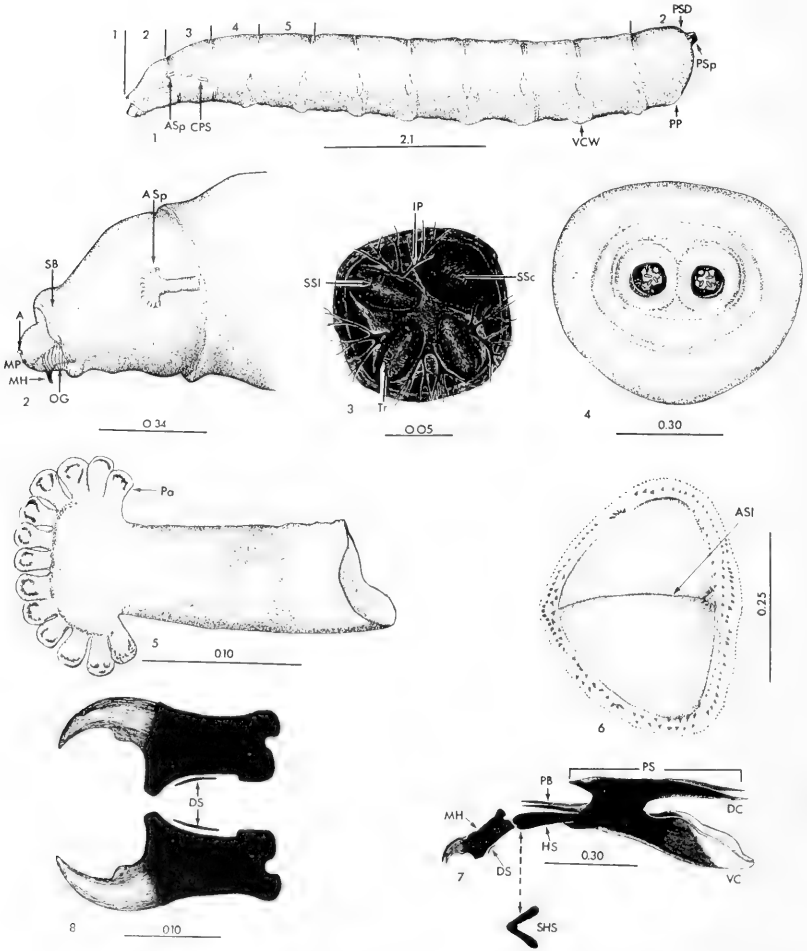
Fig. 1–8.   *Tritoxa incurva*, 3rd instar.   1, lateral habitus.   2, lateral view of anterior end.   3, posterior spiracular plate.   4, posterior spiracular disc.   5, anterior spiracle.   6, perianal pad.   7, cephalopharyngeal skeleton.   8, mouthhooks.

July 18, respectively. In contrast to these results, is the behavior of a pair of adults that emerged in the laboratory on April 11. The eggs, larvae, and puparia of these adults had been maintained in a growth chamber at a temperature of $24 \pm 0.5°$ C. and a photoperiod of 11 hours of light and 13 of dark. The 2 adults were also held at this temperature-photoperiod regime. They first mated on May 13, 32 days after emerging. Mating was frequent and lengthy thereafter and the first viable, normally pigmented egg was laid on May 25. Several

viable eggs were laid subsequently by the female over a 30-day period. Mating in nature probably occurs in late summer.

During mating, the male positioned himself dorsad the female and faced in the same direction. His head was situated just above the female's scutellum, and his wings were slightly extended. The anterior tarsi of the male were placed on the lateral surfaces of the base of the female's abdomen. The remaining tarsi were appressed to the sides of the abdomen at varying distances from the abdomen-thorax juncture. The female's wings were about half extended. Copulation lasted for as long as 90 minutes. The female ended mating by kicking upwards against the male with her hind legs. Mating was seen repeatedly, both before and after oviposition had commenced.

Because the above-ground portions of the host plant wither and disappear long before females begin to oviposit, eggs probably are deposited on the soil surface or slightly buried within it. Females in nature frequently were observed as they moved slowly over the soil surface as if searching for suitable oviposition sites. Possibly chemical compounds emanating from the buried bulbs served as the oviposition stimulus. In the laboratory, eggs were widely scattered over the surface of the peat moss covering the bottom of a breeding jar. Oviposition occasionally occurred even though onion bulbs were not present in the jars. However, a far greater number of eggs were laid in containers that held bulbs.

Females collected in nature produced many more eggs than those obtained in the laboratory rearings. Two females collected on August 21 laid 181 eggs before dying on September 8. Another female taken in nature on September 1 produced 119 eggs on September 17. In contrast, the maximum number of eggs laid by a laboratory-reared female was 17.

Less than 25% of the eggs hatched if they were kept continually at room temperatures (20–25°), and evidence indicates that this species has a relatively intense egg diapause that can be broken by exposing eggs for several days to temperatures slightly above freezing. Thirty eggs laid on September 1 by a field-collected female had not hatched by September 19 when they were dissected. All were found to contain fully-formed, though inactive, first-instar larvae. The excised larvae were then placed on bulbs of wild garlic, but no feeding occurred. Well-embryonated eggs apparently cannot withstand prolonged exposure to zero temperatures, as none of 30 eggs that were held for 30 days at room temperature (22–25°) and then for 30–90 days at 0° C hatched when subsequently returned to room temperatures. Fully formed larval mouthparts were discerned in these eggs some 10 days after they were laid, a strong indication that they were viable before they were subjected to freezing temperatures. The highest hatching percentages occurred in eggs that were incubated
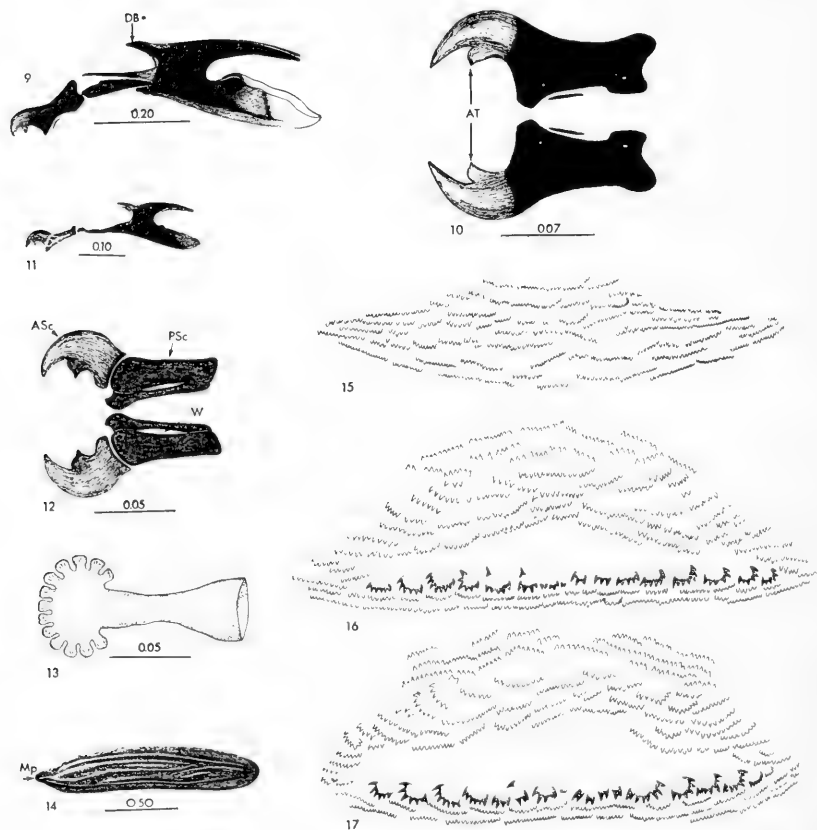
Fig. 9–17. *Tritoxa incurva.* 9, cephalopharyngeal skeleton of 2nd instar. 10, mouthhooks of 2nd instar. 11, cephalopharyngeal skeleton of 1st instar. 12, mouthhooks of 1st instar. 13, anterior spiracle of 2nd instar. 14, egg. 15, ventral creeping welt of segment 5 of 3rd instar. 16, same, segment 7. 17, same, segment 11.

at room temperatures for 30 days and then held at 5–7°C for 120–130 days before being returned to temperatures between 22 and 25° C. Up to 70% of the eggs so treated hatched. Diapause development, however, probably can be completed in 55–75 days, as several eggs that were subjected to 5–7° C. temperatures for that period of time eventually hatched. Ten eggs that were incubated for 30 days at room temperatures were subsequently buried in an inch of soil outside of the laboratory on November 3. Nine of the 10 eggs hatched between March 25 and April 5; the remaining egg had collapsed. Very small larvae also were found in nature on the bulbs of the host plant during April.

Fig. 18.   Distribution of *Tritoxa incurva* (dots) and its host plant, *A. canadense* (oblique lines).

In the laboratory, larvae fed readily on wild garlic, *A. canadense*, and the commercial onion, *A. cepa*. In contrast, larvae placed on small bulbs of the wild leek, *A. tricoccum*, failed to feed and soon died. When reared on wild garlic, larvae completed development at room temperatures in 25–52 days ($\bar{x} = 34.1$). The 1st stadium lasted 6–10 days ($\bar{x} = 6.6$); the 2nd, 6–12 ($\bar{x} = 6.6$); and the 3rd, 13–30 days ($\bar{x} = 18.8$). The duration of the larval period in larvae reared on commercial onion was somewhat prolonged, with larvae completing development in 23–77 days ($\bar{x} = 40.0$). The 1st stadium was completed in 5–30 days ($\bar{x} = 12.3$); the 2nd, in 8–20 days ($\bar{x} = 11.7$); and the 3rd, in 10–27 days ($\bar{x} = 16.0$).

The larvae caused considerable damage to the host plant, and bulbs infested by larvae in nature were largely destroyed. The softer tissues of the bulbs were completely devoured, with only the outer, more fibrous covering remaining uneaten. The younger larvae were largely, if not entirely, phytophagous but the 3rd instars probably fed to some extent as scavengers on the damaged and decaying remnants of the bulbs. In laboratory rearings 1 bulb of *A. canadense* satisfied the nutritional requirements of 1 larva, and no bulbs collected in nature had multiple infestations of 3rd-stage larvae. Nearly full-grown larvae were found in the field as early as mid-May. Natural infestations rates were low; only 1–5% of the wild garlic bulbs collected in nature contained larvae. Infested bulbs were easily recognized by the small mass of jelly-like material that accumulated on the surface of the bulb near the site of larval feeding.

Larvae did not feed for 12–24 hours prior to forming puparia. They abandoned the bulbs and moved into the surrounding soil, where they subsequently pupated. The prepupal period, from formation of the puparium to the actual appearance of the pupa, was 2–3 days. The pupal period for 10 males was 21–26 days ($\bar{x} = 23$); for 9 females, 24–28 days ($\bar{x} = 27$).

Bulbs of *A. canadense* collected in nature during the spring and early summer months were heavily infested by larvae of the lepidopteran, *Acrolepia incertella* (Chambers) (Yponomeutidae). Undoubtedly these larvae competed to some extent with those of *T. incurva* for the available bulbs.

With an egg diapause that probably lasts 2–3 months in nature, a larval period of 25–52 days, and a pupal stadium of 21–28 days, there probably is only a single generation of this species produced each year in the northeastern states. Overwintering occurs as diapausing eggs in soil. Larval feeding begins in April and ends in June. Pupation takes place in late June and July, and adults are present between early July and mid-October. There is a slight possibility that the few larvae that hatch from non-diapausing eggs in late summer can complete development and produce a 2nd generation of adults in the fall before cold weather halts all activity. However, no more than 25% of the eggs hatched without diapausing, and there was no noticeable increase in adult populations in nature during the late summer or early fall months.

DESCRIPTIONS OF IMMATURE STAGES

Egg (fig. 14): Length 1.48–1.62 mm; maximum width 0.31–0.36 mm. Yellowish tan. Cylindrical, bluntly rounded posteriorly, more pointed anteriorly. Chorion of newly laid egg striate; ridges disappearing as egg becomes turgid with water. Micropyle (Mp) terminal on small tubercle. (20 spms.)

First Instar: Similar to 3rd instar except in following characters. Length 1.48–
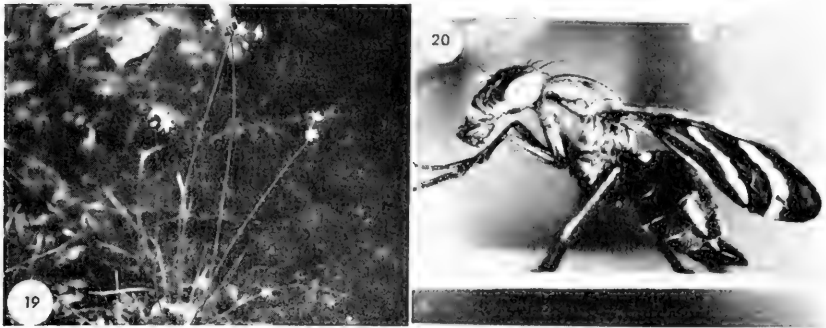
Fig. 19–20.   *Tritoxa incurva.* 19, host plant of larvae, *A. canadense.* 20, adult female.

3.20 mm; maximum width 0.25–0.51 mm. White, integument transparent; posterior spiracular disc with pebbled integument. Each posterior spiracular plate with V-shaped spiracular opening and 4, branching interspiracular processes. No anterior spiracles. Cephalopharyngeal skeleton (fig. 11) length 0.36–0.41 mm, black, lacking parastomal bars. Mouthhooks (fig. 12) paler, composed of 2 separate sclerites; anterior sclerite subtriangular and with 1 accessory tooth, posterior sclerite with ventral window. (10 spms.)

Second Instar: Similar to 3rd instar except in following characters. Length 2.94–4.30 mm; maximum width 0.51–0.56 mm. Anterior spiracles (fig. 13) yellowish white, rosette-shaped, and with 12–13 marginal papillae. Posterior spiracular plates circular. Cephalopharyngeal skeleton (fig. 9) length 0.61–0.70 mm; maximum width 0.17–0.19 mm. Mouthhooks bidentate (fig. 10). (20 spms.)

Third Instar (fig. 1):   Length 5.30–11.00 mm; maximum width 0.90–1.98 mm. Yellowish white, integument transparent; fat bodies of larva yellowish to white just prior to pupation. Conic-cylindrical, tapering anteriorly from 2nd abdominal segment. Segment 1 bilobed distally, each lobe bearing short, fleshy 2-segmented antenna apically. Maxillary palps ventral to antennae, each with C-shaped maxillary ring. Facial mask of segment 1 (fig. 2) with numerous oral grooves leading into oral opening.

Anterior margin of segment 2 with 5–6 rows of minute spinules encircling larva; anterior margins of segments 3–12 with only 2–3 encircling rows of minute spinules. Venter of segments 5–12 each with well defined creeping welts; welt of segment 5 (fig. 15) with single undivided spinule patch, and with all spinules directed posteriorly. Creeping welts on segments 6–9 (fig. 16) with spinule patch of 2 sections; 1st 3 rows of section 1 with spinules directed anteriorly, remaining spinules of that section directed posteriorly; 1st spinule row of section 2 with large, black, claw-shaped, posteriorly-directed spinules, remaining spinules small and posteriorly directed. Creeping welts on segments 10–12 (fig. 17) with spinule rows in 3 sections; 1st 3 rows of section 1 with spinules directed anteriorly; all remaining spinules directed posteriorly; 1st row of 3rd section with large, black, claw-shaped spinules. Perianal pad (fig. 6) on venter of segment 12 with single longitudinal slit, pad bordered by 2–3 rows of small spinules.

Anterior spiracles (fig. 5) posterolateral on segment 2, yellowish white, fan

shaped, with 11–14 ($\bar{x} = 13$) marginal papillae. Posterior spiracular plates (fig. 3) slightly pointed above spiracular scar, at apices of rather large, black spiracular tubes (fig. 1); spiracular scars circular and lighter in color; each spiracular plate with 3 diverging spiracular slits and 4, 3-branching interspiracular processes. Spiracular disc on segment 12 (fig. 4) circular, without lobes.

Cephalopharyngeal skeleton (fig. 7) length 0.99–1.04 mm; strongly sclerotized except on posterior portion of ventral cornua. Pharyngeal sclerite and hypostomal sclerite fused; dorsal cornua of pharyngeal sclerite joined anterodorsally by bridge; floor of pharyngeal sclerite without ridges; parastomal bars well-developed and extending forward nearly to mouthhooks, not connected apically. Hypostomal sclerite H-shaped in ventral view; subhypostomal sclerite below anterior end of hypostomal sclerite V-shaped. Mouthhooks (fig. 8) strongly sclerotized except on apex of hook part, without windows, not connected dorsally; accessory tooth on each mouthhook reduced. Dentate sclerite below each mouthhook long and narrow. (10 spms.)

Puparium: Length 5.73–6.90 mm; maximum width 1.67–2.21 mm. Largely reddish yellow and translucent, more reddish anteriorly. Cylindrical; truncate posteriorly, narrowed anteriorly and flattened dorsoventrally to form lateral ridges on cephalic caps. Anterior spiracles anterolateral on dorsal cephalic cap, fan-shaped, reddish yellow, and with 11–14 marginal papillae. Posterior spiracular disc oval; spiracular plates at apices of prominent, black spiracular tubes; plates with yellowish interslit areas. Puparium retaining spinule bands and creeping welts of 3rd instar. (20 spms.)

Discussion

In spite of its wide distribution in the Holarctic Region and elsewhere and the relative abundance of many of its species, the biology of the family Otitidae is surprisingly poorly known. Very few species have any economic importance, and the life histories of the non-pest species have been largely ignored. According to Allen and Foote (1967), the larval feeding-habits for only 41 of the 450 described species of Otitidae have been elucidated. The morphology of the developmental stages is even less known. Nearly all of the reared species have saprophagous larvae (Oldroyd, 1964), and very few of the 130 North American species of the family are known to be phytophagous (Valley et al., 1969).

Phytophagous larvae can be easily distinguished from saprophagous larvae by the absence of Y- or T-shaped ridges in the floor of the pharynx. These ridges form a filtering mechanism that allows for the straining out of particulate matter, including microorganisms, from a semi-liquid medium (Dowding, 1967). They appear as lines along the lower edge of the pharyngeal sclerite when the cephalopharyngeal skeleton is viewed laterally (Allen and Foote, 1967, fig. 5). Larvae of 2 examined species of *Tritoxa* lack pharyngeal ridges, as would be expected from their phytophagous habits.

Larvae of 2 species of *Tritoxa* are the only otitids currently known to attack bulbs of wild onions. The other phytophagous species of

Table 1.   Life Cycle Differences In *Tritoxa flexa* and *T. incurva*

	No. Gen. per year	Emergence Time	Preovip. Period	Egg Period	Larval Period	Pupal Period	Larval Feeding Time	Over-wintering Stage
T. flexa	2–3	May	2 weeks	4 days	24 days	15 days	June–Sept.	larvae, pupae
T. incurva	1	early June	4 weeks	months	34 days	25 days	April–June	eggs

the family are associated with the inflorescences of certain grasses (*Eumetopiella rufipes* (Macquart), Valley et al., 1969), roots of sugar beets (*Tetanops myopaeformis* (Roder), Hawley, 1922), corn (*Eumecosomyia nubila* (Wiedemann), Steyskal, 1966), and cherries (*Pterotaenia fasciata* Wiedemann, Porter, 1922).

The only other species of *Tritoxa* for which the larval feeding-habits and general natural history are known is *T. flexa*. Perusal of the papers by Banks (1912), Chittenden (1927), and Manis (1941) indicates that several differences in the basic life cycle of the 2 species exist (Table 1). These differences indicate that little, if any, competition occurs between *T. flexa* and *T. incurva*, even though they have rather similar distributions. The natural host of *T. flexa* is unknown but undoubtedly is 1 or more species of the onion genus *Allium*. No larvae of *T. flexa* were found in the numerous bulbs of *A. canadense* that we examined, but even if wild garlic could be the natural host, competition with larvae of *T. incurva* would not exist due to the distinctly different times of larval feeding. Larvae of *T. incurva* attack onion bulbs during the months of April, May and early June, whereas those of *T. flexa* do not even hatch until early summer. Thus, most of the *T. incurva* larvae have formed puparia before the larvae of *T. flexa* begin feeding. Manis (1941) reported that adults of *T. incurva* were found in fields of commercial onion (*A. cepa*) that also contained large populations of *T. flexa*, and our laboratory rearings indicate that larvae of *T. incurva* can develop on the bulbs of the commercial varieties. Once again, however, competition between the 2 *Tritoxa* species would not exist due to the separation of larval feeding times. It would appear that *T. incurva* could be no more than a very minor pest of commercially grown onions, as the plants are not placed in the fields until late spring and thus would not be subjected to much feeding pressure from the larvae of that species. It could well be that the striking differences in life cycles portrayed by the 2 species of *Tritoxa* (Table 1) have resulted from past competition when both utilized a common host. Temporal separation of the larval feeding stages then would have reduced or eliminated competition and permitted both species to survive in the same geographic area. Probably the other 3 species of *Tritoxa* are also associated with

various species of onion but have reduced competition by being restricted to different ranges, different habitats, or different host plants. Thus, we have collected *T. cuneata* in Montana in open woodlands, whereas *T. pollinosa* was taken in open rangeland country in western Wyoming. The larval hosts of these other species are not known.

Recently, Amonkar and Reeves (1970) have reported that oil of garlic, a mixture of several compounds that is present in the bulbs of *A. sativum* L., has insecticidal properties. If this substance is present in the bulbs of *A. canadense*, it is obvious that the larvae of *T. incurva*, and probably other species of *Tritoxa*, have acquired detoxification mechanisms. Thus, it would appear that the species of *Tritoxa*, at the moment at least, are doing well in the evolutionary chemical race between onions and their phytophagous insect enemies. More studies are needed to determine whether other species of *Allium* are resistant to attacks of *T. incurva* larvae. Along these lines, our discovery that the bulbs of wild leek, *A. tricoccum*, cannot be used by the larvae may be of considerable significance.

ABBREVIATIONS USED IN FIGURES

A, antenna; ASc, anterior sclerite; AS1, anal slit; ASp, anterior spiracle; AT, accessory tooth; CPS, cephalopharyngeal skeleton; DB, dorsal bridge; DC, dorsal cornu; DS, dentate sclerite; HS, hypostomal sclerite; IP, interspiracular process; Mp, micropyle; MH, mouthhook; MP, maxillary palp; OG, oral groove on facial mask; Pa, papilla; PB, parastomal bar; PP, perianal pad; PS, pharyngeal sclerite; PSc, posterior sclerite; PSp, posterior spiracle; PSD, posterior spiracular disc; SB, spinule band; SSc, spiracular scar; SSl, spiracular slit; Tr, trabecula; VC, ventral cornu; VCW, ventral creeping welt; W, window.
All measurements indicated by scale lines are in millimeters.

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NOTES ON NEOTROPICAL TABANIDAE: (DIPT.) XV.
SOME SPECIES DESCRIBED BY O. KRÖBER,
FORMERLY IN THE STETTIN MUSEUM[1]

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ABSTRACT—Types of 6 previously unrecognized species of Tabanidae described by O. Kröber were studied on loan from Warsaw, Poland. *Fidena ruficornis* Kröber remains unique. *Dichelacera difficilis* Kröber appears valid in *Catachlorops* (*Psarochlorops*) as catalogued (Fairchild 1971). *Stibasoma fulviventre* Kröber is no more than a color form of S. *willistoni* Lutz (new synonymy). *Tabanus* (*Phaeotabanus*) *criton* Kröber 1934 is the same as *Philipotabanus* (*Melasmatabanus*) *keenani* Fairchild 1947 (new synonymy). *Hybostraba albovillosa* is confirmed as synonym of *Tabanus pruinosus* Bigot. *Leucotabanus nigriventris* Kröber is valid. Synonymy of T. *umbraticolus* Fairchild with T. *lacajaensis* Kröber, whose type is destroyed, was confirmed through topotypical specimens determined by Kröber. *Phaeotabanus ecuadoriensis* Kröber becomes a subspecies of *Philipotabanus* (*Melasmatabanus*) *fascipennis* Macquart (new status). Notes on present status of about 20 other species determined by Kröber and preserved in Warsaw are given.

In previous publications (Fairchild, 1956, 1966, 1967) I discussed the known existing type-specimens of the Neotropical Tabanidae described by Otto Kröber. His types deposited in Hamburg and his own collection were war casualties, while those in Budapest were destroyed during later strife in Hungary. There remain 6 species unaccounted for, which he had deposited in Stettin, East Prussia (now Szczecin, Poland). I had supposed these also to be war casualties, until my friend, the late Dr. Josef Moucha, discovered that they were safely preserved in the Institute of Zoology of the Polish Academy of Sciences in Warsaw. Through the great kindness of Dr. P. Trojan, I have been enabled to study these type-specimens, as well as a number of other specimens determined by Kröber, in some cases species of which the types are no longer extant. In the following discussion the species are listed under the names they bore in Kröber's Catalogue (1934), those represented by types treated first.

Fidena ruficornis (Kröber) 1931, Stett. Entomol. Zeit. 92:90 (*Melpia*).

One male, labelled S. Catarina, Luderwaldt; pink printed Type; det. *Melpia ruficornis* Kröb. 1930, in Kröber's hand. This is a species I have not seen before. Frontoclypeus bulbous, yellow, shiny except for a dorsal pollinose patch. Antennae unusually long, yellow orange. Legs entirely dark. Wings with basal cells lightly infuscated and a

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small cloud at fork of third vein where appendix would be. Body and vestiture blackish brown, including beard and pleura, but with a silvery hair tuft on alula. Abdomen shiny brownish black, with small median tufts of white hairs on terga 3 and 4 and lateral tufts on terga 2, 5, and 6. Beneath, sterna 2, 5, and 6 have sparse white-haired posterior fringes. Kröber's description says there are small white-haired middorsal triangles on terga 4 to 6; I saw them on only 3 and 4. He compares the species to his *Fidena gracilis* (= *F. eri-omeroides* Lutz), but that species has black antennae and bicolored legs. It would seem closer to *F. eriomera* Macquart, which also has yellow antennae, but bicolored legs and less extensively bare fronto-clypeus. A male in my collection compared with specimens det. *eriomera* by Lutz agrees in leg color—femora slightly darker than tibiae, but not prominently bicolored—and in having a spot at fork of third vein, but lacks the white-fringed sterna of *ruficornis*. Only additional material will elucidate relationships here.

Dichelacera difficilis Kröber 1931, Stett. Entomol. Zeit. 92:93.

One female labelled Teffe, Hoffmanns S. and with a pink printed Type and Kröber det. 1930 label. The specimen is intact, except for a crushed and somewhat denuded abdomen. Although slightly larger, the type agrees well with a series of specimens in my collection from Mitú, Vaupes, eastern Colombia. It is very close to *Catachlorops* (*Psarochlorops*) *testaceus* (Macquart), differing mainly in having a narrower frons. Specimens from Manaos and Amapá Brazil, British Guiana (Guyana) and Surinam are similar structurally, but with more heavily marked wings, the abdomens varying from nearly im-maculate to those bearing a series of middorsal pale-haired triangles whose size increases from second to fourth or fifth terga. Kröber's statement that the subcallus is bare is misleading, as there are only 2 small worn spots on this structure and my fresher specimens have the subcallus wholly pollinose. The specimen from Demerara (Guyana) was not sent, and may have been retained by Kröber in his collection. It was said to be yellower and with a middorsal row of triangles on abdomen, thus agreeing with some from Guyana in my possession. I believe the name had best be retained for the narrow-fronted form, at least until better evidence for intergradation with *testaceus* appears. The species is correctly listed as *Catachlorops* (*Psarochlorops*) *dif-ficilis* Kröber in my Catalogue (Fairchild, 1971). It is to be noted that Kröber had doubts as to its proper placement in *Dichelacera* and noted its resemblance to *Psalidia ocellata* Enderlein.

Stibasoma fulviventre Kröber 1931, Ann. Mus. Nat. Hungarici, 17:337–338.

One female labelled Espirito Santo ex Coll. Fruhstorfer; a pink and a red printed Type labels; a printed det. Kröber 1930 label, with the

name written in Kröber's hand. A large species, superficially resem-
bling S. *panamense* Curran, but larger than any specimens of that
species. Subcallus silvery pollinose. It is structurally the same as
S. *willistoni* Lutz, but terga 2 to 6 clothed with long reddish-orange
hair, except for anterior lateral fourths of tergum 2, which are black.
Beneath, the abdomen is entirely black and black-haired. Hind tibiae
with somewhat more white hairs basally than most S. *willistoni*, but
otherwise identical. Kröber described the species from 2 specimens,
1 in Stettin, the other in Budapest, the last being described 1st and
in more detail. However the specimen sent to me agrees with his
description of the Budapest specimen in having the abdomen entirely
black beneath, and with the Stettin specimen in having the 2nd tergum
anterolaterally black-haired. I believe this is no more than a color
form of *Stibasoma willistoni*, (new synonymy) though possibly a
geographic race. My available specimens of S. *willistoni* are all from
Guanabara State (Rio de Janeiro). Three have abdomens wholly
black beneath, the 4th is extensively yellow-haired beneath. Whenever
long series from a variety of localities have been available, species of
Stibasoma have proven unusually variable in color, though quite con-
stant in details of head structure.

Tabanus (*Phaeotabanus*) *criton* Kröber 1934, Rev. Entomol. 4(3):304, nom.
nov. for *Phaeotabanus columbianus* Kröber 1931, Stett. Entomol. Zeit. 92:90–91.

One female, labelled Columbien Fusagasuga, E. Pehlke S.; pink
Type; Kröber det. 1930 in Kröber's hand. The specimen is intact and
in good condition. This has already been listed by me (Fairchild,
1971) as *Philipotabanus* (*Melasmatabanus*) *criton* (Kröber). As I
suspected, *Philipotabanus* (*Melasmatabanus*) *keenani* Fairchild 1947,
is the same species (new synonymy).

Leucotabanus nigriventris Kröber 1931, Stett. Entomol. Zeit. 92:92.

Two females labelled Mexico, Chiapas, L. Conradt S. 8–8–07; pink
Type; Kröber det. 1930, in Kröber's hand. The 2nd specimen is from
same locality, collected 26–8–07 and with a pink Cotype (= Paratype)
label. The 3rd specimen indicated in the description was possibly
retained by Kröber. Both specimens intact though quite denuded,
and in good agreement with specimens from Tabasco and Panama
in my collection. The species is about the same size as L. *exaestuans*
L. but more slender, and differs in much more slender reddish an-
tennae with style much longer than basal plate, yellowish and partly
white-haired palpi, yellow wing stigma, narrower frons with thread-
like callus, mesonotum and scutellum both whitish pollinose, and all
terga with white-haired bands. It is close to L. *janinae* Fairchild and
albovarius Walker in structure, but differs in details of coloring and
shape of antennae from both of these.

Hybostraba albovillosa Kröber 1931, Stett. Entomol. Zeit. 92:92–93.

One male labelled Costa Rica H. Schmidt S.; pink printed Type; Kröber det. 1930 in Kröber's hand. The specimen is well preserved, and confirms synonymy given by Fairchild in 1971. It agrees well with a male of *Tabanus pruinosus* Bigot in my collection from Alpoyeka, Morelos, Mexico, though the upper eye facets are dense and long pubescent in the type, but practically bare in my specimen. My specimen also agrees in having blunt orange palpi and similar extent of eye facets. Another reared male from Arizona determined as *pruinosus* has wholly bare eyes, more extensive large facets, falcate or mammillate palpi, and third antennal segment more slender. A third male received after the type had been returned, from Cerro Punta, Chiriqui, Panama, has the long eye pubescence of the type but agrees otherwise with my Mexican male, except for having slightly pointed palpi. Females of this complex seem to vary a good deal, but from my limited and mostly poorly preserved series I am not able to decide whether or not the variation is specific.

Esenbeckia balzapambana Enderlein 1925. Kröber 1932, Rev. Entomol. 2(1):55.

One female labelled Balzapambana, Ecuador, R. Haensch S.; pink Type; yellow Cotypus; Kröber det. 1930 as *Esenbeckia balzapambana* Enderlein. 1 male with same locality and determination labels. These specimens are topotypes, and the female is the type of Kröber's description of that sex—a plesiotype. The female which I compared with Enderlein's male type in Berlin (Fairchild, 1966, p. 5–6) closely matches this female, while the male has an even broader dark middorsal abdominal stripe than Enderlein's type. The species thus seems to be sexually dimorphic, as both Kröber and I associate the same type of female with the male.

Ommallia thiemeana Enderlein 1925. Mitt. Zool. Mus. Berlin. 11(2):389–390. Kröber 1931, Rev. Entomol. 1(3):296 (*Ommallia*).

One male labelled Balzapambana (Ecuador) R. Haensch S.; pink Type; yellow Cotypus; Kröber det. 1930. This is also a plesiotype of Kröber's description of this sex. It agrees closely with female *A. thiemeana* from Ecuador, and differs from males of *thiemeana surifer* Fairchild from Panama in lacking enlarged eye facets and antennal shape, the latter being like the female. It has a long appendix at fork of 3rd vein, which distinguishes it from males of *T. macquarti*. I catalogued the species (Fairchild, 1971) as *Tabanus thiemeana* (Enderlein), which should be *T. thiemeanus* (Enderlein).

Acanthocera formosa Kröber 1930.

One female from Teffe, Amazonas, det. Kröber 1930. Agrees with a homotype in my collection. I consider it a synonym of *Acanthocera*

marginalis Walker, as the wide variations are overlapping and not geographical.

Agelanius modestus Kröber 1931.

One female from Chile det. Kröber with a query and 2 females Chile det. Kröber as *trifarius* Macquart, also with a query. I consider all 3 to be *Dasybasis testaceomaculatus* Macquart.

Amphichlorops planiventris Wiedemann.

One female Espirito Santo, Brazil; 1 female Sta. Catarina, Brazil, 1 det. Kröber 1930. Both are *Stibasoma* (*Rhabdotylus*) *planiventris* Wiedemann.

Amphichlorops venenatus Osten Sacken.

Two females Costa Rica, H. Schmidt S., 1 female Balzapambana (Ecuad.) R. Haensch S. One of the Costa Rica specimens is det. Kröber 1930. All are same, the form with rufous orange hairs on pleura, largely orange-haired palpi and slightly smoky wings. The 1 from Ecuador has slightly more slender antennae. All have protuberant clavate frontal callus extending to vertex in a brown ridge. It is now known as *Stibasoma* (*Rhabdotylus*) *venenatum* (Osten Sacken).

Chlorotabanus inanis Fabricius.

One female, S. Catarina, Brazil. The specimen is not det. Kröber and is *C. parviceps* Kröber.

Dicladocera (*Dasyrhamphis*) *neosubmacula* Kröber 1930.

Three females from St. Inez and Balzapambana, Ecuador, R. Haensch. One of the Sta. Inez specimens is det. Kröber 1930. All are the same species, agreeing with specimens previously discussed under this name (Fairchild, 1966, p. 343). None are true *neosubmacula*, which has broader frons and pilose eyes.

Dichelacera grandis Ricardo.

One female Sta. Catarina, Brazil det. Kröber 1930 is not *grandis* but a form of *januarii* Wiedemann.

Dichelacera marginata Macquart.

Six females Chiapas, Mexico. All are *D. scapularis* Macquart.

Dicladocera fulvicornis Kröber 1931 Rev. Entomol. 1(4):404.

One female Baños (Ecuad.) R. Haensch S. and 1 female Sta. Inez (Ecuad.) R. Haensch. Both det. Kröber 1930. The type was from

Peru and in Kröber's collection. These 2 specimens may have been those mentioned at the end of the description, but if so, it will be difficult to determine which, if either, represents Kröber's concept of *fulvicornis*, since neither agrees with his description. The specimen from Sta. Inez is *Dasychela ocellus* Walker, while that from Baños differs from the description in lacking a clear spot in the discal cell and has an appendix at the fork of the 3rd vein. I do not think Kröber intended either of these specimens as types, as he generally labelled such specimens with a pink Cotype label. True *fulvicornis* will be difficult to recognize, as Kröber says frons about $4\frac{1}{2}$ times as high as wide, though his figure shows it but 3 times as high as wide. Kröber's later reference to the species (1940 p. 78) merely copies the original description. In any case, neither of these specimens is suitable as a neotype for *fulvicornis*.

Esenbeckia vulpes Wiedemann.

One male, Columbien, (Hac. Pehlke) E. Pehlke S., with Kröber det. 1930. This specimen differs from my notes on the type in having largely black legs and basal bands of black hair on all terga, and palpi more spatulate. It agrees with Kröber's description (1932 p. 61) of a male from Ucayali River, Peru. If it is really *vulpes*, which I doubt, it would be a new record for Columbia.

Fidena obscuripes Kröber 1931, Zool. Anz. 95:35.

Eleven females Espirito Santo, Brazil, ex Coll. Fruhstorfer, hand written det. labels not in Kröber's hand. These may be paratypes, as they bear the same locality labels as the Vienna types. As noted previously (Fairchild, 1966, p. 349) none of the specimens in Vienna or Deutsche Entomologische Institut Berlin, bore type-labels. The present specimens agree with my notes on the types, and Dr. Trojan has kindly allowed me to retain one for my collection.

Fidena rhinophora Bell.

One female, Columbien (Hac. Pehlke) E. Pehlke S. det. Kröber 1930. Agrees well with specimens from Darien, Panama, except palpi shorter and abdominal terga 5 and 6 with straw-yellow rather than orange hair.

Fidena basilaris Wiedemann var. *acutipalpis* Kröber 1931, Zool. Anz. 95(1–2): 18.

One female Espirito Santo, Brazil ex Coll. Fruhstorfer, det. Kröber 1930. This is *Fidena leucopogon* Wiedemann (Fairchild, 1971). It cannot be 1 of Kröber's paratypes, as only Ypanema and Bahia specimens were mentioned in original description.

Phaetobanus ecuadoriensis Kröber 1930.

One female, Balzapambana (Ecuad.) R. Haensch S. det. Kröber 1930. This specimen agrees with the description, and also agrees closely with *Philipotabanus* (*Melasmatabanus*) *fascipennis* (Macquart) except for lacking hyaline apex of wing, which is here dilute blackish. I believe Kröber's species best treated as a subspecies: *Philipotabanus* (*Melasmatabanus*) *fascipennis ecuadoriensis* (Kröber) (new status). The type was supposed to be in Halle, but could not be located there by Dr. J. Husing in 1965. Although no Balzapambana specimens were mentioned in the original description, this specimen seems to have been studied by Kröber, and could be made the neotype if the Halle material is proven lost. I have seen another specimen, Zaruma-Machala, El Oro, Ecuador, 10 Apr. 1965, L. E. Peña coll. in Coll. L. L. Pechuman.

Spheciogaster albomarginatus Kröber 1930.

Three females, Columbien (Hac. Pehlke) E. Pehlke S. 1925, 1 with det. Kröber 1930 in Kröber's hand. Six females Columbien (Rio Magdalena) E. Pehlke S.; these also bear Kröber det. labels, but not in Kröber's hand. All 9 specimens are the same species and are *Dichelacera* (*Nothocanthocera*) *trigonifera* (Schin.), a related but apparently distinct species. *Dichelacera trigonifera* is smaller, browner, with a shorter antennal tooth and wholly dark foretibiae. My 2 specimens of *albomarginata* from Choco, Colombia differ from Kröber's description in having both basal cells ¼ to ⅓ hyaline apically, the distal border of this hyaline area is nearly straight, however, not bowed proximally as in *trigonifera*.

Stypommisa affinis Kröber 1929.

One female S. Catarina, Brazil Luderwaldt S. with a handwritten Kröber det. 1930. This specimen does not agree with my notes on paratypes in Vienna (Fairchild 1966 p. 360, fig. 26), and I could not name it. The specimen is not in good condition.

Stypommia flavescens Kröber 1930.

One female Sta. Inez (Ecuad.) R. Haensch S. and det. Kröber 1930 in Kröber's hand. The type is destroyed but there is a neotype in Munich, and I have agreeing specimens. The species is now placed in *Stypommisa*.

Tabanus callosus var. *brunniventris* Kröber 1933.

One female Brasilia, Para 26-11-92, Kröber det. 1930 in Kröber's hand. This is *T. trivittatus* Fabricius, with elongate basal plate of antenna, and confirms placement in the catalogue (Fairchild, 1971). The type is lost and the name a homonym.

Tabanus lacajaensis Kröber 1931.

Two females Costa Rica, H. Schmidt S., Kröber det. 1930. The type was destroyed in Hamburg and 1 of these could well be made neotype. Synonymy of *T. umbraticolus* Fairchild is confirmed.

Tabanus lineola Fabricius 1794.

One female, St. Catarina, Brazil, Luderwaldt S., Kröber det. 1930 in Kröber's hand. This is *T. triangulum* Wiedemann, dark form, the same color form that Kröber (1933) later called *uruguayensis*. The locality is not one that he listed either under *lineola* or *uruguayensis*.

Tabanus unipunctatus Bigot 1892.

One female, Amazonas, São Paulo de Olivença, Hoffmann S., det. Kröber 1930 with query. This is not *unipunctatus* but a species close to *fumomarginatus* Hine. Kröber (1929 pp. 131–133) seems to have confused *unipunctatus* and *fumomarginatus*, reversing the application of the names.

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Kröber, O.   1929.   Ueber einige kleinere Gattungen der südamerikanischen Tabanini. Zool. Anz. 83:47–63, 115–137.

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SOCIETY MEETINGS

817th Regular Meeting—October 3, 1974

The 817th Regular Meeting of the Entomological Society of Washington was called to order at 8 P.M. on Oct. 3, 1974 in the Baird Auditorium of the National Museum of Natural History. Forty-five members and 25 guests were present. Minutes of the two previous meetings were read and approved.

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

Jay Abercrombie, Medical Entomology Project, Smithsonian Institution
William Downing, Cincinnati, Ohio
James F. Edmiston, Grantsville, Md.
Paris L. Lambdin, V.P.I., Blacksburg, Va.
Philip A. Lewis, USEPA, Cincinnati, Ohio
Raymond M. Miller, Iowa State University, Ames, Ia.
Wojciech J. Pulawski, Zoological Institute, Wroclaw, Poland
A. G. Wheeler, Jr., Pennsylvania Dept. of Agric., Harrisburg, Pa.
F. W. Whittemore, Office of Pesticides Programs, EPA, Wash., D.C.

Treasurer Spilman proposed in writing amending the Society's Bylaws, Article IV, Section 1, to read "nine" instead of "seven." If the amendment be passed by ⅔ of the members attending the 818th Meeting, the annual dues would be raised from seven to nine dollars.

President Burks announced that Ernestine B. Swartzwelder was continued by the Executive Committee as a member of the Society without further payment of dues. Members of 15 years or more when retired may request such standing. They are not sent copies of the Proceedings.

The first speaker of the evening was Dr. Ginter Ekis of the Dept. of Entomology, Smithsonian Institution, who spoke on his recent visit to Tassarolo Castle near Turin, Italy, where much of the Spinola Collection is housed.

He was followed by Dr. Ashley Gurney of the Systematic Entomology Laboratory, U.S.D.A., who illustrated with slides the highlights of his recent collecting trip to South Africa.

After a question and answer period, President Burks appointed members to several committees as follows:

Nominating Committee: Vic Adler, Chairman, Kellie O'Neill, and Donald Messersmith.

Auditing Committee: Paul Spangler, Chairman, Douglas Sutherland, and Robert Gordon.

An obituary committee for the late Lucille Yates: Louise Russell, Helen Sollers-Reidel, and Mr. Muesebeck.

The meeting was adjourned at 10 P.M. Cider, cookies, and sickle pears were served following the meeting.

R. J. Gagné, *Recording Secretary*

818th Regular Meeting—November 7, 1974

The 818th Regular Meeting of the Entomological Society of Washington was called to order at 8 P.M. on Nov. 7, 1974 in the Lecture Room of the National

Museum of Natural History. Fifty-five members and 20 guests were present. Minutes of the last meeting were read and approved.

Dr. Burks opened the floor to discussion on the Spilman amendment to the Bylaws, Article IV, Section 1, to read "nine" instead of "seven." There was no discussion and the amendment was passed unanimously. The annual dues are now nine dollars.

Vic Adler, Chairman of the Nominating Committee, announced the following slate of candidates for Society officers in 1975:

President-elect—G. C. Steyskal
Recording Secretary—F. C. Thompson
Corresponding Secretary—R. J. Gagné
Treasurer—T. J. Spilman
Custodian—D. R. Miller
Program Chairman—D. R. Davis
Membership Chairman—J. M. Kingsolver

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

Warren U. Brigham, Illinois Natural History Survey, Urbana, Ill.
Charles S. Henry, George Washington Univ., Washington, D.C.
Robert L. Davidson, Univ. of Vermont, Burlington, Vt.

The first speaker on the program was Dr. Oliver S. Flint of the Dept. of Entomology, Smithsonian Institution, who presented an illustrated account of some of his travels through Argentina. The second speaker, Dr. Suzanne W. T. Batra, spoke on the behavior of wild bees. A brief review of the Apoidea, which includes about 20,000 species in 9 families, was presented. Major topics included (1) characteristics of the families, (2) nesting behavior, and (3) value of wild bees as pollinators. Slides illustrating living representatives of various genera on flowers or at work in their nests, and slides of the mass rearing techniques for alkali bees and alfalfa leafcutter bees were also shown.

Notes and Exhibitions:

Ted Bissell showed a five-slide sequence of the birth of a giant hickory aphid. The slides were made by Lewis Tedders of Byron, Ga.

John Kingsolver showed a 1925 photo of the entomological workers at the U.S.N.M., which included L. O. Howard and E. A. Schwartz.

John Horne told of preparing caterpillars for freeze drying by soaking them in glutaraldehyde for three days. After air drying them for a short time, the caterpillars began to move around. They lived for two more months, without food.

E. C. Bay showed the movies he had taken at the May meeting on the occasion of the last Society meeting in Room 43.

After the introduction of visitors, the meeting was adjourned at 10 P.M. Beer and pretzels were served following the meeting.

R. J. Gagné, *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	$ 6.00
No. 2.	A Classification of Larvae and Adults of the Genus *Phyllophaga*, by Adam G. Boving. 1942	6.00
No. 3.	The Nearctic Leafhoppers, a Generic Classification and Check List, by Paul Wilson Oman. 1949	10.00
No. 4.	A Manual of the Chiggers, by G. W. Wharton and H. S. Fuller. 1952	10.00
No. 5.	A Classification of the Siphonaptera of South America, by Phyllis T. Johnson. 1957	10.00
No. 6.	The Female Tabanidae of Japan, Korea and Manchuria, by Wallace P. Murdoch and Hirosi Takahasi. 1969	12.00

Prices quoted are U.S. currency. Dealers are allowed a discount of 10 per cent on all items. 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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Organized March 12, 1884

OFFICERS FOR 1975

A BILATERAL GYNANDROMORPHIC XYLOCOPA TAKEN IN CALIFORNIA (HYMENOPTERA: APIDAE)

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ABSTRACT—Comparative morphology and notes on foraging behavior of a bilateral gynandromorphic carpenter bee, *Xylocopa brasilianorum varipuncta* Patton, taken in California are provided. The specimen is compared with a bilateral gynandromorphic *X. nigrita* Fabricius from Africa.

Because gynandromorphs are seemingly rare and of interest to many entomologists, attention is drawn to a large gynandromorphic carpenter bee *Xylolopa brasilianorum varipunta* Patton taken in California. The gynandromorphic specimen is described in detail so that students of the phenomenon may conduct comparative studies. Each side (Right-female; Left-male) is described separately.

Descriptive Comments

Female: Head convex in frontal aspect (fig. 1); entire head except malar area with umbilicate punctations; parocular area and posterior margin of vertex densely hairy; frons, genal, and malar areas sparsely hairy; clypeus moderately hairy; labrum with long thick hairs along clypeolabral margin; scrobe slightly hairy. Ocelli symmetrically placed; ocellocular distances nearly equal. Mandible bidentate (fig. 4), polished black except amber outer margin from posterior articulation to imaginary transverse line bisecting mandible. Maxilla black except amber outer margin and proximal flange. Maxillary palpus 6 segmented; stipes mostly black, apically amber; labial palpus apparently 4 segmented. Antenna (fig. 5) 12 segmented, black except amber apex of scape and pedicel.

Mesosoma (fig. 2) black, densely hairy except glabrous central region of scutellum; anterior margin of propodeum yellow with yellow hairs.

Metasoma uniformly black and typically female.

Legs uniformly black; tarsal claws and orbiculae similar on all legs (fig. 7).

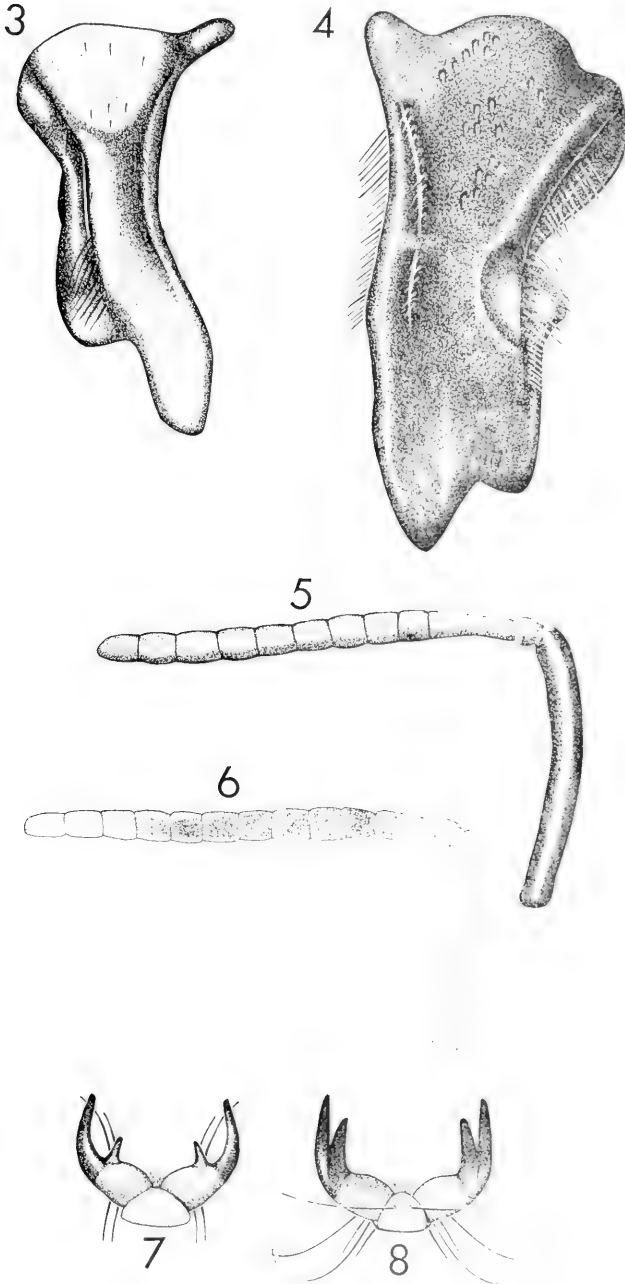Fig. 1, Head, frontal aspect. Fig. 2, Body, dorsal aspect.

Fig. 3, Male mandible, outer aspect. Fig. 4, Female mandible, outer aspect. Fig. 5, Female antenna, frontal surface aspect. Fig. 6, Male antenna, posterior surface aspect. Fig. 7, Female hind tarsal claws and orbicula. Fig. 8, Male hind tarsal claws and orbicula.

Male: Resembling the female except in the following details: vertex concave; parocular area, mandible base, genal area yellow; scrobe amber; parocular, genal, preoccipital areas with yellow setae. Mandible (fig. 3) bidentate, shorter than female mandible and inner tooth truncate; outer margin, apex amber with body blackish. Maxilla shorter than for female, yellowish except amber inner and outer margins and median carina. Antenna (fig. 6) 13 segmented, predominantly yellow except posterior aspect of scape and flagellar segments 1–8, which are dark brown, but progressively less so distally.

Mesosoma (fig. 2) yellow with yellow hairs (pilosity corresponding to that of female) on scutum, scutellum, metanotum; propodeum nearly all yellow except small transverse black strip along anterior margin; ventral portion of mesepimeron black with black hairs.

Metasomal tergum 1 yellow along lateral ⅔, remainder black; tergum 2 nearly all black except yellow anteromesal stripe that extends posteriorly along midline and does not reach posterior tergal margin; extreme lateral and mesal portion of tergum 3 black, remainder yellow; tergum 4 uniformly yellow; tergum 5 mesally yellow, laterally black; tergum 6 with small yellow mesal longitudinal stripe. Sterna uniformly black and undifferentiated from female portion of sterna.

Legs predominantly yellow except following: fore femur uniformly dark along inner surface and anterobasal portion and fore trochanter; middle femur, trochanter and coxa black except yellow beneath apex of femur; hind coxa, trochanter, femur black, brush of hairs along ventral surface of tibia and basitarsus black.

Wings of both sides similar in size; forewings with a little uniform wear; female wings distinctly more smoky.

Genitalia apparently female on both sides; sheaths (valvulae 3) of equal length and setosity; lancet complete, apparently normal; bulb asymmetrical with female side convex, male side concave giving the bulb an appearance of a bent tube.

OBSERVATIONS ON FORAGING BEHAVIOR

Despite the morphological peculiarities mentioned, the gynandromorphic specimen did not appear to have difficulty taking nectar from flowers of *Parkinsonia aculeata* L. (palo-verde). The tree was in partial bloom at the time the specimen was taken (14 August 1973). Three other carpenter bees, apparently normal females of the same species were also foraging on the flowers. The gynandrous specimen was first observed at about 10 feet above the ground foraging on the flowers. It was well out of reach of a standard insect net and thus was observed as it moved from flower to flower. The specimen visited 5 or more flowers before it was captured. Its behavior did not in any visible way differ from that of the normal females which were foraging for nectar on the same tree. No pollen collecting behavior was observed because the specimen did not attempt to collect pollen from the tree. The scopa, when examined in the laboratory, did not contain pollen. Judging from the wings of the specimen, it would appear the individual was relatively young as little wear was apparent. It is quite possible, however, that this bee would have gathered pollen from flowers of other plant species later in life

although some difficulty could be anticipated due to the absence of a scopa on the left metathoracic leg.

Carcasson (1965) has noted the existence of a bilateral gynandromorphic *X. nigrita* Fabricius collected near Kerocho, Kenya, Africa. Both gynandromorphs have several features in common: both are nearly perfect bilateral gynandromorphs with the left side male and the right side female; both have a black apical gastral tergum. The female portion of terga 1 and 2 of Carcasson's specimen has white hairs whereas the California specimen has some black hairs mesally on tergum 1; tergum 2 is nearly all black and the third tergum is mesally black on the male side. Carcasson reported the genitalia of his specimen were normal (female).

The California specimen is deposited in the P. H. Timerlake collection at the University of California, Riverside.

REFERENCE

Carcasson, R. H. 1965. A remarkable gynandrous carpenter bee. J. E. Afr. Nat. Hist. Soc. 25:75.

KEY TO THE GENERA OF SCIOMYZIDAE (DIPTERA) FROM THE AMERICAS SOUTH OF THE UNITED STATES, WITH DESCRIPTIONS OF TWO NEW GENERA

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ABSTRACT—A key is presented to the genera of Sciomyzidae (Diptera) known from the Americas south of the United States including two new genera, **Eutrichomelina** Steyskal (proposed for *Sciomyza fulvipennis* Walker) and **Calliscia** Steyskal (proposed for *Pherbellia callisceles* Steyskal).

Existing keys to the genera of snail-killing flies (Sciomyzidae) from the Americas south of the United States (e.g., Malloch, 1933) are incomplete and out of date. The key presented below includes all genera to be included in the chapter on Sciomyzidae in the catalogue of South American Diptera (Knutson, *et al.*, in press).

Two new genera are described in the key: *Eutrichomelina* Steyskal, for *Sciomyza fulvipennis* Walker; and *Calliscia* Steyskal, for *Pherbellia callisceles* Steyskal. The key also includes the monotypic genus *Pseudomelina* Malloch, based on characters given in the original description. The male holotype of *Pseudomelina apicalis* Malloch (from Puerto Montt, Chile) apparently is not in the British Museum (N.H.), and no other specimens are known to us. The tribal placement of *Pseudomelina*, as discussed by Kaczynski, *et al.* (1969), is in question.

It should also be noted that several genera included in the key are primarily North American taxa that are not known to occur south of the Isthmus of Panama (*Antichaeta, Atrichomelina, Euthycera, Hoplodictya, Sepedon* and *Tetanocera*). References to keys to species are noted for each genus, where pertinent.

1. Propleural bristle present (Sciomyzini, plus *Perilimnia* and **Shannonia** [Tetanocerini]) 2
— Propleural bristle absent, only fine hairs on propleuron (Tetanocerini, plus *Pseudomelina* [Sciomyzini]) 8
2. Propleural bristle short and fine, only slightly larger than propleural hairs; nearly entire meso- and sternopleuron, center of pteropleuron, and upper posterior edge of hind coxa with fine hairs; fore tarsus with basitarsus white, distal 4 segments black (*A. pubera* (Loew)) .... *Atrichomelina* Cresson
— Propleural bristle long and coarse or if short and fine (*Shannonia*) then without the above combination of characters 3
3. Anal vein of wing not reaching margin; wing vein R_1 not extending apicad of anterior crossvein; 2 pairs of dorsocentral bristles; anterior pair very

strong and at suture; arista short pubescent; palpus with 1 strong apical bristle; cheeks very narrow; shiny black or brown species (Malloch, 1933, as *Dichrochirosa*) .... *Parectinocera* Becker

— Anal vein of wing reaching margin, although weakly in some species; without the above combination of characters 4

4. Four pairs of dorsocentral bristles, (1 antesutural and 3 ad- and post-sutural); midfrontal stripe very short, tomentose; wing vein R_1 extending apicad of anterior crossvein (*Sciomyza fulvipennis* Walker, generitype, and *Melina albibasis* Malloch; gender feminine) .... *Eutrichomelina* Steyskal, new genus

— Two or three pairs of dorsocentral bristles, none antesutural 5

5. Three pairs of dorsocentral bristles; mesopleural bristle present; sterno-pleural bristles absent; midfrontal stripe scarcely extending beyond ocellar triangle; 1 pair of fronto-orbital bristles; wing hyaline (*Pherbellia callisceles* Steyskal, generitype; gender feminine) .. *Calliscia* Steyskal, new genus

— Two or three pairs of dorsocentral bristles; both mesopleural and sterno-pleural bristles present or both absent or only sternopleurals present 6

6. Second aristal segment about as long as wide; 3rd antennal segment rather short, rounded apically; 1 or 2 pairs of fronto-orbital bristles; sternopleural bristles present or absent; mesopleuron with or without hairs, without bristles; wing patterned or not .... *Pherbellia* Robineau-Desvoidy

— Second aristal segment 3–5 times longer than wide; 3rd antennal segment rather elongate and tapered apically; 2 pairs of fronto-orbital bristles (anterior pair sometimes small in *Perilimnia*); sternopleural bristles present; mesopleural bristle present or absent; wing hyaline 7

7. Propleural bristle large; anterior orbital bristles smaller than posterior orbitals; 1 mesopleural bristle; male 4th abdominal sternum with short, dense, black spinules along posterior margin (Kaczynski, *et al.*, 1969) .... *Perilimnia* Becker

— Propleural bristle small; anterior orbital bristles well developed, almost as long and strong as posterior oribtals; no mesopleural bristles; male 4th abdominal sternum without short, dense, black spinules along posterior margin (Kaczynski, *et al.*, 1969) .... *Shannonia* Malloch

8. Third antennal segment broadly rounded apically as in *Pherbellia*; ptero-pleuron with 1 or 2 bristles or bristly hairs; hind coxa without bristles or hairs above base of femur; 2 pairs of postsutural dorsocentral bristles (*P. apicalis* Malloch) .... *Pseudomelina* Malloch

— Without the above combination of characters 9

9. Vallar (subalar) bristles present 10

— Vallar bristles absent 11

10. Arista with sparse blackish hairs; lunule covered; face without black central spot (Steyskal, 1974) .... *Dictyodes* Malloch

— Arista densely white-pubescent; lunule broadly exposed; face with black central spot (Steyskal, 1950, 1953) .... *Protodictya* Malloch

11. Ocellar bristles well developed; 4 scutellar bristles 12

— Ocellar bristles small and weak or lacking; 2 scutellar bristles 20

12. Hind tibia with 2 dorsal preapical bristles (Fisher and Orth, 1971) .... *Antichaeta* Haliday

— Hind tibia with 1 or no dorsal preapical bristles 13

13. Arista with white pubescence or hairs; wing with strong pattern 14
— Arista with black pubescence or hairs; wing with or without pattern 16
14. Lunule exposed only mesally, between antennae; 2nd antennal segment
    about half as long as 3rd (Malloch, 1933) .... *Euthycerina* Malloch
— Lunule broadly exposed; 2nd antennal segment at least almost as long as
    3rd segment, sometimes much longer 15
15. 2nd antennal segment about as long as 3rd; head about as long as high
    (*E. mira* Knutson and Zuska) .... *Euthycera* Latreille
— 2nd antennal segment much longer than roundish 3rd segment; head at
    least 1.5 times as long as high (Steyskal, 1960) .... *Teutoniomyia* Hennig
16. Meso- and pteropleuron without bristles or hairs; if hairs present on pos-
    terior part of mesopleuron then wing without dense pattern 17
— Meso- and sometimes pteropleuron with bristles or hairs; wing with dense
    pattern 18
17. Sternopleuron with hairs only; arista long-haired to plumose (Steyskal,
    1959) .... *Tetanocera* Duméril
— Sternopleuron with 2 strong bristles; 0 or 1 presutural dorsocentral bristles,
    3 or 4 postsuturals; arista with short pubescence (Zuska and Berg, 1974)
    .... *Tetanoceroides* Malloch
18. Fronto-orbital bristles 2; 1 strong sternopleural bristle; face without black
    central spot (Fisher and Orth, 1972) .... *Hoplodictya* Cresson
— Fronto-orbital bristle 1; sternopleural bristle lacking; face with or without
    black central spot 19
19. Face with black central spot; body with many dark spots at bases of hairs
    and otherwise (Steyskal, 1954, 1960) .... *Dictya* Meigen
— Face without black central spot; body largely plain tawny (*G. straminata*,
    (Wulp)) .... *Guatemalia* Steyskal
20. Sternum closed above hindcoxae; lower head drawn out into conical ros-
    trum into which proboscis may be withdrawn; palpus not developed; post-
    ocellar and usually fronto-orbital bristles lacking; pleural sclerites without
    hairs or bristles, except a few hairs on propleuron close above forecoxa
    .... *Thecomyia* Perty
— Sternum above hindcoxae divided by membranous area; lower head not
    forming tube into which proboscis may be withdrawn; palpus well de-
    veloped; postocellars present or absent; 1 or 2 pairs of fronto-orbital
    bristles; pleura frequently with numerous hairs 21
21. Postocellar bristles absent; 1 pair of fronto-orbital bristles; midfemur with
    minute bristles or setae, none of which is distinctly larger than the others;
    hind femur almost twice as long as abdomen (Steyskal, 1951) ....
    .... *Sepedomerus* Steyskal
— Postocellar bristles well developed; 0, 1, or 2 pairs of fronto-orbital
    bristles; midfemur with 1 or more distinctly larger anterior setae near its
    midlength; hind femur only about ⅓ longer than abdomen 22
22. Face with black spot in each lower corner; forefemur with at least 1
    outstanding dorsal bristle; male with surstyli fused along median line
    (Steyskal, 1951) .... *Sepedonea* Steyskal
— Face without spots in lower corners; forefemur without outstanding dorsal
    bristle; male with surstyli well separated on median line (Steyskal, 1951)
    .... *Sepedon* Latreille

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NORTH AMERICAN SPECIES OF THE GENUS BRACHYPODA
(ACARINA: ATURIDAE: AXONOPSINAE)[1]

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ABSTRACT—The North American members of the water mite genus *Brachy-poda* Piersig are treated and 2 species, *B.* **fimbricaudata** and *B.* **affinis**, are described as new.

Four species of *Brachypoda* Piersig (and an additional subspecies) have been previously described by Herbert Habeeb from North America. These are: *B. cornipes cornipes*, *B. cornipes owascoa*, *B. setosicaudata*, *B. acuticaudata* and *B. oakcreekensis*. The type-material on which these species were based has been privately retained and all recent attempts to borrow the specimens have been unsuccessful. The previous descriptions and illustrations are lacking in critical detail but, with the exception of *cornipes* and its subspecies, the recollection of specimens at or near the type locality has made identification reasonably certain.

Species diagnoses are based primarily on morphology of the male, especially shape of the cauda and structure of the genital field region. Females, with two known exceptions, are so similar that they cannot be identified to species with certainty. Identification of females based on correlation with males present in the collection is useful but is complicated by the fact that more than one species of *Brachypoda* may occur in the same locality, especially in eastern North America.

Two new species are described, the holotypes and allotypes of which will be placed in the Field Museum of Natural History (Chicago).

KEY TO THE NORTH AMERICAN SPECIES OF *BRACHYPODA*
(BASED ON MALES ONLY)

1. A long ridge on each side extending far anterolaterally from the second pair of acetabula; posterior end of genital field distinctly set off from the ventral shield (fig. 6) .... *B. cornipes* (two subspecies) 2
— Either no ridge or only a short ridge on each side extending anterolaterally from the second pair of acetabula; posterior end of genital field grading almost imperceptibly into the sclerotization of the ventral shield (fig. 8, 14, 15) 3
2. Body 685μ–700μ in length; longest claw on fourth leg 75μ–90μ in length .... *B. cornipes cornipes* Habeeb
— Body 580μ–595μ in length; longest claw on fourth leg 54μ–60μ in length .... *B. cornipes owascoa* Habeeb

3. Lateral edges of genital field with many long setae, some of which extend
   beyond the posterior end of the cauda (fig. 14, 19, 20) 4
— Lateral edges of genital field with a few long setae, none of which extend
   to the posterior end of the cauda (fig. 8, 15) 6
4. A distinct ridge on each side extending between the outer edges of the
   most medial two pairs of acetabula (fig. 19, 20) 5
— No ridges extending between the outer edges of the most medial two pairs
   of acetabula .... *B. setosicaudata* Habeeb
5. Anterior edge of genital field with a continuous row of small setae (fig.
   20) .... *B. fimbricaudata* Cook, n. sp.
— Anterior edge of genital field with a wide setae-free area (fig. 19) ....
   .... *B. affinis* Cook, n. sp.
6. Cauda decidedly narrowed posteriorly (fig. 15) .... *B. acuticaudata* Habeeb
— Cauda only slightly narrowed posteriorly (fig. 8) .... *B. oakcreekensis* Habeeb

Brachypoda (Brachypoda) cornipes Habeeb
Fig. 1–7

Brachypoda cornipes Habeeb, 1956. Leaflets Acadian Biol., 12:1.

Male: Dorsal shield 506μ–586μ in length, 349μ–365μ in width; 2 pairs of greatly enlarged glandularia setae present laterally; stippled areas on fig. 3 illustrate dorsal color pattern; ventral shield 532μ–593μ in length, 365μ–395μ in width; first coxae projecting slightly beyond body; condyles associated with insertions of first legs apparent in ventral view; transverse ridge present immediately anterior to genital field and ridge present on each side extending far anterolaterally from region of second pair of acetabula; 3 pairs of acetabula, first and second pair located very close together; pair of lobed projections present between second and third acetabula (fig. 6); numerous small setae associated with genital field, those at posterior end bifurcate; width between outer edges of most lateral pair of acetabula 204μ–229μ.

Dorsal lengths of palpal segments: P-I, 35μ–38μ; P-II, 62μ–66μ; P-III, 42μ–45μ; P-IV, 93μ–100μ; P-V, 34μ–35μ; projection on ventral side of P-II relatively large; structure of palp similar to that of female (fig. 5) except P-IV bears numerous small setae; dorsal lengths of distal segments of fourth leg: IV-Leg-4, 118μ–128μ; IV-Leg-5, 164μ–186μ; IV-Leg-6, 150μ–173μ; IV-Leg-4 with long projection at distal end, this projection bearing 2 heavy setae at tip; 3 very heavy setae extending ventrally from IV-Leg-4; fig. 2 shows proportions and chaetotaxy of these segments; claws at tip of fourth leg without ventral clawlet; longest claw at tip of IV-Leg-6, 55μ–76μ in length; II-Leg-6 abruptly expanded at proximal end; III-Leg-6 only slightly longer than III-Leg-5.

Female: Dorsal shield (not including excretory pore platelet) 517μ–547μ in length, 358μ–395μ in width; excretory pore platelet 111μ–118μ in width; fig. 1 illustrates structure and color pattern of dorsal shield; length from anterior end of dorsal shield to posterior end of genital field 525μ–547μ; width 410μ–441μ; coxae not projecting; condyles associated with insertions of fourth legs may be seen in ventral view (fig. 7); 3 pairs of genital acetabula; width between outer edges of most lateral pair of acetabula 200μ–207μ.

Dorsal lengths of palpal segments: P-I, 34μ–35μ; P-II, 59μ–64μ; P-III, 39μ–42μ; P-IV, 82μ–89μ; P-V, 34μ–35μ; projection on ventral side of P-II well de-
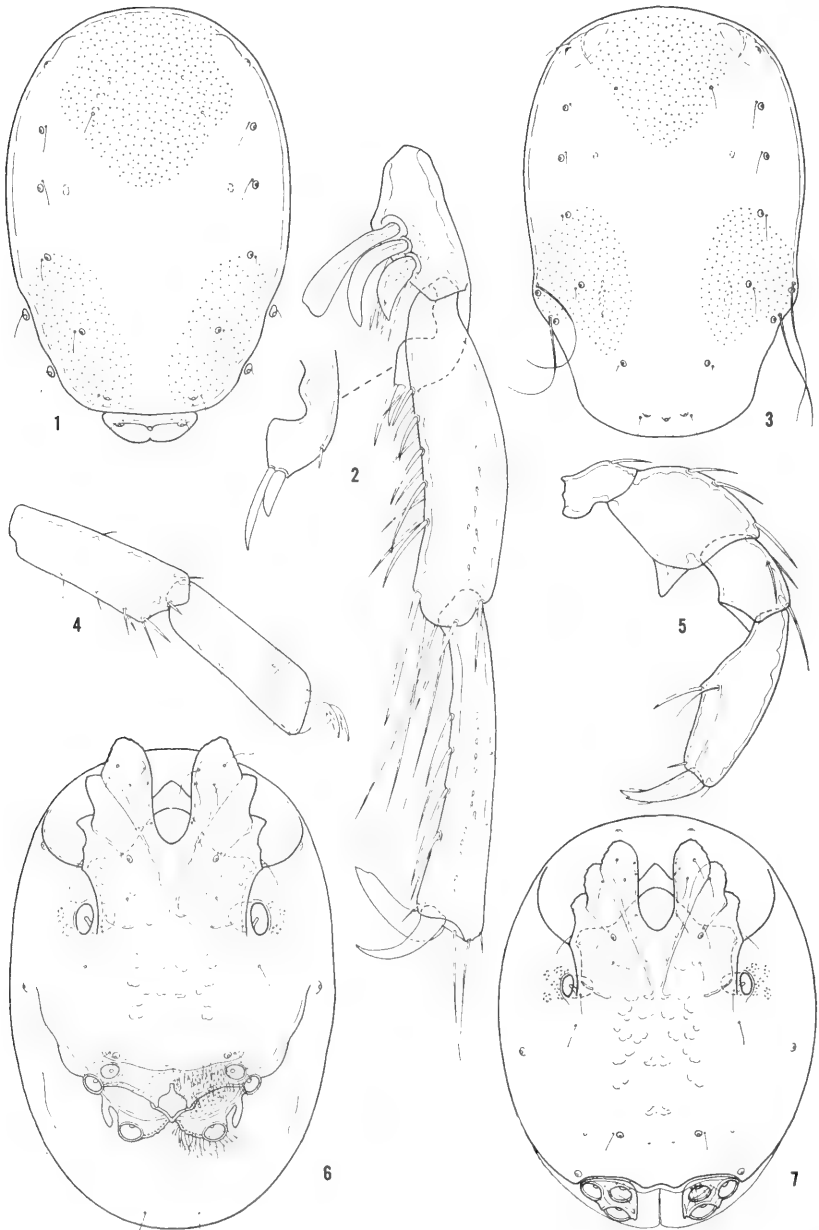
Fig. 1–7, *Brachypoda cornipes.* 1, dorsal shield, female. 2, distal segments of fourth leg, male. 3, dorsal shield, male. 4, I-Leg-5 and 6, female. 5, palp, female. 6, ventral shield, male. 7, ventral shield, female.

veloped; fig. 5 shows proportions and chaetotaxy of palp; dorsal lengths of distal segments of first leg: I-Leg-4, 72μ–79μ; I-Leg-5, 80μ–86μ; I-Leg-6, 80μ–86μ; fig. 4 shows I-Leg-5 and 6.

Material Examined: 9 ♂ ♂, 3 ♀ ♀, taken by stirring up bottom gravels in Black River on Road CC (north of Clear Water Reservoir), Reynolds Co., Missouri, June 21, 1967; 1 ♂, 1 ♀, taken in Flatbrook south of Bevans, Sussex Co., New Jersey, Sept. 7, 1968; 1 ♀, taken by stirring up bottom gravels in Thompson Creek near McClung, Bath Co., Virginia, Sept. 9, 1968; 4 ♂ ♂, from bottom deposits in tributary of Jackson River near Bacova, Bath Co., Virginia, Sept. 9, 1968; 1 ♂, 2 ♀ ♀, from South Branch of Umpqua River near Milo, Douglas Co., Oregon, Aug. 11, 1961.

Discussion: The original description of *cornipes* is so general as to be nearly useless and it includes only a very diagrammatic drawing of the male fourth leg. Thus, in the absence of type or topotypic material, identification of the present species with *cornipes* should be regarded as tentative. However, there is nothing in the original description and drawing which would suggest they are not conspecific. The type locality is a brook in Victoria Co., New Brunswick. Habeeb (1966) described a subspecies, *cornipes owascoa*, from Dutch Hollow Creek in Cayuga Co., New York, stating the latter was smaller and had much shorter claws on the male fourth leg. Habeeb gives a body length of 685μ–700μ for the typical subspecies, 580μ–595μ for *owascoa*. The claws of the fourth leg had a length of 75μ–90μ in *cornipes cornipes*, and a length of 54μ–60μ in the subspecies from New York. All material in the present study falls within the size variation expected in *owascoa*. My specimens from Oregon lack the distinctive color pattern found in the eastern representatives (fig. 1, 3) but otherwise seem similar.

Brachypoda (Ocybrachypoda) oakcreekensis Habeeb, new status

Fig. 8–13

Brachypoda acuticaudata oakcreekensis Habeeb, 1961. Leaflets Acadian Biol., 24:2.

Male: Dorsal shield 494μ–585μ in length, 350μ–410μ in width; no setae on dorsal shield greatly enlarged; ventral shield 486μ–592μ in length, 380μ–441μ in width; first coxae not projecting beyond end of body; condyles associated with insertions of fourth legs not visible in ventral view; indistinct ridge present immediately anterior to genital field; no ridges extending anterolaterally from most lateral pair of acetabula; 3 pairs of genital acetabula; width between outer edges of most lateral pair of acetabula 214μ–266μ; typically with 4 pairs of long setae flanking genital field, these not extending to posterior end of body (fig. 8); posterior end of body (cauda) only slightly narrowed laterally; degree of sclerotization of posterolateral edges of ventral shield variable producing slight indentations in cauda in some specimens.

Dorsal lengths of palpal segments: P-I, 32–36μ; P-II, 59μ–66μ; P-III, 34μ–37μ;
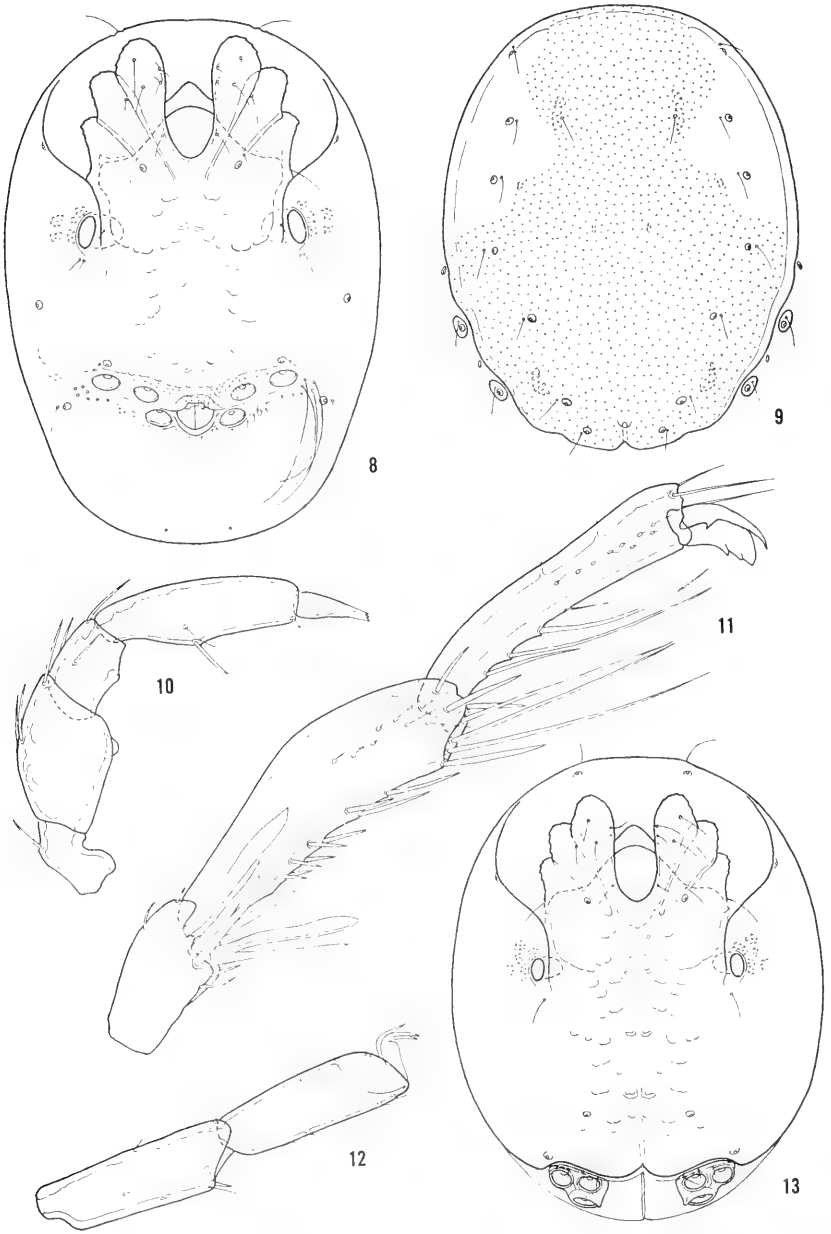
Fig. 8–13, *Brachypoda oakcreekensis.* 8, ventral shield, male. 9, dorsal shield, female. 10, palp, female. 11, distal segments of fourth leg, male. 12, I-Leg-5 and 6, female. 13, ventral shield, female.

P-IV, 84μ–98μ; P-V, 31μ–34μ; projection on ventral side of P-II moderately developed; structure of palp similar to that shown for female except surface of P-IV bears numerous small setae; capitulum 124μ–135μ in length, chelicera 118μ–131μ in length; dorsal lengths of distal segments of fourth leg: IV-Leg-4, 66μ–83μ; IV-Leg-5, 159μ–190μ; IV-Leg-6, 149μ–169μ; most distal of 2 long setae on ventral side of IV-Leg-6 located near middle of segment; fig. 11 shows specialized chaetotaxy of IV-Leg-4; 1 claw of fourth leg with ventral clawlet.

Female: Dorsal shield 502μ–608μ in length, 395μ–412μ in width; excretory pore platelet fused with dorsal shield (fig. 9); length from anterior end of ventral shield to posterior end of genital field 517μ–592μ, width 426μ–456μ; coxae not projecting to anterior end of body; condyles associated with insertions of fourth legs not visible in ventral view (fig. 13); 3 pairs of genital acetabula; width between outer edges of most lateral pair of acetabula 211μ–222μ.

Dorsal lengths of palpal segments: P-I, 35μ–38μ; P-II, 62μ–69μ; P-III, 35μ–38μ; P-IV, 85μ–96μ; P-V, 34μ–36μ; projection on ventral side of P-II moderately developed; fig. 10 shows proportions and chaetotaxy of palp; capitulum 130μ–141μ in length, chelicera 128μ–131μ in length; dorsal lengths of distal segments of first leg: I-Leg-4, 71μ–76μ; I-Leg-5, 83μ–90μ; I-Leg-6, 76μ–83μ; fig. 12 illustrates I-Leg-5 and 6.

Material Examined: 3 ♂ ♂, 13 ♀ ♀, taken in Oak Creek in Oak Creek Canyon (type-locality), Coconino Co., Arizona, Oct. 24, 1970; 22 ♂ ♂, 21 ♀ ♀, taken in Little Creek on Highway 15 near Gila Cliff Dwellings National Monument, Catron Co., New Mexico, Oct. 21, 1970; 1 ♂, 1 ♀, taken in Moccasin Creek, Tuolumne Co., California, Oct. 26, 1970; 5 ♂ ♂, 3 ♀ ♀, from South Fork of Trinity River, Trinity Co., California, July 30, 1966; 1 ♂, 1 ♀ collected in Gibbon River above Virginia Cascades, Yellowstone National Park, Wyoming, Sept. 1, 1961.

Discussion: *Brachypoda oakcreekensis* and all of the remaining species are assigned to the subgenus *Ocybrachypoda*, the latter erected by Cook (1974). This subgenus is predominantly a North American group but the European species *B. celeripes* Viets is also included. The original description of *oakcreekensis* is inadequate and lacking in illustrations. However, there apparently is only one species present in the type locality and identification therefore seems reasonably certain. The most distinctive feature of the present species is the fusion of the excretory pore platelet with the dorsal shield in the female (fig. 9). In females of all other species of *Brachypoda*, this platelet (fig. 21) is separate. The largest measurements given are from the individuals collected in Yellowstone National Park. Specimens from the type locality are nearer the low end of the size range.

Brachypoda (Ocybrachypoda) setosicaudata Habeeb

Fig. 14, 17

Brachypoda setosicaudata Habeeb, 1953. Leaflets Acadian Biol., 1:12.

Male: Dorsal shield 646μ–714μ in length, 441μ–458μ in width; no setae of dorsal shield greatly enlarged; ventral shield 638μ–745μ in length, 456μ–516μ
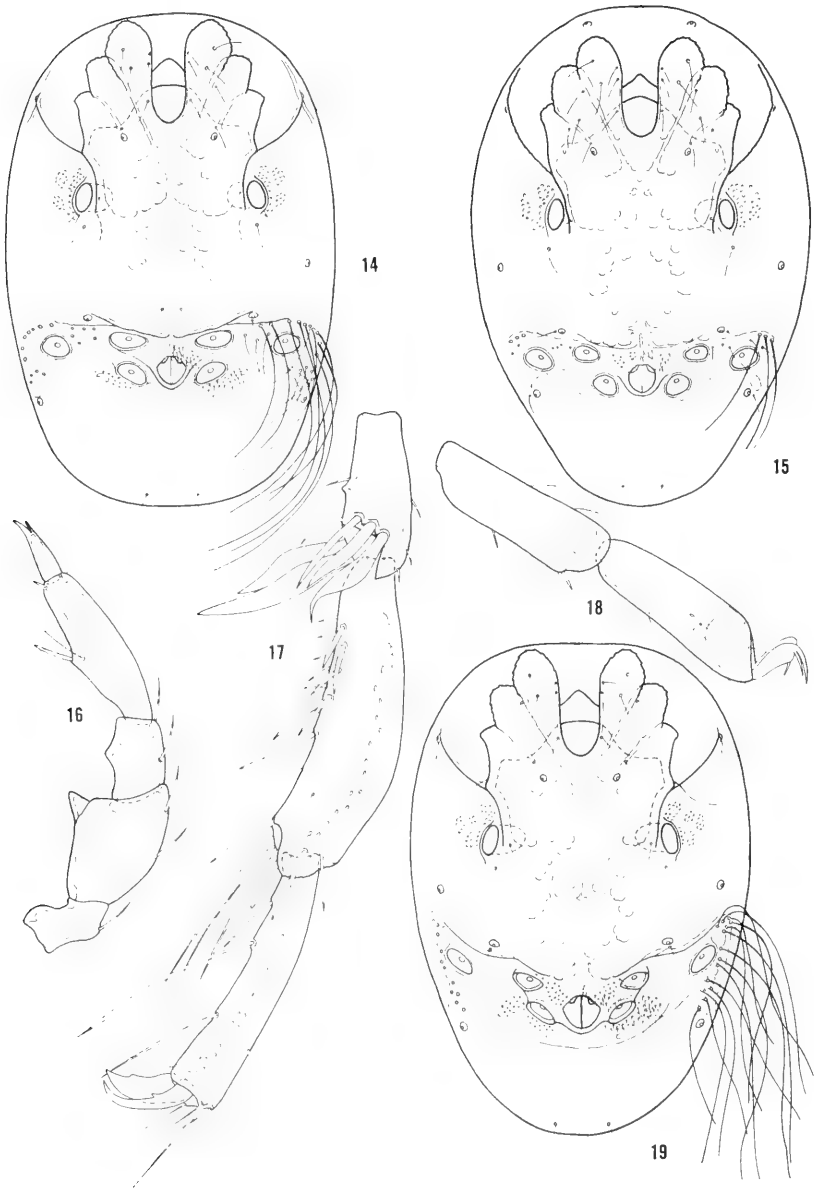
Fig. 14–19, *Brachypoda* spp. 14, *B. setosicaudata*, ventral shield, male. 15, *B. acuticaudata*, ventral shield, male. 16, *B. affinis*, palp, female. 17, *B. setosicaudata*, distal segments of fourth leg, male. 18, *B. affinis*, I-Leg-5 and 6, female. 19, *B. affinis*, ventral shield, male.

in width; first coxae extending nearly to anterior end of body; condyles associated with insertions of fourth legs not visible in ventral view; well developed ridge present immediately anterior to genital field which extends to associated pair of glandularia and indistinct ridge on each side extending to area of most lateral glandularia; 3 pairs of genital acetabula; width between outer edges of most lateral pair of acetabula 348μ–362μ; indistinct ridge on each side extending from gonopore to first pair of acetabula; numerous long setae present in lateral portions of genital field, some of which extend well beyond posterior end of cauda (fig. 14); posterior end of body somewhat truncate and only slightly narrowed.

Dorsal lengths of palpal segments: P-I, 38μ–42μ; P-II, 69μ–73μ; P-III, 44μ–48μ; P-IV, 116μ–126μ; P-V, 35μ–38μ; projection on ventral side of P-II well developed; surface of P-IV with numerous small setae; capitulum 149μ–156μ in length, chelicera 142μ–145μ in length; dorsal lengths of distal segments of fourth leg: IV-Leg-4, 97μ–104μ; IV-Leg-5, 196μ–214μ; IV-Leg-6, 177μ–189μ; most distal of 2 long setae on ventral side of IV-Leg-6 located near distal end of segment; fig. 11 shows specialized setae of IV-Leg-4; 1 claw of fourth leg with ventral clawlet.

Female: Dorsal shield (not including the excretory pore platelet) 577μ–668μ in length, 440μ–486μ in width; excretory pore platelet free and 126μ–155μ in width; length from anterior end of ventral shield to posterior end of genital field 608μ–707μ, width 486μ–547μ; coxae not extending to anterior end of body; condyles associated with insertions of fourth legs not visible in ventral view; 3 pairs of genital acetabula; width between outer edges of most lateral pair of acetabula 266μ–295μ.

Dorsal lengths of palpal segments: P-I, 38μ–39μ; P-II, 64μ–66μ; P-III, 42μ–44μ; P-IV, 97μ–107μ; P-V, 33μ–36μ; dorsal lengths of distal segments of first leg: I-Leg-4, 80μ–93μ; I-Leg-5, 87μ–100μ; I-Leg-6, 96μ–101μ.

Material Examined: 2 ♂ ♂, 18 ♀ ♀, collected in Adam's Creek approximately 5 miles east of Mesick, Wexford Co., Michigan, July 13, 1959; 1 ♂, 3 ♀, taken in Miner River immediately above Miner's Falls, Alger Co., Michigan, Aug. 27, 1959; 1 ♂, from Duck Creek 1 mile south of Watersmeet, Gogebic Co., Michigan, Aug. 14, 1960; 1 ♂, 1 ♀, from Jardine Brook 10 miles southwest of St. Quentin, Victoria Co., New Brunswick, Aug. 27, 1964; 2 ♂ ♂, 1 ♀, taken in headwaters of Grand River, Victoria Co., New Brunswick, Sept. 3, 1968; 1 ♂, from stream in Howard Co., Maryland, Nov. 1952.

Discussion: The long setae flanking the genital field, only slightly narrowed posterior end of the body and lack of distinct ridges extending between the outer edges of the most medial two pairs of acetabula is diagnostic for males of the present species. Females of *setosicaudata* and the following species are very similar and can be distinguished with certainty only by association with the male. As mentioned in the introduction, this association is complicated by the possible occurrence of two or more species of *Brachypoda* in the same area, especially in eastern North America. Measurements are given for the female but the possibility exists that the series contained a mixture of species. The female venter is similar to that shown in fig. 13 but the dorsal shield resembles that illustrated in fig. 21.

Brachypoda (Ocybrachypoda) acuticaudata Habeeb
Fig. 15

Brachypoda setosicaudata acuticaudata Habeeb, 1953. Leaflets Acadian **Biol.**
1:12.
Brachypoda acuticaudata Habeeb, 1961. *op. cit.*, 24:2.

Male: Dorsal shield 586μ–638μ in length, 395μ–426μ in width; no setae of dorsal shield greatly enlarged; ventral shield 593μ–662μ in length, 425μ–471μ in width; first coxae not extending to anterior end of body; condyles associated with insertions of fourth legs not visible in ventral view; moderately developed ridge present immediately anterior to genital field; 3 pairs of genital acetabula, most posterior pair of which are closest to gonopore; width between outer edges of most lateral pair of acetabula 288μ–314μ; typically with 3 pairs of long setae present in lateral portion of genital field, but these not extending to posterior end of body (fig. 15); cauda decidedly narrowed posteriorly.

Dorsal lengths of palpal segments: P-I, 35μ–38μ; P-II, 61μ–66μ; P-III, 39μ–43μ; P-IV, 104μ–111μ; P-V, 31μ–34μ; projection on ventral side of P-II well developed; surface of P-IV with numerous small setae; capitulum 148μ–155μ in length, chelicera 142μ–145μ in length; dorsal lengths of distal segments of fourth leg: IV-Leg-4, 80μ–89μ; IV-Leg-5, 176μ–190μ; IV-Leg-6, 155μ–161μ; chaetotaxy of these segments as described and illustrated for preceding species (fig. 17).

Female: Similar to that of *setosicaudata* but averaging somewhat smaller. However, larger individuals of *acuticaudata* are larger than smaller specimens of the former, and therefore a female unassociated with the male cannot always be identified with certainty. Individuals, apparently belonging to the present species, had a dorsal shield length (not including the excretory pore platelet) of 547μ–608μ.

Material Examined: 1 ♂, 2 ♀ ♀, from Little Wapskehegan River east of Plaster Rock, Victoria Co., New Brunswick, Sept. 5, 1968; 1 ♂, collected in stream flowing into St. Froid Lake (near the town of Eagle Lake), Aroostook Co., Maine, Sept. 3, 1968; 12 ♂ ♂, 5 ♀ ♀, from Flatbrook south of Bevans, Sussex Co., New Jersey, Sept. 7, 1968.

Discussion: The present species seems most closely related to *B. setosicaudata*. It differs in its narrowed cauda and fewer and shorter setae flanking the genital field (compare fig. 14, 15). The male of *acuticaudata* somewhat resembles the western species, *B. oakcreekensis*, but the latter has a much less narrowed cauda. Females of these latter two species are very distinctive for the excretory pore platelet of *oakcreekensis* is fused with the dorsal shield.

Brachypoda (Ocybrachypoda) fimbricaudata Cook, new species
Fig. 20–25

Male: Dorsal shield 608μ in length, 395μ in width; no setae of dorsal shield greatly enlarged (fig. 25); ventral shield 616μ in length, 425μ in width; first coxae not extending to anterior end of body; condyles associated with insertions of fourth legs not visible in ventral view; well developed ridge present immediately anterior to genital field; 3 pairs of genital acetabula; width between outer edges of most lateral pair of acetabula 311μ; short ridge present on each side extending
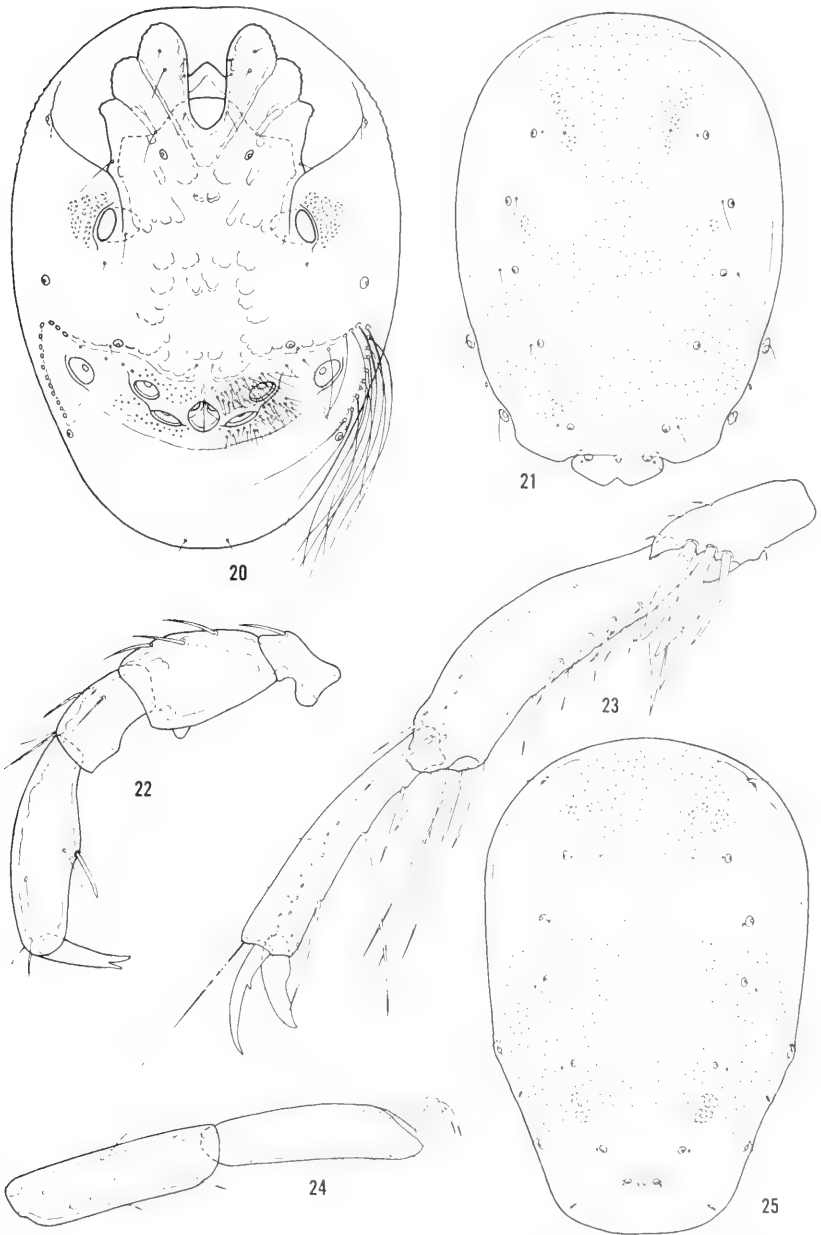
Fig. 20–25, *Brachypoda fimbricaudata*. 20, ventral shield, male. 21, dorsal shield, female. 22, palp, female. 23, distal segments of fourth leg, male. 24, I-Leg-5 and 6, female. 25, dorsal shield, male.

between outer edges of most medial 2 pairs of acetabula (fig. 20); numerous long setae present lateral to genital field, several of which extend well beyond posterior end of cauda; several shorter setae forming continuous row slightly anterior to acetabula; posterior end of body somewhat narrowed.

Dorsal lengths of palpal segments: P-I, 36μ; P-II, 59μ; P-III, 39μ; P-IV, 100μ; P-V, 33μ; projection on ventral side of P-II moderately developed; surface of P-IV with numerous small setae; capitulum 136μ in length, chelicera 131μ in length; dorsal lengths of distal segments of fourth leg: IV-Leg-4, 88μ; IV-Leg-5, 190μ; IV-Leg-6, 156μ; most distal of 2 long setae on ventral side of IV-Leg-6 located near distal end; fig. 23 illustrates proportions and chaetotaxy of these segments; 1 claw at tip of fourth leg with ventral clawlet.

Female: Dorsal shield (excluding excretory pore platelet) 623μ in length, 462μ in width; excretory pore platelet free and 126μ in width; length from anterior end of ventral shield to posterior end of genital field 638μ, width 517μ; coxae not extending to anterior end of body; condyles associated with insertions of fourth legs not visible in ventral view; 3 pairs of genital acetabula; width between outer edges of most lateral pair of acetabula 281μ.

Dorsal lengths of palpal segments: P-I, 38μ; P-II, 64μ; P-III, 44μ; P-IV, 101μ; P-V, 35μ; fig. 22 illustrates structure of palp; capitulum 145μ in length, chelicera 131μ in length; dorsal lengths of distal segments of first leg: I-Leg-4, 80μ; I-Leg-5, 97μ; I-Leg-6, 93μ; fig. 24 shows I-Leg-5 and 6.

Holotype: Adult ♂, collected from mosses on a rock in a mountain stream at Pine Grove Furnace State Park, Cumberland Co., Pennsylvania, May 21, 1961.

Allotype: Adult ♀, same data as holotype.

Discussion: The present species is most closely related to the following species (see remarks under the latter). Both differ from all other known species of *Brachypoda* in having a very pronounced ridge on each side extending along the outer edges of the two most medial pair of acetabula in the male (fig. 19, 20). *Brachypoda fimbricaudata* differs from the following species in that the setae of the male genital field extend completely across the area anterior to the acetabula.

Brachypoda (Ocybrachypoda) affinis Cook, new species

Fig. 16, 18, 19

Male: (Measurements of holotype are given first, range of variation of type-series is given in parentheses); dorsal shield 562μ (547μ–577μ) in length, 380μ (350μ–380μ) in width; no setae of dorsal shield greatly enlarged; ventral shield 570μ (555μ–593μ) in length, 414μ (379μ–414μ) in width; first coxae projecting nearly to anterior end of body; condyles associated with insertions of fourth legs not visible in ventral view; well-developed ridge present immediately anterior to genital field; 3 pairs of genital acetabula; width between outer edges of most lateral pair of acetabula 326μ (296μ–326μ); short ridge present on each side extending between outer edges of most medial 2 pairs of acetabula; numerous long setae present lateral to genital field, several of which extend well beyond posterior end of cauda; setae-free area extending along anterior edge of genital field (fig. 19); posterior end of body somewhat narrowed.

Dorsal lengths of palpal segments: P-I, 35μ (35μ–38μ); P-II, 57μ (55μ–59μ); P-III, 41μ (40μ–44μ); P-IV, 93μ (92μ–100μ); P-V, 33μ (31μ–34μ); projection on ventral side of P-II varying from moderately to well developed; numerous small setae present on surface of P-IV; capitulum 124μ (121μ–128μ) in length, chelicera 118μ (117μ–125μ) in length; dorsal lengths of distal segments of fourth leg: IV-Leg-4, 83μ (76μ–86μ); IV-Leg-5, 180μ (173μ–183μ); IV-Leg-6, 149μ (144μ–156μ); structure of these segments similar to those described and illustrated for *B. fimbricaudata* (fig. 23).

Female (?): Dorsal shield (not including excretory pore platelet) 470μ in length, 364μ in width; excretory pore platelet 96μ in width; length from anterior end of ventral shield to posterior end of genital field 502μ, width 425μ; coxae not extending to anterior end of body; condyles associated with insertions of fourth legs not visible in ventral view; 3 pairs of genital acetabula; width between outer edges of most lateral pair of acetabula 204μ.

Dorsal lengths of palpal segments: P-I, 31μ; P-II, 52μ; P-III, 38μ; P-IV, 78μ; P-V, 31μ; fig. 16 illustrates proportions and chaetotaxy of palp; capitulum 118μ in length, chelicera 116μ in length; dorsal lengths of distal segments of first leg: I-Leg-4, 66μ; I-Leg-5, 73μ; I-Leg-6, 76μ; fig. 18 shows I-Leg-5 and 6.

Holotype: Adult ♂, taken by stirring up bottom gravels in Simpson Creek approximately 6 miles east of Cowpasture River, Alleghany Co., Virginia, Sept. 9, 1968.

Paratypes: 5 ♂ ♂, same data as holotype.

Discussion: The single female specimen is so noticeably smaller than the males that it is not certain they actually are conspecific. However, no other species (based on males) is known from the type locality, and color pattern and structure (other than size) are as would be expected for the female of *affinis*. The present species is most closely related to *B. fimbricaudata*. Males of *affinis* differ in being somewhat smaller and bearing a wide setae-free area at the anterior end of the genital field (compare fig. 19, 20). If the female specimen actually is conspecific, it differs from *fimbricaudata* in proportions of the leg segments (compare fig. 18, 24) as well as in body size.

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NEW SYNONYMY IN THE NEARCTIC ANTHICIDAE (COLEOPTERA)[1]

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I have used the following synonymies in identification for some time but have never validated them formally. I am presenting them here in order to make them available for use in the proposed new catalog of Nearctic Coleoptera.

Amblyderus granularis (Leconte)
   Anthicus granularis Leconte, 1850:231.
   Amblyderus punctiger Casey, 1895:747. NEW SYNONYMY.
Amblyderus obesus Casey, 1895:743.
   Amblyderus albicans Casey, 1895:744. NEW SYNONYMY.
Amblyderus pallens (Leconte)
   Anthicus pallens Leconte, 1850:231.
   Amblyderus arenarius Casey, 1895:748. NEW SYNONYMY.
Amblyderus parviceps Casey, 1895:744.
   Amblyderus gracilentus Casey, 1895:745. NEW SYNONYMY.
Anthicus punctulatus Leconte, 1851:155.
   Anthicus mercurialis Casey, 1895:707. NEW SYNONYMY.
Malporus formicarius (LaFerté)
   Anthicus formicarius LaFerté, 1848:185.
   Malporus blandus Casey, 1895:654. NEW SYNONYMY.
Thicanus texanus (LaFerté)
   Anthicus texanus LaFerté, 1848:301.
   Anthicus reiectus Leconte, 1852:97. NEW SYNONYMY.

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NOTES ON THE STATUS AND RELATIONSHIPS OF SOME GENERA IN THE TRIBE MILESIINI (DIPTERA: SYRPHIDAE)

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ABSTRACT—The taxonomic status and the phylogenetic relationships of certain genera in the tribe Milesiini (Diptera: Syrphidae) are discussed. *Lejota* Rondani, *Chalcosyrphus* Curran, and *Cynorhinella* Curran are transferred from the tribe Myoleptini to the tribe Milesiini. *Xylotodes* Shannon, *Cheiroxylota* Hull, and *Neplas* Porter are synonymized with *Chalcosyrphus* (*Xylotomima* Shannon). The following are reduced to subgeneric status: *Chrysosomidia* Curran as a subgenus of *Hadromyia* Williston, *Crioprora* Osten Sacken as a subgenus of *Brachypalpus* Macquart, and *Xylotomima* Shannon as a subgenus of *Chalcosyrphus* Curran.

The status and relationships of a number of genera in the tribe Milesiini of the subfamily Eristalinae (= Milesiinae) have been confused. For the forthcoming Manual of North American Diptera a new arrangement of these genera will be used. To avoid further confusion and uncertainty about these taxa, the reasons for the new arrangement and the changes involved are here briefly explained.

The taxa treated are first listed synonymically[2], then they are discussed individually and in alphabetical order, followed by a key summarizing the diagnostic characters of the valid genera and subgenera. A complete key to the Nearctic syrphid genera will be included in the forthcoming North American Diptera Manual. The male genitalia of the type-species of all the discussed taxa are figured.

SYNONYMICAL LIST OF TAXA MENTIONED IN THIS PAPER

Tribe Brachyopini Williston, 1885

Myolepta Newman, 1838, Entomol. Mag. (Newman's) 5:373. Type-species, *Musca luteola* Gmelin (mono.). See Thompson (1974) for detailed synonymy and discussion of phylogenetic relationships.

Tribe Milesiini Rondani, 1845

The *Blera* Group

Blera Billberg, 1820, Enum. Insect. in Mus. Blbg:118. Type-species, *Musca fallax* Linnaeus (Johnson, 1911, Psyche. 18:73). See Wirth, *et al.* (1965:610) for synonyms.

Caliprobola Rondani, 1845, Nouv. Ann. Sci. Nat. Bologna (2)2:455. Type-species, *Syrphus speciosa* Rossi (as *Milesia speciosa* Fabr.) (orig. des.)

Lejota Rondani, 1857, Dipt. Ital. Prodr. 2:176. Type-species, *Psilota ruficornis* Zetterstedt (Goffe, 1944, Entomol. Mon. Mag. 80:29). See Wirth, *et al.* (1965:590) for synonyms.

The *Tropidia* Group

Cynorhinella Curran, 1922, Can. Entomol. 54:14. Type-species, *canadensis* Curran (orig. des.). See Wirth, *et al.* (1965:588) for synonyms.

The *Xylota* Group

Brachypalpus Macquart, 1834, (Roret's Suite a Buffon), Dipt. 1:523 (Hist. Nat. Ins., Dipt. 1:523). Type-species, *tuberculatus* Macquart (Rondani, 1844, Nouv. Ann. Sci. Nat. Bologna (2)2:456) = *Syrphus valgus* Panzer.

Subg. *Crioprora* Osten Sacken, 1878, Catal. Descr. Dipt. N. Amer., 2nd. ed.: 136, 251. Type-species, *Pocota alopex* Osten Sacken (Williston, 1887, Bull. U. S. Natn. Mus. [1886] 31:217). NEW STATUS

Chalcosyrphus Curran, 1925, Kan. Univ. Sci. Bull. [1924] 15:122 (as a subgenus of *Chalcomyia*). Type-species, *atra* Curran (orig. des.) = *Chalcomyia depressa* Shannon.

Subg. *Xylotomima* Shannon, 1926, Proc. U. S. Natn. Mus. 69(9):7, 15. Type-species, *Xylota vecors* Osten Sacken (orig. des.). As first revisor I select *Xylotomima* as being senior to *Xylotodes*. NEW STATUS

Planes Rondani, 1863, Dipt. Exot. Rev. Annot.:9 (preocc. Bowdich, 1825; Saussure, 1862). Type-species, *Xylota vagans* Wiedemann (mono.).

Xylotodes Shannon, 1926, Proc. U. S. Natn. Mus. 69(9):7, 22. Type-species, *Brachypalpus inarmatus* Hunter (orig. des.). NEW SYNONYMY

Neplas Porter, 1927, Revta chil. Hist. Nat. 31:96. New name for *Planes* Rondani. NEW SYNONYMY

Cheiroxylota Hull, 1949, Trans. Zool. Soc. London. 26:361. Type-species, *Xylota dimidiata* Brunetti (orig. des.). NEW SYNONYMY

Hadromyia Williston, 1882, Can. Entomol. 14:78. Type-species, *grandis* Williston (mono.).

Subg. *Chrysosomidia* Curran, 1934, Man. Fam. Gen. N. Amer. Dipt., 2nd ed.:261. Type-species, *Caliprobola crawfordi* Shannon (orig. des.). NEW STATUS

Macrometopia Philippi, 1865, Verh. Zool.-Bot. Ges. Wien 15 (abh.):740. Type-species, *atra* Philippi (mono.). See Thompson (1972:152) for redescription.

Pocota Lepeletier and Serville, 1828, Ency. Meth. (Ins.) 10(2):518 (as a subgenus of *Milesia*). Type-species, *Milesia apicata* Meigen (mono.) = *Musca apiformis* Schrank.

Xylota Meigen, 1822, Syst. Beschr. Zweifl. Ins. 3:211. Unjustified new name for *Heliophilus* Meigen. See Wirth, *et al.* (1965:604) for detailed synonymy and reasons for use of *Xylota*.

Heliophilus Meigen, 1803, Mag. Insektenk. (Illiger). 2:273. Type-species, *Musca sylvarum* Linnaeus (mono.).

GENERIC DISCUSSIONS

Blera Billberg (fig. 30–33): Both *Blera* (fig. 32–33) and *Somula* (fig. 29) share the basal elongation of the aedeagus and its fusion
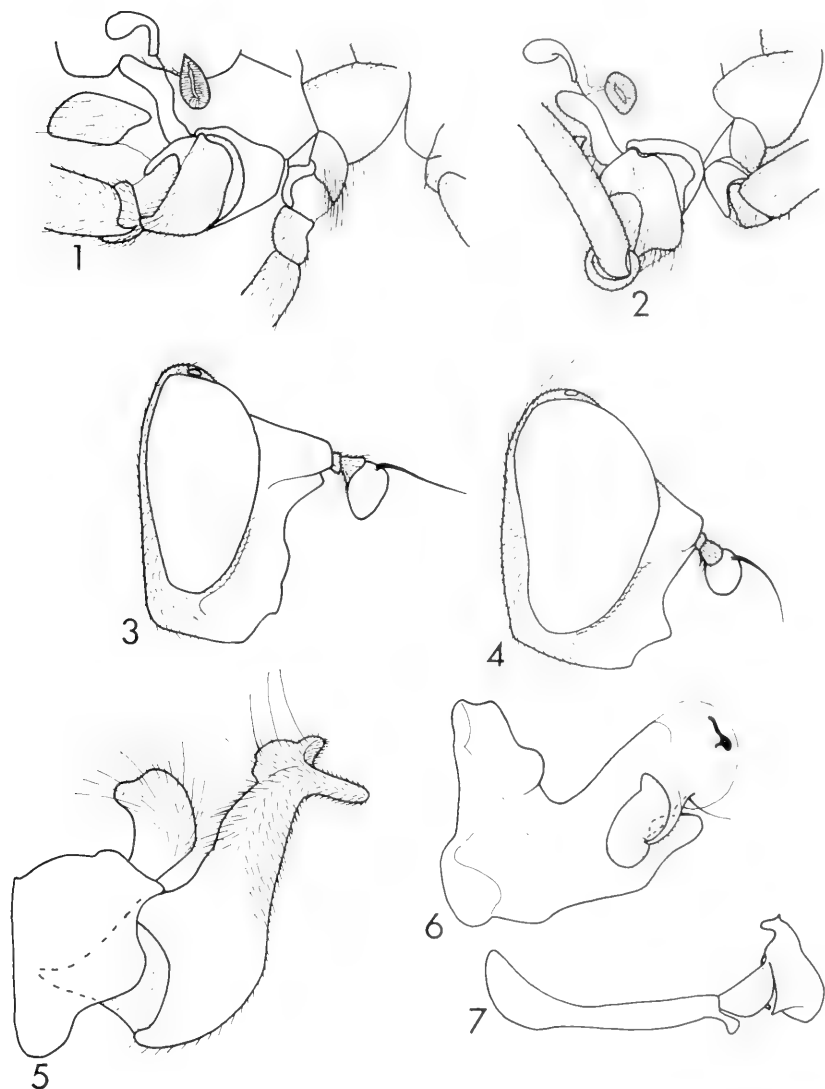
Fig. 1–2. Metasterna and associated structures, lateral view. 1, *Hadromyia* (*Chrysosomidia*) *pulcher* (Williston). 2, *Caliprobola speciosa* (Rossi). Fig. 3–4. Heads, lateral view. 3, *Caliprobola speciosa* (Rossi). 4, *Hadromyia* (*Chryso-somidia*) *pulcher* (Williston). Fig. 5–7. Male genitalia of *Caliprobola speciosa* (Rossi), lateral view. 5, 9th tergum. 6, 9th sternum. 7, aedeagus.

to the aedeagal apodeme. *Blera* may be a paraphyletic group, and *Somula* may be only a highly specialized derivative from 1 of the groups now included in *Blera.* Too little is known of the phylogeny of *Blera* to classify *Blera* and *Somula* with certainty.

Blera group (fig. 27–36): In my revision of the Neotropical milesiine genera (Thompson, 1972) I divided the genera of the tribe Milesiini into 6 groups following in part the tribal arrangement of Hull (1949) (his Xylotinae = Milesiini). One of these groups is the *Blera* group, characterized by: 1, a produced frontal prominence (fig. 3); 2, bare and undeveloped metasternum (fig. 2); 3, elongate, singular, and tubular ejaculatory process (fig. 29, 32–33, 36); and 4, elongate ligula and open lateral membranous area on the 9th sternum in the male (fig. 28, 31, 35).

Chalcosyrphus Curran (fig. 37–39): *Chalcosyrphus* has been considered a member of the tribe Myoleptini and as either a separate genus or a subgenus of *Lejota* Rondani. The reasons for this association were probably based on the basal position of the anterior crossvein and the overall dark coloration of these flies, both symplesiomorphic character states. As *Chalcosyrphus* does not have the swollen and spinose anterior femora of the Myoleptini (*q.v.*), it can not be included in that taxon. *Chalcosyrphus* has a prominent metasternum and concave face, apomorphic characters which indicate a placement in the *Xylota* group (*q.v.*). The combination of swollen hind femora, slightly arcuate hind tibiae, and pilose metasternum and face suggest that *Chalcosyrphus* is the plesiomorphic sister-group to *Xylotomima* (*q.v.*). With the exception of the ventrolateral spur on the superior lobe of the male genitalia, all the distinctions between *Chalcosyrphus* and *Xylotomima* are minor and may not even be valid when the full range of variation in *Xylotomima* is known. Thus, I am treating *Chalcosyrphus* and *Xylotomima* as subgenera of *Chalcosyrphus.*

Chrysosomidia Curran (fig. 1, 4, 11–13): The species of *Chrysosomidia* were originally described in the genus *Caliprobola* Rondani. Shannon (1926:40) noted that these species differ "considerably" from the type-species of *Caliprobola* by their head shape. Curran formalized this distinction by naming the genus *Chrysosomidia.* Hull (1949:368–369) treated *Chrysosomidia* as separate from *Caliprobola* and noted that the distinctions between *Chrysosomidia* and *Xylota* were "weak." Thus the synonymy of *Chrysosomidia* under *Caliprobola* in the recent North American Diptera Catalog (Wirth, *et al.*, 1965:608) was surprising. *Chrysosomidia* differs from *Caliprobola* as follows: 1, the face is concave and without a tubercle (fig. 4); 2, the frontal prominence is low (fig. 4); 3, the metasternum is developed (fig. 1); 4, the hind femur has distinct apicoventral spines; 5, the surstyle has a distinct ventral lobe and a simple apical lobe (fig. 11); 6, the 9th
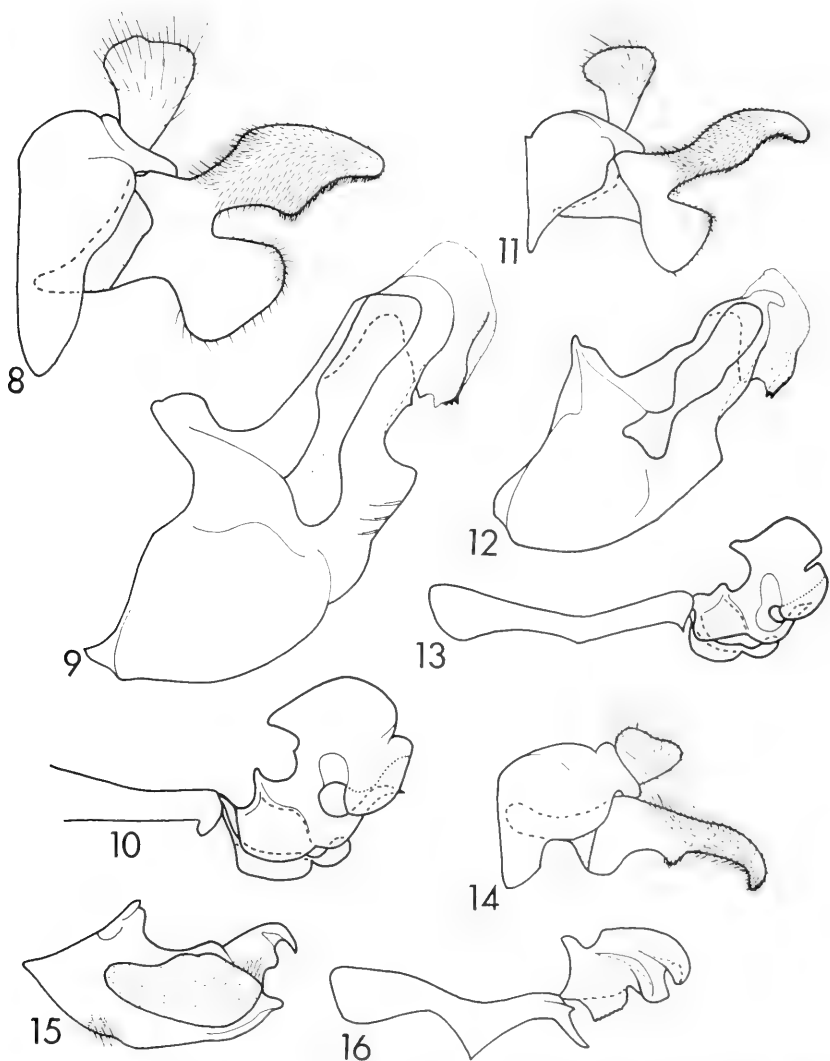
Fig. 8–10. Male genitalia of *Hadromyia* (*s.s.*) *grandis* Williston, lateral view. 8, 9th tergum. 9, 9th sternum. 10, aedeagus. Fig. 11–13. Male genitalia of *Hadromyia* (*Chrysosomidia*) *crawfordi* (Shannon), lateral view. 11, 9th tergum. 12, 9th sternum. 13, aedeagus. Fig. 14–16. Male genitalia of *Cynorhinella bella* (Williston), lateral view. 14, 9th tergum. 15, 9th sternum. 16, aedeagus.

sternum is without a distinct ligula, but has an enclosed lateral mem-
branous area (fig. 12); and 7, the aedeagus is of a xylotine type (fig.
13). *Chrysosomidia* is very closely related to and is here considered
as a subgenus of *Hadromyia* Williston. *Chrysosomidia* and *Hadromyia*
are the only 2 taxa of the *Xylota* group with completely yellow faces
(synapomorphy). The differences between the 2 taxa, with the excep-
tion of the spur on the middle femur of the male of *Hadromyia*, are
the consequences of 1 being a bee mimic. *Hadromyia* is a bumble
bee mimic; thus it is larger and more robust than the typical fly of
the *Xylota* group and has a distinctive yellow and black pilose color
pattern. These differences are not of sufficient gravity to indicate
to me an absolute age of origin to warrant separate generic status
for the 2 taxa (see also under *Crioprora*).

Crioprora Osten Sacken (fig. 46–48): *Crioprora* is very similar
to and is the sister group of *Brachypalpus* Macquart as indicated
in the key and phylogeny. The principal difference between *Crioprora*
and *Brachypalpus* is the shape of the face, which is produced much
more forward in *Crioprora*. Absolute ranking can only be determined
by the geologic age of the origin of the taxon and the relative ranking
is determined in respect to the phylogenetic relationships of the taxon
(*i.e.*, sister-groups must be of equal rank). Thus, *Crioprora* and
Brachypalpus must have the same rank, but because we know nothing
of the past history of these flies it is difficult to assign a categorical
rank to these taxa. However, in the absence of such evidence I feel
it is proper to equate degree of morphological divergence with geo-
logical age, especially when this is done in reference to a phylogeny.
Considering the position of *Crioprora* and *Brachypalpus* in the phy-
logeny of the *Xylota* group and the relative amount of morphological
difference between the 2, I believe they should be accorded sub-
generic rank. On this basis I also consider *Chrysosomidia*, *Hadromyia*,
Chalcosyrphus and *Xylotomima* (*q.v.*) as subgenera.

Cynorhinella Curran (fig. 14–16): *Cynorhinella* is somewhat of
an enigma to me; it does not appear to fit readily into any of the
groups of genera I recognize in the tribes Milesiini or Brachyopini.
The small ventrolateral tubercle on the apical ⅓ of the hind femur
may indicate a relationship with the *Tropidia* group of the tribe
Milesiini. The basic ground plan of the *Tropidia* group is char-
acterized by a ventrolateral protuberance on the hind femur and a
developed metasternum which has a membranous crease basolaterally.
This characteristic crease may be the result of the incomplete closure
of the developing metasternum, which would suggest that the sister-
group to this taxon has an undeveloped metasternum. *Cynorhinella*
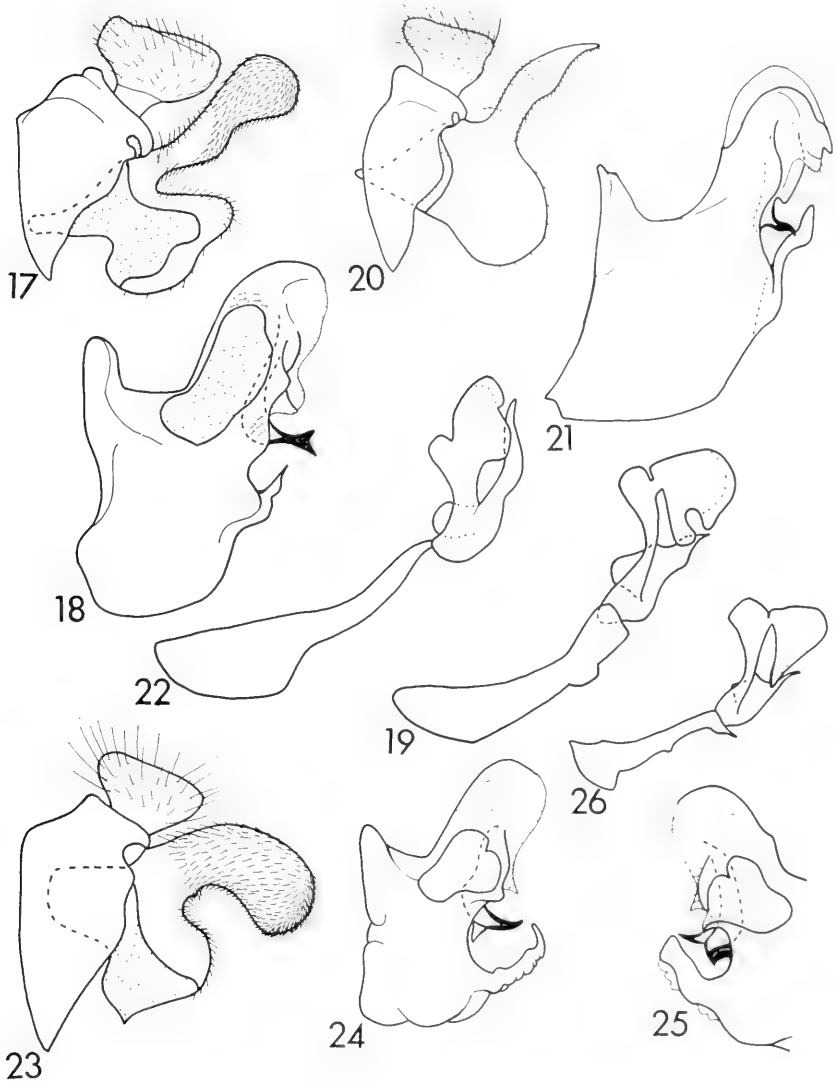has an undeveloped metasternum and may be the plesiomorphic sister-

Fig. 17–19. Male genitalia of *Chalcosyrphus* (*Xylotomima*) *inarmatus* (Hunter), lateral view. 17, 9th tergum. 18, 9th sternum. 19, aedeagus. Fig. 20–22. Male genitalia of *Chalcosyrphus* (*Xylotomima*) *vecors* (Osten Sacken), lateral view. 20, 9th tergum. 21, 9th sternum. 22, aedeagus. Fig. 23–26. Male genitalia of *Chalcosyrphus* (*Xylotomima*) *dimidiatus* (Brunetti), lateral view. 23, 9th tergum. 24, 9th sternum, right side. 25, 9th sternum, left side. 26, aedeagus.

group to the *Tropidia* group. Thus, I have tentatively included *Cynorhinella* with that group.

Lejota Rondani (fig. 34–36): *Lejota* has usually been considered a member of the tribe Myoleptini (Fluke & Weems, 1956; Wirth, *et al.*, 1965:590; Thompson, 1968). As *Lejota* does not have all the femora swollen and spinose, it cannot be closely related to *Myolepta* (*q.v.*). Boyes and van Brink (1967) have suggested, on the basis of similar karyotypes, that *Lejota* belongs in the tribe Milesiini and is closely related to *Blera*. *Lejota* is quite similar to *Blera* although most of these similarities are based on symplesiomorphy. However, *Lejota* shares a number of synapomorphic character states with those genera here considered as the *Blera* group (*q.v.*). *Lejota* differs from *Blera* and the other genera of the *Blera* group in the structure of the male genitalia; the very elongate and curved ejaculatory process and the jointed dorsal lobe of the aedeagus (fig. 36) are unique (autapomorphy). I consider *Lejota* a valid genus of the *Blera* group in the tribe Milesiini.

Myolepta Newman and tribe Myoleptini: Shannon (1923:19) established this tribe for those syrphids with "all the femora swollen and spinose on lower side." This character state is unique among syrphids and clearly demonstrates the monophyly of the taxon. Other authors, especially Fluke and Weems (1956) and Thompson (1968), enlarged the tribe to include groups which lack swollen and spinose femora. As the tribal limits were expanded, they became more nebulous. In 1972 I abandoned my attempts to define the tribe, combined Myoleptini *sensu* Shannon with the tribe Brachyopini (= Chrysogasterini), and transferred the other genera I had previously included in it to either that tribe or to the Milesiini. The relationships of the genera transferred to the tribe Milesiini are here discussed under *Chalcosyrphus*, *Cynorhinella*, and *Lejota*.

Xylota Meigen (fig. 40–42): *Xylota* was restricted by Shannon (1926) to those species which had the metasternum bare and a few other characters in common. Hippa (1968) refined Shannon's definition by adding a number of male genitalic characteristics and by noting that there were a few exceptions to the metasternal character. These exceptions were *Xylotomima pigra* (Fabricius) and *X. fulviventris* (Bigot) and *Xylota lenta* Meigen. *Xylotomima pigra* and *X. fulviventris*, while having most of the metasternum bare, almost always have a few long posterolateral hairs on it. These species have

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Fig. 27–29. Male genitalia of *Somula decora* Macquart, lateral view. 27, 9th tergum. 28, 9th sternum. 29, aedeagus. Fig. 30–32. Male genitalia of *Blera fallax* (Linnaeus), lateral view. 30, 9th tergum. 31, 9th sternum. 32, aedeagus. Fig.
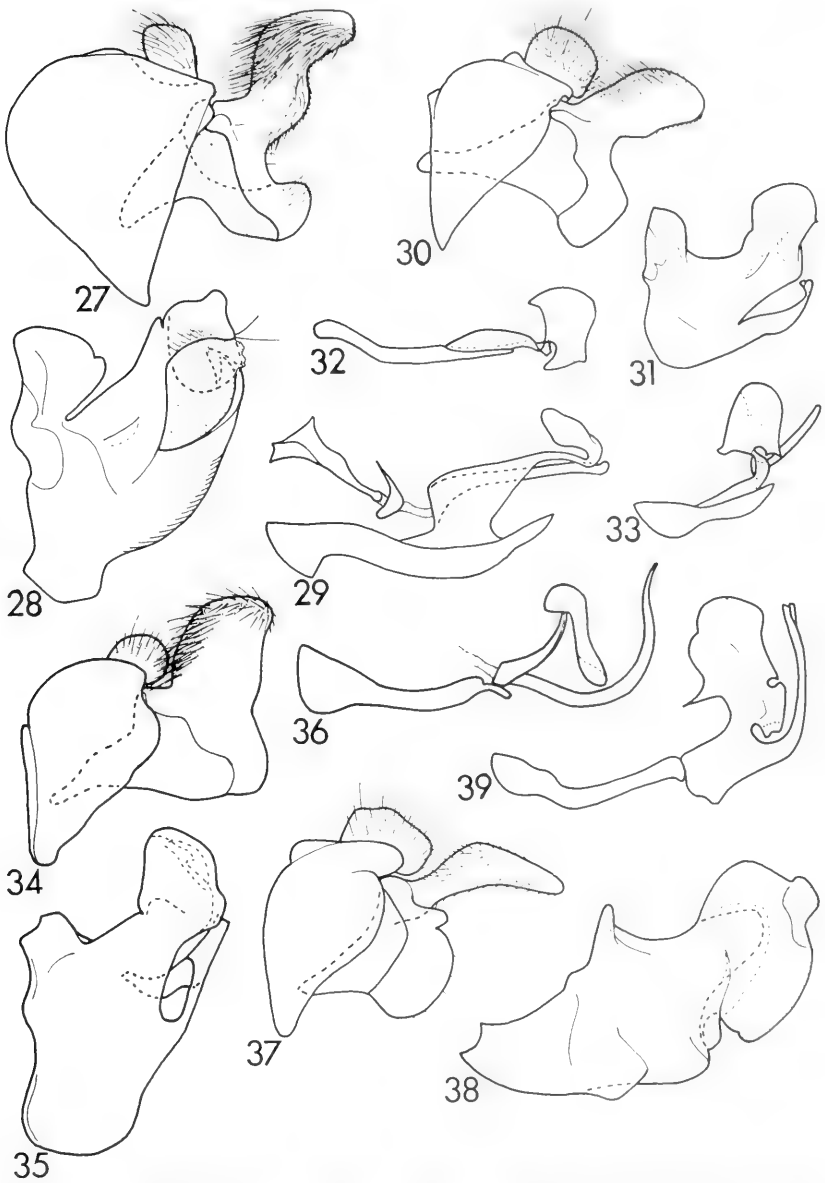
33. Aedeagus of *Blera nigra* (Williston), lateral view. Fig. 34–36. Male genitalia of *Lejota ruficornis* (Zetterstedt), lateral view, drawn from holotype of *beckeri* Shannon. 34, 9th tergum. 35, 9th sternum. 36, aedeagus. Fig. 37–39. Male genitalia of *Chalcosyrphus* (*s.s.*) *depressus* (Shannon), lateral view, drawn from holotype. 37, 9th tergum. 38, 9th sternum. 39, aedeagus.

the characteristic spur of *Xylotomima* (*q.v.*) on the superior lobe of
the male genitalia. Thus the "bare" condition in these species is due
to convergence. *Xylota lenta* has the metasternum completely bare
and does not have a spur on the superior lobe. *Xylota lenta* agrees
with *Xylota* in having an enlarged metathoracic spiracle, long arista,
and a bare metasternum. As noted by Hippa (1968), this species
differs from the typical *Xylota* (*sensu sylvarum* Linnaeus) species by
the shape of the aedeagus, which has elongate ejaculatory processes.
Because some *Xylotomima* species also have elongate ejaculatory
processes, Hippa (1968) placed *lenta* in that genus. The elongate
ejaculatory processes in *lenta* and *Xylotomima nemorum* (Fabricius)
appear to be of a different nature and origin and thereby the results
of convergence. I consider *lenta* a member of *Xylota* but would per-
haps place it in a separate subgenus. This subgenus could be dis-
tinguished from *Xylota, sensu stricto,* by the lack of a spur on the
hind trochanter of the male and the elongate ejaculatory processes.
These are characteristics of the male only and until female characters
are found I prefer not to name this subgenus. *Xylota makiana* (Shiraki)
belongs to this *lenta* group.

Xylota group: "Xylotinae" was originally set up for elongate, rather
bare flies with concave faces. In the present classification of Syrphidae
this taxon is treated as only an informal group of genera in the tribe
Milesiini (see under *Blera* group). The search for the sister-group of
these typical xylotine flies has led to the inclusion of genera which
do not have the characteristic facies of *Xylota*. However, all the
genera now included in the *Xylota* group have an unique form of
the aedeagus or a modification thereof. The basic ground plan con-
dition of the xylotine aedeagus is illustrated by *Hadromyia* (fig. 10,
13), *Brachypalus* (fig. 45) and *Sterphus* (see Thompson, 1973). This
basic structure includes a large, laterally flared ventral lobe, a pair
of lateral lobes (= ejaculatory processes) between which is the ejacu-
latory duct, and an enlarged dorsal lobe, which has its posterior surface
flared so that the lateral lobes extend along the resultant groove. A
tentative phylogeny of the *Xylota* group is presented (Diagr. 1).
While all phylogenies are hypotheses and thereby tentative. I labelled
this one tentative because I am not sure of the status of 1 character.
The presence of bare metasterna in all the groups of clade D may
not be true synapomorphy. Thus either clade E may be the sister-
group to clades $C + F$ or clades $C + H$ (= *Xylota* of older authors)
may be the sister-group to clades $G + E$ (the traditional view). Also,
Pocota has not been included in this phylogeny because I am
uncertain of its placement in the *Xylota* group.

Xylotomima Shannon (fig. 17–26): *Xylotomima* was erected for
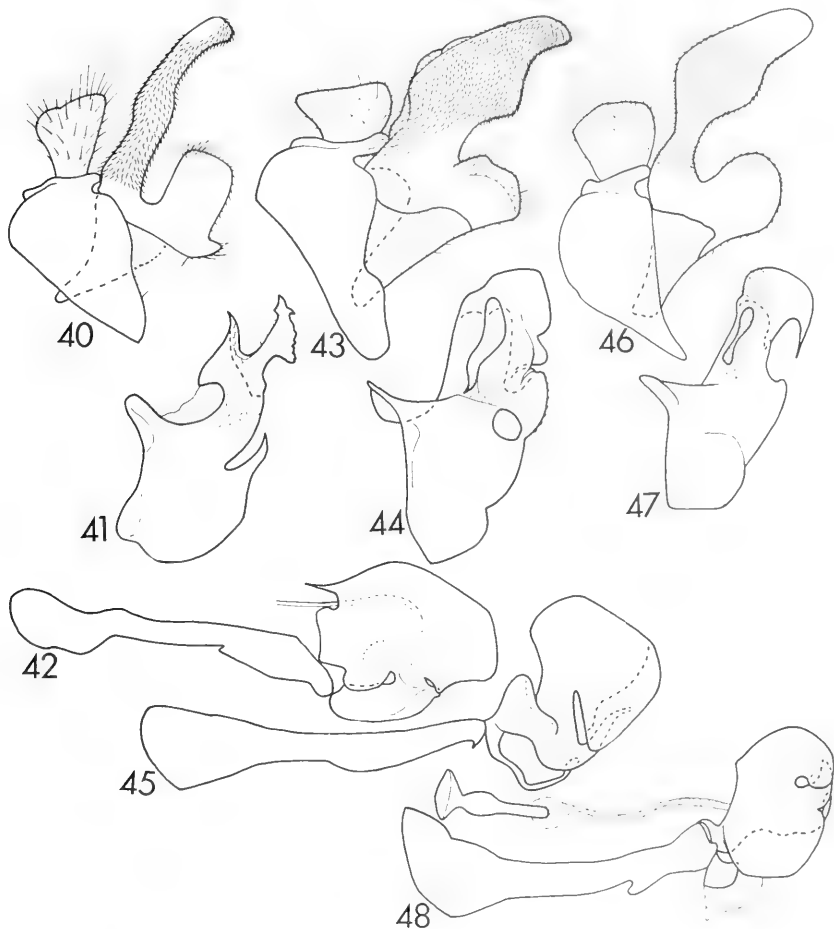those species of *Xylota* of authors which have the metasternum pilose.

Fig. 40–42. Male genitalia of *Xylota sylvarum* (Linnaeus), lateral view. 40, 9th tergum. 41, 9th sternum. 42, aedeagus. Fig. 43–45. Male genitalia of *Brachypalpus* (*s.s.*) *valgus* (Panzer), lateral view. 43, 9th tergum. 44, 9th sternum. 45, aedeagus. Fig. 46–48. Male genitalia of *Brachypalpus* (*Crioprora*) *alopex* (Osten Sacken), lateral view. 46, 9th tergum. 47, 9th sternum. 48, aedeagus.

At the same time Shannon erected *Xylotodes* for those species of *Brachypalpus* which also has a metasternum pilose. The differences Shannon noted between the 2 genera were the head shape ("broadly elliptical" versus "triangular") and length and density of the body pile ("inconspicuous" versus "usually fairly long and dense"). These differences are rather minor and not accepted here. *Neplas* Porter, a Neotropical group, also has pilose metasternum and is separated
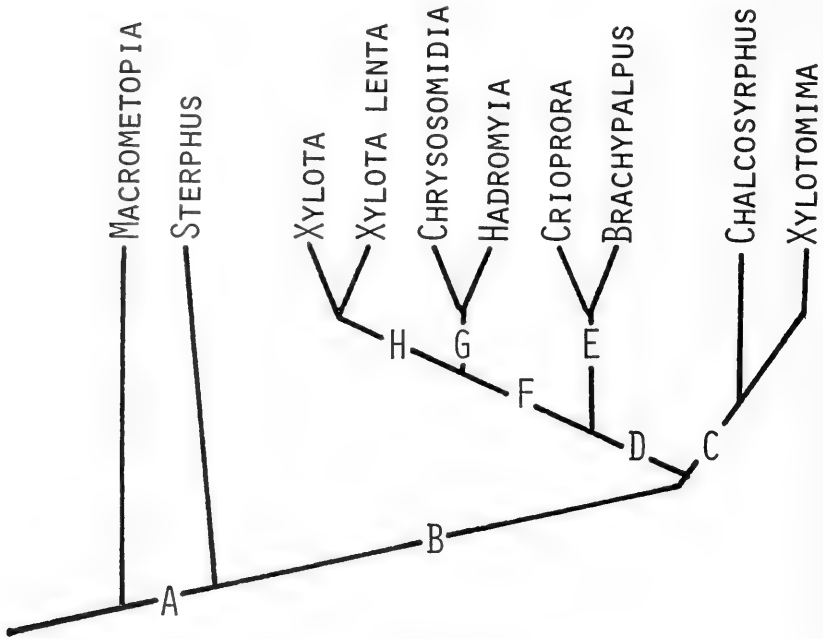
Diagr. 1. Phylogenetic diagram of the *Xylota* group.
    The synapomorphic character states for the principal clades are: A, eyes bare, metasternum developed, apical cell (R $4 + 5$) with long petiole; B, face concave; C, hind femora enlarged; D, metasternum bare; E, hind femora massive and each with an apicoventral tubercle, aristae short and thickened; F, head shape elliptical, cheeks elongate, eyes round; G, face entirely yellow; H, aristae elongate, metathoracic spiracles enlarged. The autapomorphic character states for the genera and subgenera are: *Macrometopia*, uniquely shaped aedeagus, which has a greatly enlarged dorsal lobe; *Sterphus*, metasternum bare (paraphyletic?): *Chalcosyrphus*, eyes dichoptic, aedeagus with dorsal lobe enlarged, surstyles strongly dimorphic, ejaculatory processes elongate, mesonotum depressed in front of scutellum; *Xylotomima*, face bare, superior lobe with strong ventrolateral spur; *Brachypalpus*, not known (paraphyletic?); *Crioprora*, epistoma produced forward; *Hadromyia*, middle femora of male with basal spur; *Chrysosomidia*, middle coxae with posterior surfaces bare; *Xylota lenta* group, hind trochanters of male without spurs, aedeagus with long ejaculatory processes; *Xylota*, uniquely shaped aedeagus which has the lateral lobes forming internal spurs.

from *Xylotomima* and *Xylotodes* by a number of characters (see Thompson, 1972:157–158). *Cheiroxylota* Hull is the palaeotropic counterpart of *Neplas* and agrees with all the essential characteristics of *Neplas* except that the face is not as strongly carinate. All these taxa have 1 unique characteristic in common, a strong ventrolateral spur on the superior lobe of the male genitalia. Also, the aedeagus has the same basic structure, although the precise shape of the dorsal lobe and the length of the ejaculatory processes are somewhat variable.

The distinctive characteristics of *Neplas* (and *Cheiroxylota*), such as the greatly swollen hind femora, strongly arcuate hind tibiae, carinate pleurotergite and face, etc., are only those of magnitude and can be found in lesser degrees in many species of *Xylotomima* (*cf.* especially *X. metallica* (Wiedemann)). Thus I consider *Xylotomima* + *Xylotodes* + *Cheiroxylota* + *Neplas* to represent a single monophyletic morphocline and clade. The question is how many genera should be recognized for the components of this clade. Whereas *Neplas* (and *Cheiroxylota*), the end point of the morphocline, is amply distinct and thereby recognizable, the other components are not. The recognition of *Neplas* as a distinct genus would leave the other components as a paraphyletic genus, thus, I prefer to recognize 1 subgenus for the whole clade (*v. Chalcosyrphus*).

KEY TO THE ERISTALINE GENERA TREATED IN THIS PAPER

1. All femora swollen and with strong apicoventral spines ....
.... (Brachyopini (pt.)) .... *Myolepta* Newman
— Front 4 femora slender and without spines .... (Milesiini (pt.)) 2
2. Metasternum developed (fig. 1); face always concave (fig. 4); male
usually holoptic and frequently with spur on hind trochanter or tibia
.... (*Xylota* group) 3
— Metasternum not developed (fig. 2); face usually tuberculate or flat (fig.
3); male frequently dichoptic and always with simple legs ....
.... (*Blera* group) 9
3. Metasternum bare 4
— Metasternum pilose, always with at least some long hairs posterolaterally
.... *Chalcosyrphus* Curran 8
4. Face yellow in ground color; abdomen completely dark, without yellow
or orange markings; hind femur slender .... *Hadromyia* Williston 5
— Face usually completely black in ground color, rarely partly yellow; if
partly yellow, then either abdomen with yellow or orange spots or hind
femur greatly enlarged 6
5. Abdomen black, black pilose except yellow pilose on 4th tergum; male
with long basal spur on middle femur; large, robust, bumble bee mimics
(western Nearctic) .... *Hadromyia* (*Hadromyia*)
— Abdomen brassy yellow pilose, with shiny metallic fasciae; middle femur
simple; smaller and slender flies, not bee mimics (Nearctic) ....
.... *Hadromyia* (*Chrysosomidia* Curran)
6. Head triangular in anterior view; face extensively shiny; cheek broad,
much broader than metathoracic spiracle; 3rd antennal segment kidney-
shaped, wider than long; hind femur greatly enlarged, arcuate, with a
small apicoventral tubercle (frequently hidden by tibia); arista short,
shorter than width of face .... *Brachypalpus* Macquart 7
— Head elliptical in anterior view; face pollinose; cheek narrow, narrower
than metathoracic spiracle; 3rd antennal segment orbicular; hind femur
neither greatly enlarged nor arcuate, without ventral tubercle; arista long,
much longer than width of face (Holarctic; Oriental) .... *Xylota* Meigen

7. Face straight under antennae, with epistoma strongly produced forward
   and beyond antennal bases (Nearctic) ....
   .... *Brachypalpus* (*Crioprora* Osten Sacken)
— Face concave, with epistoma not produced and ending at or before level
   of antennal bases (Holarctic) .... *Brachypalpus* (*Brachypalpus*)
8. Face and cheek pilose, mostly shiny; anterior crossvein (r–m) before
   middle of discal cell (M 1 + 2); male with eyes narrowly separated and
   with tubercle on hind trochanter; frequently with flattened area in front of
   scutellum (Nearctic) .... *Chalcosyrphus* (*Chalcosyrphus*)
— Face bare; face and cheek extensively pollinose; anterior crossvein usually
   at or beyond middle of discal cell; male with eyes holoptic and without
   tubercle on trochanter; never with flattened area in front of scutellum
   (all regions except Australian) .... *Chalcosyrphus* (*Xylotomima* Shannon)
9. Face, thorax, legs, and abdomen all black; anterior crossvein (r–m) basal,
   before middle of discal cell (M 1 + 2) 10
— Face and/or abdomen always partially pale, yellow to reddish brown, fre-
   quently legs and humerus also partially yellow; position of anterior cross-
   vein variable 11
10. Apical cell (R 4 + 5) with long petiole, about as long as humeral crossvein
    (h); frontal prominence produced forward, so that tip of epistoma and
    bases of antennae are approximately even or with antennal bases extended
    beyond tip of epistoma (Holarctic) .... *Lejota* Rondani
— Apical cell with a very short petiole, less than ½ as long as humeral cross-
   vein; frontal prominence low; epistoma produced forward, so that tip of
   epistoma projects greatly beyond antennal bases (Nearctic) ....
   .... *Cynorhinella* Curran
11. Abdomen elongate, with 3 pairs of large yellow lateral spots; wing with
    brown anterior margin; anterior crossvein at outer ⅓ of discal cell; frontal
    prominence greatly produced (eastern Nearctic) .... *Somula* Macquart
— Abdomen never with yellow spots, sides or basolateral corners of terga
   sometimes yellow; other characters variable (*v.i.*) 12
12. Abdomen elongate; terga with apical margins brassy and with brassy
    yellow pile; frontal prominence greatly produced; wing with orange
    anterior margin and brown apex; anterior crossvein at outer ⅓ of discal
    cell (Palaearctic) .... *Caliprobola* Rondani
— Abdomen oval, never with apical fasciae of brassy yellow pile or yellow
   ground color; frontal prominence never greatly produced; wing hyaline
   or uniformly darkened; anterior crossvein at most only slightly beyond
   middle of discal cel (Holarctic) .... *Blera* Billberg

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A REPLACEMENT NAME FOR ICHNEUMON COERULATOR
FABRICIUS, 1804
(HYMENOPTERA: ICHNEUMONIDAE)

Fabricius (1796; Ent. systematica, index alphabeticus, p. 83, 84) proposed the name *Ichneumon coerulator* as a replacement name for *Ichneumon lapidator* Fabricius (1787; Mantissa insectorum, v. 1, p. 266) (= *Trogus lapidator*) instead of the junior homonym, *I. lapidator* Fabricius (1793; Ent. systematica, v. 2, p. 160) (= *Neotypus coreensis* Uchida, n. status, n. syn.). Fabricius (1804; Systema piezatorum) gave a treatment of his 1787 *lapidator* on page 67; on page 68, without referring to his earlier use of the name *coerulator*, he described as *I. coerulator* a specimen or specimens of the Holartic, northern subspecies of *Trogus lapidator* (identity of a type specimen confirmed by Townes, Momoi, and Townes, 1965; Mem. Amer. Entomol. Inst. 5:517) which he had received from Panzer. The name of the latter is here replaced by *Trogus lapidator panzeri* Carlson, n. name.

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STUDIES ON IDIOCERINAE LEAFHOPPERS, XVI: PACHYMETOPIUS MATSUMURA TRANSFERRED TO COELIDIINAE (CICADELLIDAE: HOMOPTERA)

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ABSTRACT—*Pachymetopius decoratus* Matsumura, 1914 is herein transferred from Idiocerinae to Coelidiinae (Cicadellidae: Homoptera) where its morphological characters indicate it belongs.

Matsumura (1914:218) established the genus *Pachymetopius* to include the beautiful species *P. decoratus* from Taiwan. He did not assign *Pachymetopius* to any subfamily. However, it is listed under Idioceridae by Metcalf (1966). Metcalf in the same paper lists the complete bibliography for the genus up to 1956.

Recently, thanks to the courtesy of Dr. S. Takagi, of Hokkaido University, Japan, I examined the type. It is evident that this genus does not belong in Idiocerinae. *Pachymetopius decoratus* seems to be allied to *Placidellus ishiharei* Evans, 1971. These two species share the following characters: frontoclypeus quite close to eyes, the supraantennal ledges oblique, antenna long, and the pronotum collarlike. Regarding the position of *Placidellus*, J. W. Evans wrote to me "I have tentatively placed it on the Coelidiinae, though it is clearly not closely related to *Coelidia* spp. . . . but I prefer not to make a new subfamily for every aberrant cicadellid."

COELIDIINAE

Pachymetopius decoratus Matsumura
Fig. 1–4

Pachymetopius decoratus Matsumura, 1914. Sapporo Col. Agr. J. 5:218.

Examination of the female holotype reveals this species is not an Idiocerinae. The lack of a broad appendix in the forewing in addition to the morphological characters in figures 1 to 4 clearly indicate this. Because of its proximity to *Placidellus* Evans, a Coelidiinae, I am herein transferring *Pachymetopius* to Coelidiinae.

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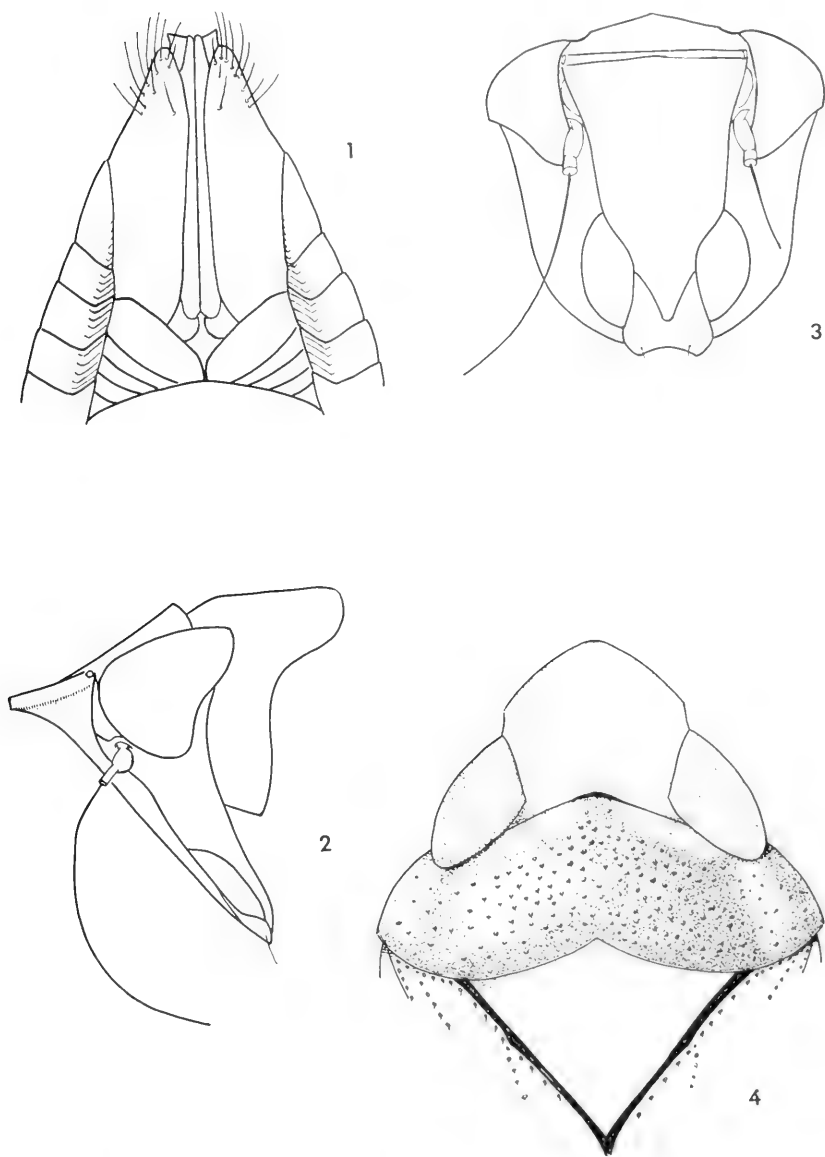
Fig. 1–4, *Pachymetopius decoratus*. 1, apex of abdomen, ventral. 2, head and pronotum, lateral. 3, head, front. 4, head and pronotum, dorsal.

BIOLOGY AND IMMATURE STAGES OF EIGHT SPECIES
OF LAUXANIIDAE (DIPTERA)
I. BIOLOGICAL OBSERVATIONS

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ABSTRACT—Life history information and observations on larval feeding habits are given for 8 species of Lauxaniidae occurring in eastern North America. Larvae of *Homoneura americana* (Wiedemann) and *Minettia lupulina* (Fabricius) were found in leaf litter where they fed on decomposing tree leaves. Larvae of *Poecilominettia ordinaria* (Melander) and *Pseudocalliope flaviceps* (Loew) were found in birds' nests where they fed on decaying vegetable matter. Larvae of *Camptoprosopella confusa* Shewell, *Lyciella browni* (Curran), *Minettia lyraformis* Shewell, and *Pseudogriphoneura gracilipes* (Loew) were not discovered in nature, but were reared in the laboratory on decaying tree leaves and lettuce.

Data are given on such aspects of the life cycle as adult longevity and fecundity, courtship behavior, incubation period, larval period, pupal period, overwintering habits, diapause stages, and number of generations produced each year.

Food preference tests indicated that larvae of *H. americana* developed best on decomposing leaves of sugar maple (*Acer saccharum* Marshall) and wild black cherry (*Prunus serotina* Ehrhart). Considerable development occurred also on leaves of American elm (*Ulmus americana* L.) and alder (*Alnus* sp.), although no larvae formed puparia. Some feeding occurred on leaves of apple (*Malus* sp.), trembling aspen (*Populus tremuloides* Michx.), and willow (*Salix* sp.). No or very little feeding occurred on American beech (*Fagus grandifolia* Ehrhart) or white oak (*Quercus alba* L.).

The family Lauxaniidae of the acalyptrate Diptera is composed of small, variously marked flies that rarely are over 6 mm in length. Adults range in color from pale yellow through bluish grey, coppery, and brownish red to black. Some species have pictured wings and, in life, strikingly colored eyes. Distinguishing characteristics of the family are: postocellar bristles convergent, oral vibrissae absent, subcosta complete, anal vein short and not reaching wing margin, and dorsal preapical bristles usually present on all tibiae. The family is worldwide in distribution and has a rich tropical element. Some 135 species and 23 genera have been reported from America north of Mexico (Shewell, 1965).

Adults of Lauxaniidae are usually found in moist, shady habitats, particularly in woodlands where they may occur in large numbers. They are commonly seen on low vegetation and some visit flowers. We have observed that they become more conspicuous and active

during the evening hours. Some species are attracted to light; others will come to baits of decaying fruit or meat.

The larval stages apparently are largely saprophagous, having been found in fallen leaves, straw, rotting wood, and birds' nests. A few species have been reported as phytophagous, having been discovered in the root collars, stems, and leaves of clover, in the ovaries of *Viola*, and in the leaf-like phylloclades of *Opuntia* cacti. Little attention has been given to the immature stages, probably because no species is known to be of significant economic importance to man. The object of this study, therefore, has been to acquire information on the life cycle of as many Eastern species as possible. We are including in this paper natural history observations 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). A subsequent paper will describe and illustrate the immature stages. All 8 species are common and widely distributed in eastern North America. Our study was carried out in Portage County in northeastern Ohio between 1967 and 1969.

<center>Review of Literature</center>

The family Lauxaniidae was established in 1804, when P. A. Latreille removed the species *cylindricornis* Fabricius from *Musca* and erected a new genus, *Lauxania*, to receive it. The family is sometimes referred to as the Sapromyzidae, although C. F. Fallén did not erect the genus *Sapromyza* from *Musca flava* Linneaus until 1810.

Hendel (1916) established the superfamily Lauxanioidea in which he placed the Lauxaniidae, Celyphidae, and Chamaemyiidae as well as certain other families no longer considered as belonging to the superfamily. Malloch (1932) recognized that the Periscelididae are also closely related to the Lauxaniidae, and Hennig (1958) placed the Periscelididae in the Lauxanioidea. Griffiths (1972) generally agreed with Hennig's treatment except that he excluded the family Periscelididae from the Lauxanioidea. The external characters of the adults that are usually used for classification suggest that the Lauxaniidae and Chamaemyiidae are very close, although they may be separated by an examination of the preapical tibial bristles. These are well developed in the Lauxaniidae, but are minute or absent in the Chamaemyiidae. Frey (1921) also reported that differences exist in the mouthparts of the 2 families. In the Old World tropics, the Lauxanioidea has an offshoot in the "beetle-flies" of the family Celyphidae. In this family, the scutellum is so much enlarged that it not only conceals the abdomen, but also acts as a fixed cover for the wings in the resting position (Oldroyd, 1964). Griffiths (1972) placed the

Celyphidae in the family Lauxaniidae. The Lauxaniidae is the largest member of the superfamily.

Hennig (1958) stated that the only character which can definitely be designated as apomorphic, occurring in all species in this group of related families, is the shortened anal vein ($Cu_{1b} + 1A$), which does not reach the wing margin. There are 2 apomorphic characters (apart from the shortening of the anal vein, which belongs to the ground plan of the Lauxanioidea) for the Lauxaniidae: the post-vertical bristles are convergent to decussate, and the 7th spiracle of the female post-abdomen lies in the region of the tergite (however, this cannot be definitely stated because too few species have been examined). Griffiths (1972) felt that another apomorphic condition for the Lauxaniidae is the presence of repeatedly branched male accessory glands.

Sturtevant (1926) and Hennig (1958) reported that there are 3 spermathecae in the Lauxaniidae and Periscelididae, whereas there are 4 in the Chamaemyiidae. Sturtevant, moreover, found a striking difference in the genital structure of the males. Males of Chamaemyiidae have 2 simple unbranched paragonia, or accessory reproductive glands, which is the usual condition among the acalyptrate Diptera. However, in the Lauxaniidae (*Calliopum, Camptoprosopella, Lauxania, Minettia, Sapromyza,* and *Stegolauxania* were examined) the paragonia are repeatedly branched. Sturtevant added that this is the only case in which he found what appears to be a good diagnostic character in the soft parts of the male genitalia for a large group of flies (the Lauxaniidae). In a study of the male copulatory apparatus, Hennig (1948) concluded there was no proof that the Lauxaniidae is related to any other families included in the Lauxanioidea.

Early studies of the family Lauxaniidae were primarily descriptive and systematic. The 1st noteworthy survey of the early literature was given by Becker (1895) in his monograph of the family. In 1908 Hendel published a complete review of the literature and world monograph of the family. The latter included references to the biology of 5 species, a key to the recognized genera, and a catalog of the known species. Later, Hendel (1925) recognized many additional genera in a revised key to world genera.

The most recent monograph of the family was published by Czerny (1932). Czerny included mainly species of the Palearctic Region in his catalog and key to genera and species. He also included illustrations of the external and internal adult morphology and gave biological references for 12 species. Other significant taxonomic works include Malloch (1929)—the Philippines; Curran (1938)—Africa; Collin (1948)—Great Britain; Harrison (1959)—New Zealand; and Stuckenberg (1971)—Old World.

Melander (1913) published the 1st important revision of the North American species. More recent revisions are by Malloch and McAtee (1924), species of eastern United States; and Shewell (1938), those of eastern Canada. The recently published catalog of Lauxaniidae represents a major contribution for North America north of Mexico (Shewell, 1965). Curran (1934) published a key to the genera of North America. A catalog of the species occurring in Central and South America by Shewell (personal communication) will be the only major work for the entire Neotropical Region.

Most of the studies on the natural history of the Lauxaniidae have been conducted in Europe, but life cycle data, as well as adequate descriptions of the immature stages, are lacking even for most of these species. Investigations usually have been concerned only with adults that were reared from immature stages discovered in nature.

Most papers on the biology of the Lauxaniidae have reported that the larvae are saprophagous. Perris (1852) found larvae of *Sapromyza quadripunctata* (L.) in rotting straw taken from thatched roofs; he also described the larva and puparium. Vimmer (1925) also briefly described the immature stages of this species. There are 2 reports of immatures inhabiting rotting wood. Meijere (1909) found the puparium of *Lyciella pallidiventris* (Fallén) under decaying bark, and Collin (1948) bred adults of *L. affinis* (Zetterstedt) from larvae found in a rotting tree stump.

Six species of 5 genera have been reported from birds' nests (Hicks 1959). Basden (*in* Collin 1933) bred *Calliopum simillimum* (Collin) from a robin's nest in England. Edwards (1925) obtained *Lyciella decempunctata* (Fallén) from thrush and blackbird nests. Basden (*in* Armstrong, 1953) reared *L. decipiens* (Loew) and *Minettia longipennis* (Fabricius) from nests of the European wren. *Poecilocalliope flaviceps* (Loew) has been obtained from nests of robins and catbirds (Dobroscky, 1925; McAtee, 1927) as well as wood thrushes, redstarts, chipping sparrows, song sparrows, goldfinches and red-eyed vireos (Dobroscky, 1925). Johnson (1925) listed this same species from an unidentified nest. Malloch (1927) described and illustrated the puparium of *P. ordinaria* and *P. flaviceps*.

Seguy (1946) reported on the immature stages of the only species, *Prorhaphochaeta inusta* (Meigen), that is known from a mammal burrow. Adults were reared from material taken from the nest of a mole.

Most of the saprophagous species have been found as larvae between or within rotting, fallen leaves. Although they technically may make a mine and thus could be considered as true leaf miners, they obtain quite different food materials than those larvae that feed as miners within living plant tissue (Hering, 1951). They are best considered

as only a special case of the primitive, compost-feeding type of dipterous larva (Oldroyd, 1964).

Seven species of 5 genera have been reported from rotting leaves. Meijere (1909) found larvae of *Calliopum aeneum* (Fallén), *Homoneura notata* (Fallén), *Lyciella subfasciata* (Zetterstedt), *Minettia plumicornis* (Fallén) and *Sapromyza obsoleta* (Fallén) mining in decaying leaves of apple, willow, prune, and certain other species of trees. He also gave a relatively detailed description of an unnamed larva. *Calliopum aeneum* has been bred also from crab-apple leaves (Hamm, *in* Collin, 1933). In a spring area, Thienemann (1926) found 1 larva of *Lyciella decipiens* and many of *L. rorida* (Fallén) in mines within fallen leaves. Hennig (1952) presented the only complete description and illustration of the mature larva of *L. rorida* available. Bouché (1847) apparently was the first to discover a lauxaniid larva in nature. He found larvae of *Sapromyza obsoleta* in rotting tree leaves; he also described briefly the larva and puparium.

The only described species reported to have phytophagous habits is *Calliopum aeneum*, which is also known to be saprophagous. Winnertz (*in* Kaltenbach, 1874) apparently was the 1st to report that larvae of this species live in the gall-like ovaries of *Viola arvensis* Murr. and *V. tricolor* L. Schlechtendal (1890) apparently was referring to Winnertz's report in his key to gall makers. Marchal (1897) discovered larvae mining the root collars and stem bases of clover. Similarly, Oettingen (1934) found overwintering larvae in clover stems. Both Colyer and Hammond (1951) and Oldroyd (1964) mention that larvae of *Calliopum aeneum* mine the leaves of clover, but the original source of this assumption could not be determined. Hering (1951) refers to a South American lauxaniid whose larvae live in the phylloclades of a prickly pear cactus (*Opuntia* sp.). In Java, Jensen (*in* Meijere, 1910) found unknown dipterous larvae in the calyx of *Nepenthes*. Meijere (1910) described and illustrated the larvae and indicated that they might represent a species of Lauxaniidae.

BIOLOGICAL OBSERVATIONS

Camptoprosopella confusa Shewell, 1939

Flies of the genus *Camptoprosopella* are distinguished from other North American genera of Lauxaniidae by having the anterior frontoorbital bristles directed inward and the 1st antennal segment as long as the 2nd. The genus is restricted to the Western Hemisphere. It has been revised by Shewell (1939), and 19 species are presently recognized in North America (Shewell, 1965).

Camptoprosopella confusa has been recorded as being fairly common within its range from southern Manitoba and Nova Scotia south

to Texas and North Carolina (Shewell, 1938, 1965). Biological observations are based on rearings initiated by adults that were swept from hydrophilic grasses growing around a seepage area in a mesic woodland and from herbaceous vegetation bordering a sluggish stream in a lowland woods. Grass, soil, leaf litter, and other possible larval microhabitats were sampled in the areas where adults were collected, but no immature stages were found.

Adults remained common in northeastern Ohio throughout the flight period from mid-June to mid-September. Males collected in nature lived 30–95 days in the laboratory; females, 65–116 days. Reared males (4) lived 36–78 days, females (5) 26–77 days. The preoviposition period, from emergence of the female to her first egg-laying, ranged from 15 days to 30 days. Oviposition generally occurred between late afternoon and late evening. The primary site of oviposition in the breeding jars was moist peat moss in which eggs were slightly buried. They were placed also on leaves, on the basal parts of grass shoots, on the nylon mesh covering the jars, and on the adult food of honey and brewer's yeast. Most eggs were laid singly, but a few were laid in clusters of 2–6. Individual field-collected females laid from 134 to 332 eggs and averaged 1–3 eggs per day. Reared females, in contrast, deposited only 16–23 eggs, indicating perhaps a dietary deficiency.

The incubation period at room temperatures (22–25 C) was highly variable, ranging from 3 days to more than 6 months. Many eggs appeared to be in a weak diapause which usually could be broken by exposing the eggs to low temperatures (5–7 C) for at least a week before returning them to room temperatures. Many of the unhatched eggs contained well-developed larvae, indicating that embryogeny had proceeded normally and without interruption. Several larvae excised from eggs that were 5–10 days old became active and developed normally.

Larvae fed readily on decaying lettuce, indicating that in nature they are scavengers on rotting plant materials. They also consumed decaying tree leaves, grass blades, peat moss, and paper toweling, although larval growth was most rapid on a rotting lettuce diet. Usually the first instar was spent entirely as a miner between the epidermal layers of the lettuce leaves. The 2nd and 3rd instars were miners also, but moved from 1 leaf to another more frequently than did the 1st instar. Fully grown larvae abandoned the food substrate and usually migrated to somewhat drier areas within the rearing dishes before forming puparia. Many larvae crawled out of the dishes and were lost. Others formed their puparia on the lids. The 3 larval stadia lasted 3–10, 3–10, and 4–14 days, respectively.

All puparia were covered by a white calcareous substance that was

secreted from the anus of the larvae shortly before undergoing pupar-
ium formation. This material dried quickly and remained as a white
coating over the entire puparium. The prepupal period, beginning
with formation of the puparium to actual appearance of the pupa,
was approximately 36 hours. The pupal period for males was 11–12
days; for females, 12–14 days.

The total time required to complete a life cycle under laboratory
conditions varied from 52–96 days, depending largely on whether or
not there was an egg diapause. Because some eggs hatched without
diapause, this species probably in nature is at least bivoltine. The
fact that many diapausing eggs hatched after being exposed to only
a few days of low temperatures perhaps indicates that the eggs hatch
during the fall months, with overwintering occurring as variously
aged larvae. Some feeding probably occurs during the warmer days
of winter, but most of the larval development probably takes place
in late spring.

Homoneura americana (Wiedemann), 1830

The genus *Homoneura* is characterized by the absence of intra-alar
bristles and by the presence of minute black costal setulae that extend
to the tip of the 3rd vein. It has a worldwide distribution except that
it has not been reported from New Zealand (Harrison, 1959). *Homo-
neura* is the largest known lauxaniid genus in North America, con-
taining 31 species (Shewell, 1965). Malloch and McAtee (1924) and
Shewell (1938) have presented keys to the species of eastern North
America.

Homoneura americana ranges from South Dakota to Nova Scotia
and south to Texas and Georgia (Shewell, 1965). Our observations
are based primarily on rearings initiated by several adults that were
collected from a stand of skunk cabbage (*Symphoricarpus foetidus*
(L.) Nuttall) growing in a lowland woods. One rearing was initiated
from a puparium and a larva that were found in moist to wet leaf litter
in a floodplain forest.

Adults were fairly common throughout the flight period from late
May to mid-September. Males collected in nature lived 50–109 days
in the laboratory; females, 64–136 days. Reared males (4) lived 40–
64 days; females (3), 60–80 days. The preoviposition period for 3
reared females ranged from 23–35 days. In the breeding jars, eggs
were deposited on and in moist peat moss and underneath and
between decaying tree leaves. Eggs were not discovered in nature,
but probably are placed within leaf litter. Most eggs were laid singly,
but a few were placed in clusters of 4 or 5. Females collected in
nature laid between 185–364 eggs each, averaging 2–4 eggs daily.
One female, however, averaged 9 eggs per day during the 45 days
she remained alive in the breeding jar. Reared females produced

72–204 eggs each, averaging 1–4 eggs daily. The incubation period of most eggs maintained in the laboratory varied from 2 to 22 days, indicating that if there was an egg diapause it was ephemeral. It was not necessary to subject eggs to low temperatures to induce hatching. One egg, however, required 44 days to hatch, an indication that there is some genetic variability.

Recently hatched larvae were given decaying lettuce, rotting tree leaves, peat moss, and paper toweling. They showed obvious preference for decaying leaves over the other food materials. Some of the 1st instars mined the rotting tissue lying between the 2 epidermal layers. Older larvae also frequently mined, although many others fed between adjacent leaves rather than entering them. The 3 larval stadia lasted 4–10, 5–17, and 6–38 days, respectively. As larvae matured, they migrated to drier areas of the breeding dishes where puparia were formed. A few puparia were formed within or between decaying leaves, particularly if the leaves had dried somewhat.

To determine whether larvae could develop in a variety of tree leaves, samples composed of approximately 20 unfed, newly hatched larvae were placed in different dishes containing moist, rotting leaves of the following tree species: trembling aspen (*Populus tremuloides* Michx.), willow (*Salix* sp.), alder (*Alnus* sp.), sugar maple (*Acer saccharum* Marshall), wild black cherry (*Prunus serotina* Ehrhart), apple (*Malus* sp.), American beech (*Fagus grandifolia* Ehrhart), white oak (*Quercus alba* L.), and American elm (*Ulmus americana* L.). No larva lived more than 3 days in the oak and beech leaves and most died in 2 days. A few larvae reached the 2nd instar in the apple leaves, but then succumbed. A slightly greater number of larvae reached the 2nd instar in dishes containing aspen or willow leaves, but none molted a 2nd time. Four larvae reached the 3rd instar on a diet of elm leaves, and 7 reached this instar in the dish containing alder leaves. However, none of the 11 larvae formed puparia. In contrast, nearly all of the larvae that had been placed in dishes containing sugar maple or wild cherry developed rapidly and many formed puparia. Leaves of both of these trees were abundant in the wet lowland forests where *H. americana* was collected most abundantly, and it seems reasonable to assume that they form the preferred larval food.

Shortly before forming a puparium, the larva voided the contents of the gut and then released a calcareous substance from its anus. The posterior end of the larva was quickly covered, and the larva then moved backwards through the wet material, coating the rest of the body surface. The whole process from voiding of the material from the anus to complete covering of the puparium usually took less than 2 minutes. As the material dried it turned white and hard and formed a hydrofuge layer over the puparium. The puparium

itself was reddish orange when the calcareous substance was dissolved in a dilute solution of HCl. The prepupal period was approximately 48 hours. The pupal period for males was 11–12 days; females, 12–13 days.

The total time required to complete a life cycle in the laboratory varied from 55 to 65 days, indicating that in northeastern Ohio this species is at least bivoltine. There was no distinct diapause in any of the life stages, although a few eggs did show a lengthened incubation period. A mature larva and a puparium were collected in early May, indicating that overwintering can occur either as larvae or pupae. Larvae probably continue to feed during the winter on warmer days and complete their development in April and May.

<center>*Lyciella browni* (Curran), 1933</center>

The genus *Lyciella* is closely related to the genus *Sapromyza* as shown by the absence of intra-alar bristles and by the fact that the costal setulae extend only slightly beyond the apex of the 2nd vein. It is distinguished from *Sapromyza* by having near the dorso-central bristles 2 dark vittae that begin on the frons and extend onto the scutellum. *Lyciella* has an Holarctic distribution and there are 12 North American species (Shewell, 1965).

Lyciella browni has been recorded from Wisconsin to New Brunswick and south to Georgia (Shewell, 1965). We initiated rearings by adults collected from herbaceous vegetation growing near a sewage drainage ditch, from the margins of a vernal stream in a swampy woodland, and from skunk cabbage and ferns growing in a poorly drained floodplain forest. No immature stages were found in nature.

Although the flight period extended from early June to early September, adults were uncommon. The 1 male that was collected in nature lived 105 days in the laboratory; 7 field-collected females lived 32–199 days. A reared male lived 90 days; a female, 72 days. Adults seemed relatively inactive both in nature and in the laboratory breeding jars. They did little flying and moved slowly about on low vegetation. The only mating that was observed took place during the evening and lasted for nearly 3 hours. The male was situated dorsally and faced in the same direction as the female, with his head positioned slightly anterior to the midpoint of her thorax. His fore tarsi were placed along the lateral frontal vittae of the female's head and were hooked over her frontal-facial ridge just laterad to the antennae. The male's mid tarsi were hooked over the costal margin of the female's wing near the end of the humeral crossvein. The hind tarsi either were appressed to the female's partly spread wings or were pressed against the sides of her abdomen. The mating pair remained inactive during the entire mating period except for an occasional wing flick by the female.

The preoviposition period for the 1 reared female was 22 days. Egg laying occurred between late afternoon and early evening. Eggs were attached to the nylon mesh covering the jar, edges of leaves, twigs, and peat moss. The eggs possess numerous small spines and in nature possibly are deposited into small openings where they are held in place by the stiff projections. They were laid singly. One field-collected female laid 88 eggs, averaging 3 eggs per day during the 30 days that she lived in the laboratory. The reared female deposited a total of 161 eggs. The incubation period usually varied between 3 and 11 days, but a few eggs required 19–23 days to hatch under laboratory conditions.

The 3 larval stadia lasted 3–11, 3–13, and 4–20 days, respectively; the total larval period was 10–44 days. There was no obvious rejection of any of the decaying organic matter provided to the larvae, but all instars seemed to prefer decaying lettuce and maple leaves to grass, peat moss, and leaves of skunk cabbage. Larvae were very active and wandered freely through the decaying maple leaves. Mature larvae usually moved to drier areas within the rearing dishes before forming puparia.

The prepupal period lasted approximately 60 hours. The pupal period for the reared male and female was 11 days. Pupae formed during the fall apparently entered diapause or possibly died. In any case, no adults were obtained from several puparia formed in October. The total life cycle required 61 days in the 1 successful rearing. Although the laboratory rearings indicate that there might be 2 generations a year, no indication of a 2nd generation was observed in nature. Overwintering apparently occurs as diapausing pupae.

Minettia lupulina (Fabricius), 1787

Flies of the genus *Minettia* are distinguished from those of other North American genera of Lauxaniidae by possessing intra-alar bristles and having the scutellum bare above. The genus is Holarctic in distribution (Hendel, 1925; Czerny, 1932). There are 16 North American species, 2 of which are found also in the Palearctic Region (Shewell, 1965). Keys to the species occurring in eastern North America have been published by Malloch and McAtee (1924) and Shewell (1938).

Minettia lupulina is a rather large (4–5 mm) species having the knobs of the halteres yellowish; a black, but densely pollinose thorax, and the margins of the scutellum sooty black. It is a Holarctic species and is very common and widely distributed in North America from Alaska and eastern Canada south to Arizona and North Carolina (Shewell, 1965). Biological observations are based on rearings initiated by adults that were collected from seepage areas in open fields and

mesic woodlands. Six rearings were initiated by nearly mature larvae that were collected from leaf litter in a lowland forest. Twenty-three larvae were found in nature, either in mines or lying in the upper layers of the litter composed mostly of maple, wild cherry, and alder leaves.

Adults were common to abundant in numerous habitats ranging from open fields to dense, lush woodlands during a flight period that lasted from mid-May to late September. Males collected in nature lived 45–85 days in the laboratory; females, 60–154 days. Eight males reared from puparia lived 35–145 days; 6 females, 38–141 days. Mating was witnessed only once in the laboratory and never in nature. The male was situated dorsally on the female and had his head at about midlength of the female's thorax. The male's fore tarsi were hooked over the costal vein near the humeral crossvein, and his right mid-tarsus was placed near the tip of her subcostal vein. The male's left hind tarsus was placed against the female's half-outstretched wing between the R_{2+3} and R_{4+5} veins. His right hind tarsus clasped the abdominal sternites of the female. As in *Lyciella browni*, the male occasionally tapped the female's head but used only his left fore tarsus. Copulation lasted about 30 minutes.

The preoviposition period for 6 reared females ranged from 22–60 days. Oviposition took place between late afternoon and early evening. Eggs were placed in moist peat moss, on the surface of decaying grass and leaves, and underneath rotting tree leaves. They were usually laid singly, but a few females occasionally placed eggs in clusters of 2–7. Females collected in nature each laid between 189 and 513 eggs. Reared females deposited 61–972 eggs; they averaged 2–5 eggs per day.

The incubation period was quite variable, apparently because of a weak egg diapause. Some eggs hatched in 3–12 days, but most had to be subjected to low temperatures (5–7°C) for a week or more before larvae would emerge. Diapausing eggs that were left at room temperature frequently failed to hatch, although many became translucent and obviously contained fully formed 1st-stage larvae.

The 1st larval stadium lasted 5–10 days; and the 2nd, 7–42 days. The 3rd stadium was not determined. Mature or nearly mature larvae appeared to go into diapause in late summer and none formed puparia. All instars seemed to prefer decaying maple and wild cherry leaves to rotting lettuce, various species of herbaceous plants, and peat moss. All 3 instars actively mined plant tissues. One 2nd instar and 10 3rd instars were collected in leaf litter during late January. The younger larva molted the day following its capture and began feeding; it eventually formed a puparium. All of the 3rd instars formed puparia within 17 days after being placed in the laboratory rearing dishes. Twelve apparently mature 3rd instars that were collected in nature

during early May formed puparia in the laboratory 4–11 days later. All larvae moved to drier areas in the rearing dishes before pupating. Events accompanying puparium formation resembled closely those described for *Homoneura americana* except that the larvae of *Minettia lupulina* rarely moved backwards through the calcareous material. As the secretion dried, debris surrounding the puparium became fused to it and obscured the puparium's shape, size and color. The prepupal period lasted approximately 48 hours. The pupal period for 9 males was 12–13 days; for 7 females, 13–14 days.

Although direct evidence was not obtained, it appeared that there was a distinct diapause that affected the 3rd instars during late summer. This probably means that there is only 1 generation a year, at least in northeastern Ohio.

Nearly 25% of the pupae were destroyed by parasitoid wasp larvae belonging to a species of *Pseudocoila* (*Pentamerocera*) of the family Cynipidae. Predation on *Minettia* larvae by larvae of *Gymnopternus nigribarbus* Loew, *Campsicnemus hirtipes* Loew, and *Sympycnus lineatus* Loew (Diptera: Dolichopodidae) was observed in nature and in the laboratory.

Minettia lyraformis Shewell, 1938

Minettia lyraformis belongs to the *obscura* group of *Minettia*, a cluster of black species that can be distinguished easily from each other by the structure of the male or female genitalia (Shewell, 1938).

This species has been reported to range from southern Manitoba east to southern Quebec and New York and south to Georgia and Tennessee (Shewell, 1965). Biological observations are based on rearings initiated by adults swept from a mixed stand of skunk cabbage and ferns growing in a lowland forest. No immature stages were discovered in nature.

Adults were taken commonly during late spring, but their numbers declined rapidly as summer advanced and none was found in nature after mid-August. Males collected in the field lived 20–69 days in the laboratory; females, 26–71 days. Mating was not observed. The preoviposition period was not determined exactly, but females collected during mid-May began to oviposit around the 1st of June. Because these were the 1st adults taken in nature, it seems reasonable to assume that they had recently emerged from puparia and thus a preovipositional period of 15–20 days is likely. Eggs were deposited on decaying tree leaves, moist peat moss, the nylon mesh covering the jars, and on the glass walls. They were slightly sticky on the ventral surface when 1st laid and adhered closely to the substrate. Females collected in nature each laid between 220 and 505 eggs and averaged 7–10 eggs per day during the time they were confined to breeding jars.

Table 1. Life Cycle Data for Eight Species of Lauxaniidae.

Species	Larval Microhabitat	Larval Food	Preovip. Period (days)	Fecundity	Incubation Period (days)	Larval Period (days)	Pupal Period (days)	No. Gens. /Year	Overwintering Stage	Diapause Stage
Camptoprosopella confusa	ND	Rotting Veget.	15–30	134–332	3–180	10–34	11–14	2+	Larva	Egg, Larva
Homoneura americana	Leaf Litter	Rotting Leaves	23–35	185–364	2–44	15–65	11–13	2+	Larva, Pupa	Egg
Lyciella browni	ND	Rotting Veget.	22	88–161	3–23	10–44	11	2?	Pupa?	Egg, Pupa?
Minettia lupulina	Leaf Litter	Rotting Leaves	22–60	66–972	3–?	ND	12–14	1	Larva	Egg, Larva
Minettia lyraformis	ND	Rotting Veget.	15–20	220–505	3–25	17–74	ND	1	Pupa	Egg, Pupa
Poecilominettia ordinaria	Birds' Nests	Rotting Veget.	30–33	ND	ND	ND	11–12	1	Adult	Adult
Pseudocalliope flaviceps	Birds' Nests	Rotting Veget.	27–50	6–62	2–4	53–71	ND	ND	Larva, Pupa	Larva, Pupa
Pseudogriphoneura gracilipes	ND	Rotting Veget.	14–29	83–303	4–60	16–47	10–11	2?	Larva, Pupa?	Egg, Larva

ND: not determined.

The incubation period varied from 3 to 25 days. Most eggs hatched at room temperatures in 3–13 days, but a few in each group required a longer time. These slow-hatching eggs contained fully formed first instars after 5 days, although the larvae commonly did not leave the egg until 2 or more weeks had elapsed. All instars seemed to prefer decaying lettuce to rotting tree leaves and moistened peat moss, although many newly hatched larvae entered maple and wild cherry leaves and fed as miners on the decomposing mesophyll tissue. Older larvae were more active and rarely mined. As in *M. lupulina*, a calcareous substance was secreted over the body of the larva shortly before it formed a puparium. The 1st larval stadium lasted 3–12 days; the 2nd, 3–14; and the 3rd, 11–48. The total larval period varied from 17 to 74 days.

The prepupal period lasted approximately 72 hours. All of the 24 pupae that were obtained in the laboratory rearings went into diapause, and only 1 produced an adult. All were allowed to remain at room temperatures for at least 2 weeks, then were placed for varying periods in a photo-chamber programmed to give 15 hours of light in each 24 hour cycle. The temperature varied from 5° to 7°C. After treatment, puparia were returned to room temperatures. The sole puparium that produced an adult female on May 1 had been subjected to the long-day and low temperature regimen for 3 months. The female emerged 30 days after the puparium had been returned to room temperature. All other puparia molded, indicating that the pupae had died.

The rearing records indicate that *M. lyraformis* produces only 1 generation a year in northeastern Ohio, with overwintering taking place as diapausing pupae.

Poecilominettia ordinaria (Melander), 1913

Poecilominettia is distinguished from the closely related genus *Minettia* by having short and distally diverging ocellar bristles. The position of the anterior fronto-oribtal bristles is also different in the 2 genera. The genus has a Nearctic and Neotropical distribution, with 5 species being recorded from America north of Mexico (Shewell, 1965). A key to the species of eastern North America was presented by Malloch and McAtee (1924, *Minettia*, part).

Poechilominettia ordinaria is easily distinguished from the other species of *Poecilominettia* by the absence of black spots on the face, ocellar triangle, and abdomen. It ranges from southern Ontario south to Kansas, Tennessee, and Florida (Shewell, 1965). Biological observations are based on rearings initiated by puparia found in robins' nests that were collected from apple orchards and crabapple groves.

Reared males lived 52–166 days in the laboratory; females, 61–305 days. The 1 female that lived over 300 days emerged in late summer

and deposited several eggs during the early fall. The preoviposition period for 3 reared females ranged from 30–33 days. Oviposition took place during the early evening in a robin's nest. The 3 females each laid only 3–9 inviable eggs.

One 2nd and 12 3rd instars were found in the mud composing the floor and sides of a robin's nest that was collected in early July. The larvae became very active in the breeding dishes and moved continually through the nest substrate, apparently feeding on the decomposing organic matter littering the floor and incorporated into the mud. When mature, larvae usually crawled to the drier areas of the nest material, voided the gut contents, and formed puparia. Pupation began in late July and continued until mid-August. Nests collected in nature commonly contained between 10 and 40 puparia. They were not enclosed in mud-plant debris cases, as were the puparia of another nest-inhabiting lauxaniid, *Pseudocalliope flaviceps*. The prepupal period for 9 males and 6 females was 11–12 days. Females usually began emerging a day or so before the males.

A robin's nest that was examined in mid-November contained 2 adults. McAtee (1927) also found adults in nests collected in November. These observations coupled with the extended longevity of infrequently ovipositing females under laboratory conditions indicate that overwintering can occur as adults in a state of reproductive diapause. Females reared from puparia during the fall months rarely oviposited, and many contained no developing eggs when they were subsequently dissected. Neither larvae nor puparia were collected in nests during the winter. It is possible, of course, that eggs were present but were overlooked. In any case, it appears that this species has only 1 generation a year in northeastern Ohio.

McAtee (1927) reported that he obtained parasitoid wasps belonging to the genus *Psilus* (*Galesus*) (Chalcididae) from puparia of *P. ordinaria*. We obtained 18 adults of *Trybliographa* (*Didyctium*) *marlatti* (Crawford) (Cynipidae). The highest rate of infestation of puparia was obtained from 1 nest in which 45% of the puparia produced adult wasps.

Pseudocalliope flaviceps (Loew), 1866

The genus *Pseudocalliope* is closely related to *Calliopum* as indicated by the presence of a glossy and convex face in both genera. *Pseudocalliope* is distinguished from *Calliopum* by having intra-alar bristles, a patch of setulae on the hind tibiae, and by lacking a transverse depression on the face. The genus is strictly Nearctic and includes only 4 known species (Shewell, 1965). A key was presented by Melander (1913, *Minettia* and *Caliope* [sic], parts).

Pseudocalliope flaviceps, the only species known from eastern North America, has been recorded from southern Ontario, New

York, Massachusetts, Maryland, Virginia, and Texas (Shewell, 1965). The collection of adults in Ohio thus constitutes a new state record. This species apparently is rarely collected, probably because the flies do not wander far from the larval habitat of birds' nests. We did not encounter adults in the field during 2 years of intensive collecting effort. Biological observations are based on rearings initiated by puparia collected during the fall, winter, and early spring months in nests of at least 4 species of small passerine birds.

Although many adults were reared from field-collected puparia, neither courtship behavior nor mating was observed. Males lived 22–100 days; females, 37–112 days. Adults were relatively inactive in the breeding jars and spent most of their time sitting motionless on the nest material or on the peat moss. The preoviposition period for 9 reared females ranged from 27–50 days. Egg-laying occurred only during the evening hours. Most of the eggs were placed in decaying nest material, but a few were deposited on moist peat moss and decomposing tree leaves. No clusters of eggs were discovered, and nearly all eggs were scattered over the surface of the substrate. They were not inserted into the nest material. Twelve reared females each produced from 0 to 6 eggs, 5 others laid 7–31, and 1 female produced 47 eggs. The female that produced the greatest number of eggs laid an average of 1 egg every other day during the 97 days she was held in a breeding jar. Three females that were dissected after dying without ovipositing contained between 38 and 62 partially formed eggs. In comparison to other species of Lauxaniidae, *P. flaviceps* appears to have a low reproductive potential. The incubation period lasted 2 to 4 days, although many eggs were inviable.

From records maintained on 5 larvae, the 1st stadium lasted 2–4 days; the 2nd, 5–17 days; and the 3rd, 46–50 days. The total larval period thus ranged between 53 and 71 days. All instars fed readily on moistened birds' nest material and occasionally on decaying tree leaves and lettuce. Dobroscky (1925) stated that the larvae fed exclusively on the debris and seeds they found in the nests. We found no feeding on seeds, although they were present in 3 of the field-collected nests.

A mature larva usually constructed a rather solid capsule composed of mud and plant fragments in which it subsequently formed a puparium. McAtee (1927) likewise reported that he had found mature larvae and puparia within cells composed of dirt and fine vegetable debris. The chambers formed solid, felt-like masses in the more thickly compacted regions of the nest. The hard, inconspicuous cases undoubtedly reduced dessication rates and possibly prevented or at least lowered predation on the developing pupae. Puparia collected in nature varied greatly in size, and it is probable that nests differed in the quantity and quality of food material avail-

able to the developing larvae. The prepupal period was approximately 48 hours. All reared pupae went into an intense diapause, and none survived laboratory experiments designed to initiate development. Pupae were exposed to periods of low temperatures (5°–7° C) and long-day photo-periods (15 hours of light/24 hr. cycle) ranging from 3 weeks to 3 months before being warmed to 20–25° C., but no adults were obtained. In contrast, puparia collected in nature during the fall months and held continuously at room temperatures began to produce adults in late January.

Most puparia were found in small nests that contained large amounts of decaying plant material. Such nests commonly produced 13–61 puparia each. Although a few puparia were found in larger nests containing much non-plant material (e.g. mud nest of robins), the numbers obtained were always much lower than those found in small nests. The most productive nests were in low trees and shrubs growing in marshy or swampy habitats. Relatively few puparia were collected from nests situated in old fields and other less humid environments.

Examination of 7 nests that were collected in mid-May revealed that most of the puparia had already produced adults. In 1 nest, adults began emerging the day following its collection. Dobroscky (1925) also reported that adult emergence occurred in early May. In early June, a nest was found that contained approximately 15 hatched eggs. The presence of many ridges on the chorion indicated that these eggs belonged to *P. flaviceps*. Decaying leaves in the immediate vicinity of the egg cases were being mined, and many had been largely skeletonized. Three 1st instars, 7 2nd instars, and 17 3rd instars were found in the floor of this nest.

Interestingly, moisture conditions of the nest seemed to influence when puparia would be formed. In nests that were allowed to dry out mature larvae quickly formed puparia. In contrast, similarly sized larvae living in nests that were continually wet frequently did not form puparia until an additional month had passed. Nests examined throughout the fall months contained many puparia and a few mature larvae. A few 3rd instars were found also in nests collected during the spring. Overwintering, therefore, can occur both as pupae and as 3rd-stage larvae.

Valley et al. (1969) reported that larvae of *Gaurax pallidipes* Malloch (Diptera: Chloropidae) readily invaded and fed upon damaged pupae of *Pseudocalliope flavipes* [sic] that were within ruptured puparia. We observed numerous *Gaurax pallidipes* larvae in nests containing puparia of *Pseudocalliope flaviceps*, but never observed them to attack the lauxaniid pupae. McAtee (1927) reported that he had obtained adults of *Psilus* (*Galesus*) sp. (Chalcididae), *Spalangia* sp. (Pteromalidae), and an undetermined species of Pteromalidae

from puparia of *Pseudocalliope flaviceps*. We reared only 1 specimen of *Spalangia drosophilae* (Pteromalidae) from the scores of puparia that were collected in nature.

Pseudogriphoneura gracilipes (Loew), 1861

Pseudogriphoneura is distinguished from the closely related genus *Neogriphoneura* by having a non-concave frons that is broader than long. The genus contains 7 species in America north of Mexico (Shewell, 1965) and has several Neotropical representatives (Hendel, 1925). Malloch and McAtee (1924, *Deceia* part) and Curran (1942) have published keys to the Nearctic species.

Pseudogriphoneura gracilipes has been recorded from southern Quebec and New Hampshire south to Mississippi and Florida (Shewell, 1965). Our observations are based on rearings initiated by adults that were collected in lowland forests. No immature stages were found in nature.

Adults remained fairly common during the flight period that extended from mid-June to mid-September. Males collected in nature lived 51–88 days in the breeding jars; females 36–93 days. Mating was observed twice in the laboratory but never in nature. The mating position was very similar to that described for *Lyciella browni*. Each mating lasted between 2 and 3 hours. The preoviposition period for 6 reared females ranged from 14–29 days. Eggs were scattered onto the glass walls, the nylon mesh covering the breeding jars, small twigs, and decaying tree leaves. Most were placed in small depressions on twigs; many others were attached to the glass walls. The ventral surface of the eggs appeared to be covered with a sticky substance which glued each egg firmly to the substrate. Reared females laid between 133 and 281 eggs each; field-collected females deposited between 83 and 303 eggs.

The incubation period was highly variable. Most eggs hatched in 4–13 days, but a few produced larvae only after 50–60 days had elapsed. It appeared that a relatively weak diapause was affecting some eggs. Partial hatching was obtained by subjecting slow-hatching eggs to low temperatures (5–7°C) for about a week before returning them to room temperatures. Larvae excised from non-hatching eggs quickly became active and began feeding.

Larvae fed readily on decaying maple and wild cherry leaves, but showed less interest in rotting lettuce, wood, and moist peat moss. All instars were relatively inactive and most mined the decomposing mesophyll tissue in the leaves. Mature larvae moved to drier areas of the rearing dish before forming puparia, and most puparia were formed between relatively dry leaves. The larval stadia were 5–10,

5–16, and 6–21 days, respectively. The total larval period thus ranged between 16 and 47 days. The variation in larval development time probably was due to differences in food quality and quantity.

The prepupal period lasted 48 to 66 hours. The pupal period for 6 males and 4 females was 10–11 days. The total time required to complete a life cycle in 3 laboratory rearings was 60, 68, and 107 days, depending on the intensity of the egg diapause and the abundance and quality of the larval food material. Laboratory rearings indicate that at least 2 generations a year could be produced in northeastern Ohio, although field collection records of adults did not indicate a population surge in late summer. Overwintering probably occurs as larvae and puparia within moist leaf litter.

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A COMPARATIVE MORPHOLOGICAL STUDY OF THE HIND WING VENATION OF THE ORDER COLEOPTERA, PART I.

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ABSTRACT—A comparative morphological study of the wing venation of Coleoptera determined that the coleopterous venation has a close affinity to the venational pattern exhibited by the suborder Megaloptera of the order Neuroptera. In addition, the available fossil record revealed that no single described wing possessed the composition necessary to serve as a coleopterous ancestral form. Therefore the alternative was the selection of a pattern which would serve as a guide in determining the line of development leading to both Coleoptera and Megaloptera. The order selected was the fossil order Protorthoptera.

From a study of the Megaloptera, Protorthoptera, Lepidoptera and the families of Coleoptera, a comparative coleopterous-megalopterous pattern was constructed, the composition of which included a pectinate radial pattern, an anal lobe consisting of a postcubital vein, a lack of any anal cross-vein pattern, and the establishment of a single anal vein which has undergone branching. Such a pattern served as a basis for comparison of Coleoptera to Megaloptera as well as the various patterns exhibited by the families within the Coleoptera.

Early investigations of insect wing venation were based on comparative morphology with an attempt to establish a uniform terminology of wing venation throughout the different orders of winged insects.

Many early workers (Hagen, 1870; Adolph, 1879; Redtenbacher, 1886) attempted to homologize the wing veins of the various orders of insects and developed the current system of venational nomenclature. However, due to the inability of establishing a uniform system of terminology as well as the lack of sufficient fossil evidence, comparative studies were relegated a secondary role in favor of the ontogenetic study of wing venational homology as proposed by Comstock and Needham (1898a, 1898b and 1899, and Comstock 1918).

Objections to this ontogenetic method of determining venational homologies were raised by Tillyard (1928), Martynov (1924) and Carpenter (1966), all of whom believed that certain facts, established as the result of applying the ontogenetic approach, were in conflict with the fossil record. Thus there developed a new school of thought based upon the concept that the true nature of venational homologies was dependent upon the study of the fossil record.

Recent investigators, such as Holdsworth (1940, 1941), Smart (1956), Whitten (1962) and Leston (1962), conducted histological studies concerning the nature of the development of nymphal wing pads, tracheae and veins. From these investigations, it was concluded that tracheation could not be taken as fundamental in determining the homologies of the insect wing veins.

An approach similar to the one used in the present paper was conducted by Adams (1958). In this study he used both comparative morphology and paleoentomological evidence in support of the parallel venational pattern exhibited by the present-day suborder Megaloptera and the fossil family Lemmatophoridae.

Lameere (1922), Snodgrass (1935), Carpenter (1943a, 1943b, 1966) and many others have proposed various theories which in part have helped to develop some of the venational nomenclature presently in use.

Although the ontogenetic method is not considered fundamental, many of the conclusions reached by Comstock and Needham as a result of their comparative studies provided a basic foundation for solving the evolutionary venational affinities of the alate insect orders. We realize that the last word in solving problems concerning the homologies of insect wing venation rests with the discovery of new fossil insect records. Wherein the insect fossil record is incomplete, the solution to venational problems depends largely on studies of comparative morphology involving present-day insect groups.

The order Coleoptera is one such insect group, which was regarded by Comstock as an order in which the veins of the wings preceded their tracheation. Therefore the venation of such a highly modified pattern did not lend itself readily to interpretation but required evidence of a more extensive nature.

Although the present paper follows the recent evidence which considers tracheation as an inaccurate guide to determining wing venational homologies, much of the work conducted by Forbes (1922) was based upon comparative studies and is regarded as fundamental. Therefore the present study is a modification and expansion of the Forbes system as a result of evidence accumulated from an investigation of the fossil records, a more extensive study involving a comparative morphology of the families of Coleoptera, and wing venational concepts proposed by investigators since Forbes.

In order to consider such a proposal, it is necessary to provide a basis upon which a comparison can be drawn between the Coleoptera and on the basis of other characters, a closely related present-day order of insects. It has been determined by several workers that the larval and adult features of Coleoptera share many characteristics found in the order Neuroptera. Forbes concluded that the coleop-

terous wing venation is based upon the same fundamental plan as that of Neuroptera. Although Forbes recognized this affinity, he did not attempt to construct his hypothetical coleopterous wing from any other than the wings within the order Coleoptera itself.

Parallel evidence in regard to paleoentomological affinities is based upon a study of the Lemmatophoridae, which possesses both a well developed anal lobe and anal pattern. The anal pattern exhibited by the Lemmatophoridae is interpreted as having much in common with both Megaloptera and Neuroptera.

Therefore, in view of the converging evidence accumulated, this study will:

1. Illustrate that Coleoptera, although exhibiting an unusual type of venational pattern, shares a pattern common to all other alate insect orders.
2. Compare the coleopterous wing venation to that of the neuropteroid group, the suborder Megaloptera.
3. Demonstrate that such a venational pattern as seen in the Lemmatophoridae shares much in common with both the Coleoptera and the Megaloptera.
4. Conduct a comparative study of the individual coleopterous families, as well as their relationship to the comparative coleopteran venational pattern.

Materials and Methods

Many of the wings selected were drawn from slides of the various families included in the excellent and extensive collection of Dr. Edwin W. King, Professor of Entomology, Clemson University. Much of the Scarabaeidae analysis was the result of the particularly large series which is a part of this collection. Certain families or species of a particular family not available, required the use of the following technique for removal of the wing.

1. Relaxation of the specimen was accomplished either by leaving it in a relaxing jar for several days or more rapidly by placing the specimen in hot water for a few minutes.
2. Since a beetle is pinned through the right elytron, the left elytron was raised and with a pair of fine forceps the left wing was removed. This procedure involved grasping at the base and carefully removing the hind wing including the basal sclerites. Care was taken to prevent tearing either the wing or the thorax.
3. The wing was placed in 70% ethanol and then carefully unfolded and spread by means of blunt needles. Following this the wing was transferred to absolute alcohol for about 2 minutes. Then the wing was washed briefly in xylene and placed on a slide containing a drop of synthetic mounting medium, the basal sclerites were cut away and final spreading and orientation of the wing was made. A cover slip was placed in position, after

which a gentle pressure was applied to further spread the wing and remove excessive mounting medium.

4. If spreading proved difficult, the wing was transferred from 70% alcohol directly into hot water which aided in the unfolding.

In order to obtain a constant size and proportion, the illustrations were drawn with the aid of a modified microprojector Ken-A-Vision Model No. L 2. Drawings are original unless otherwise designated.

RESULTS AND DISCUSSION

In meeting the objectives set forth, certain assumptions were necessary. They are:

1. The wing venation of Insecta is arranged on a common plan.
2. The earliest venation was simple in pattern as proposed by Comstock (1899).
3. A parallel venational pattern exists in both present-day forms as well as fossil forms, which serves as a guide to the homology of the veins in Coleoptera.

In order to gain an understanding of the unusual type of venation seen in Coleoptera, it was necessary first to conduct a comparative study of selected generalized wings from the families of Coleoptera. The selection of the generalized family venational pattern was based upon the most complete and stable venation available. The number of genera and species studied per family varied considerably ranging from large series as represented by the Buprestidae and Cerambycidae investigations of Good (1925, 1929), to that of a single specimen. The venational pattern of a single specimen is not necessarily representative of the generalized venation of a given family.

The hypothetical coleopterous wing of Forbes (fig. 1) was based upon three families: Cupedidae, Cebrionidae, and Hydrophilidae. A more detailed analysis involved application of information received from such additional families as Scarabaeidae, Dermestidae, Dytiscidae and Cerambycidae.

Since Neuroptera is considered closest to the Coleoptera, further comparative studies were conducted within this order. The principal character sought was the possession of an anal lobe with venation enough to compare to the Coleoptera. Such a requirement was found in the family Corydalidae, suborder Megaloptera. Examination of

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Fig. 1, Coleopterous hypothetical wing of Forbes; redrawn from Forbes, 1922. 2, Comparative coleopterous-megalopterous venational pattern. 3, *Aphodius denticulatus* Hald. (Scarabaeidae). 4, *Paraprisca gragilis* (Sellards) (Protoperlaria; Lemmatophoridae); after Tillyard, 1928. 5, *Scaptolenus lecontei* (Sallé)
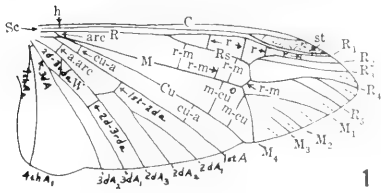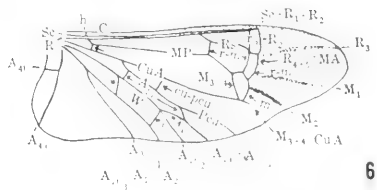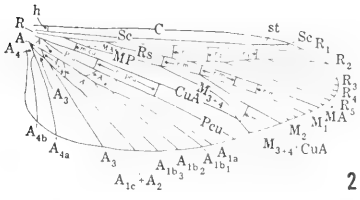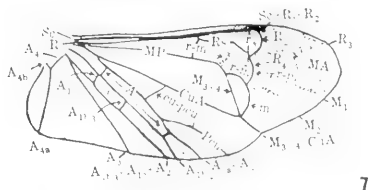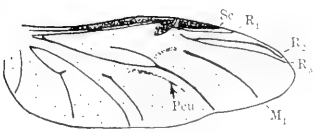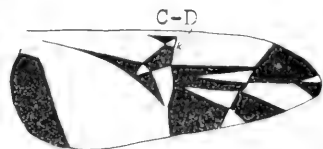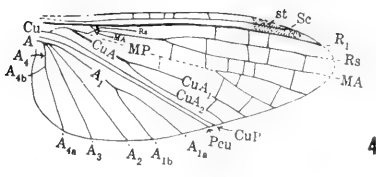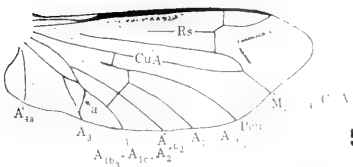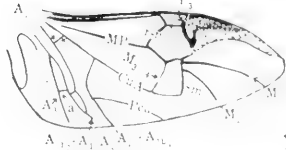
(Cebrionidae), pattern of individual variation in the species. 6, *Priacma serrata* (Lec.) (Cupedidae). 7, *Cupes concolor* Westw. (Cupedidae). 8, *Harpalus caliginosus* (Fab.) (Carabidae); folding pattern. 9, *Dineutus assimilis* (Kby.) (Gyrinidae). 10, *Dineutus ciliatus* (Forsberg) (Gyrinidae).

the fossil records revealed that the fossil family Lemmatophoridae possessed a comparable venational pattern.

In addition to the importance of the comparison in relation to the anal venation, the family Corydalidae also serves as a basis for an understanding of the preanal pattern. Included as supportive evidence in establishing the coleopterous preanal venation are some selected parallel patterns exhibited by Sialidae and Lepidoptera.

It is necessary, before entering into a discussion involving the trends of specialization within the Coleoptera, to analyze each particular vein and cross-vein which enters into the synthesis of the proposed comparative coleopterous-megalopterous venational pattern (See Plate 1 and fig. 2).

In the order of appearance from anterior to posterior the longitudinal veins are as follows:

Costa (C)—This is the very anterior marginal vein, considered present throughout the Coleoptera.

Subcosta (Sc)—This second longitudinal vein is in close proximity to the radius. The condition of this vein will be discussed in its relationship to radius.

Radius (R)—The radius runs parallel to the subcosta and in comparison to the Scarabaeidae pattern does not appear to fuse at the apex (fig. 3). When compared to the fossil hind wing of *Parapresia fragilis* (Sellards), family Lemmatophoridae (fig. 4), the subcosta also is distinct apically with that of the radius, and in turn passes through a stigmatic area. Therefore, by comparison, it appears that the condition, as noted in the Lemmatophoridae, is paralleled in the Coleoptera and indicates a more generalized condition than occurs in present-day Megaloptera.

Radial Sector (Rs)—In the Coleoptera, the principal vein branching from radius generally atrophies at the base forming what often is referred to as a radial recurrent (Rr). The radial sector, as interpreted by Forbes (1922), branches from the radius in the same manner as would be found in the Cupedidae.

It appears as noted in the Cebrionidae, that the branching of the radial sector could be interpreted as arising more basally (fig. 5). This would be more in keeping with the pattern of the radial sector and its relationship to the anterior media formed in both the Corydalidae and Lemmatophoridae.

From a comparative study of the Adephaga, Cupedidae, Scarabaeidae and Hydrophilidae it becomes apparent that the factor, which greatly influenced the unusual configuration of the radial sector as well as the apical venation, is that of folding. Accompanying this unusual configuration is either complete absence of part of the venational pattern or the presence of sclerotized venational traces. There-
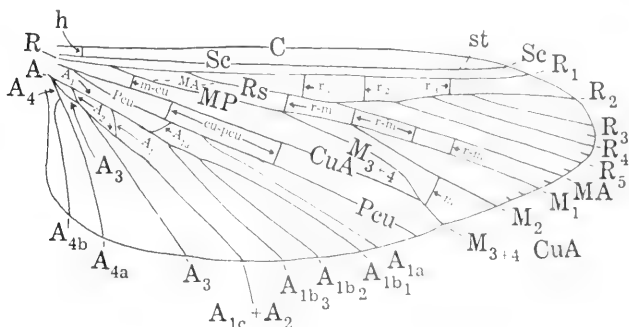
Abbreviations Used

C – Costa	h – humeral
Sc – Subcosta	r – radial cross-vein
R – Radius	r-m – radio-medial cross-vein
Rs – Radial sector	m – medial cross-vein
M – Media	m-cu – medio-cubital cross-vein
MA – Anterior media	cu-pcu – cubito-postcubital cross-vein
MP – Posterior media	st – Pterostigma
CuA – Anterior cubitus	a – Accessory longitudinal vein
CuP – Posterior cubitus	W_1 – Primary wedge cell
Pcu – Postcubitus	W_2 – Secondary wedge cell
A – Anal	W_3 – Tertiary wedge cell

A_1, A_2, A_3, A_4 – Primary anal branches

A_{1a}, A_{1b}, A_{1c}, A_{4a}, A_{4b} – Secondary anal branches

A_{1b1}, A_{1b2}, A_{1b3} – Tertiary anal branches

Plate I.   Comparative Coleopterous-Megalopterous venational pattern.

fore, as a result of a sharing of other parallel venational affinities, the coleopterous apical venation has much in common with the basic pectinate nature of the radial pattern as noted in the Corydalidae. Although based upon the same fundamental plan, it becomes necessary

from a study of the families in both the Cupedidae-Adephaga series, as well as the Polyphaga series, to construct separate comparative illustrations in order to explain the different lines of specialization along which the apical patterns developed.

In the Cupedidae-Adephaga (fig. 6–18) emphasis was placed upon the fusion of radial sector with radius. In turn, as a result of folding similar to the generalized condition of the Cupedidae-Adephaga line (fig. 8), a C–D fold (Forbes, 1926) slightly alters either the radial sector in its path, as in the Cupedidae (fig. 6–7) or completely interrupts the radial sector as appears in most of the Adephaga (fig. 11–18). Most of the apical venational pattern is lost, leaving only a trace of the principal veins in the radial area.

The remaining apical pattern (fig. 19–20) consists of a third radial cross-vein (r_3) distal to the C–D fold. In addition R_1 fuses distally a short distance with the fused vein R_{4+5} plus anterior media (MA). R_3 then becomes a prominent vein running nearly to the margin of the wing. There remains in the Adephaga only a spur of what is believed to be the fused branches $R_{4+5} + $ MA. Included is a series of hypothetical stages (fig. 21–24) suggesting the possible manner in which folding has influenced a basic pectinate pattern to produce the type of apical venation exhibited by the Cupedidae-Adephaga series.

Although the Hydrophilidae (fig. 26) retain what appears to be a complete apical venation, a further study of the Scarabaeidae series proves instructive in interpreting the fusion of the branches of radial sector.

The configuration of the polyphagan pattern (fig. 27–29) is interpreted as a forcing of the branches of the radial sector to separate proximal to the C–D fold (fig. 30). This involves the forcing of R_2 and R_3 toward the anterior margin at a point distal to the second radial cross-vein. In the same respect R_4, R_5, and MA are forced toward the medial branch. There is the additional fusion basally of R_2 with R_3 as well as R_4 with R_5. R_{4+5} is accompanied also by fusion with MA.

As a result of the comparison of the Hydrophilidae to that of the Corydalidae, it is entirely possible that the apical pattern consists of several accessory branches. This is indicated in the comparative

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Fig. 11, *Agabus lugens* (Lec.) (Dytiscidae). 12, *Amphizoa insolens* LeC. (Amphizoidae). 13, *Hygrobia hermanni* (Fab.) (Hygrobiidae). 14, *Hydrocanthus iricolor* Say (Noteridae). 15, *Peltodytes muticus* (LeC.) (Haliplidae). 16, *Rhysodes* sp. (Rhysodidae). 17, *Calosoma sycophanta* L. (Carabidae). 18, *Cicindela sexguttata* Fab. (Cicindelidae). 19, *Gyrinus fraternus* Coup. (Gyrinidae). 20, *Cicindela sexguttata* Fab. (Cicindelidae).
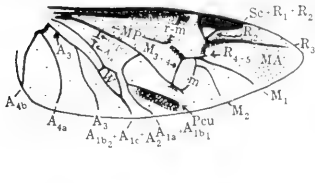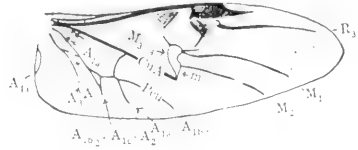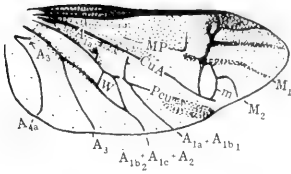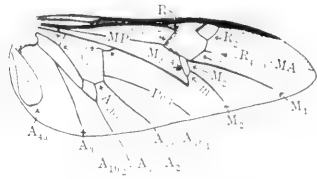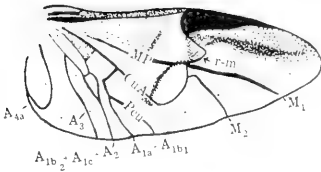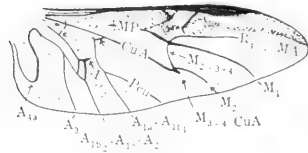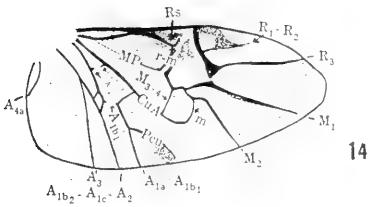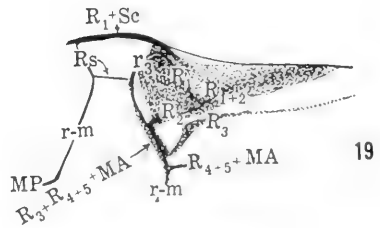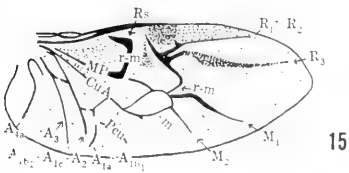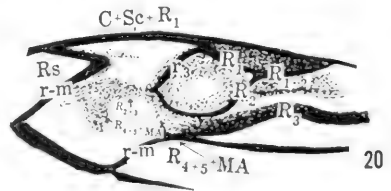
patterns by a dash placed between two main branches. Since accessory veins are considered a part of the original pattern and due to the incomplete nature of the coleopterous apical venation, only an approximation can be given to the amount of accessory venation attributed to any primary branch (i.e. Hydrophilidae).

Anterior Media (MA)—The fossil evidence proposed by Martynov (1924), Tillyard (1932) and Carpenter (1943a, 1943b) interpreted the neuropteran venation as having an anterior media. This branch, although arising from the posterior media, fuses basally with the radial sector. It continues as part of the radial sector where it subsequently emerges as an independent apical vein.

On the basis of the interpretation of Coleoptera sharing a common pattern with that of Megaloptera, there is the inclusion of anterior media as part of the apical venation, even though the proximal connection of MA to Rs as occurs in Megaloptera is absent.

Media (M)—This vein emerges proximally from the radius. In the Adephaga this vein is complete, while in the Polyphaga the proximal segment has atrophied as paralleled in the Lemmatophoridae and Sialidae (fig. 4, 32, 36).

Forbes, although recognizing the fact that a tracheal branch enters the proximal stem (labeled M_{3+4} in fig. 6–7) of cell 10 (i.e. oblong cell by previous authors) of the Cupedidae and Adephaga (fig. 35), chose to regard this as not of any consequence on the assumption that it would not work out to any logical interpretation of the marginal veins. Thus he considered this a medio-cubital cross-vein and not a branch of media.

However, if the condition in *Sialis mohri* Ross (fig. 36) is examined the pattern is seen to consist of an unbranched M_{1+2} with M_{3+4} fusing with cubitus. The fusion of M_{3+4} results in a medial cross-vein appearing distally and aligning itself with an anterior r-m cross-vein.

In comparing the Sialidae to the Cupedidae-Adephaga (fig. 6–18) it becomes evident that the condition of the fusion of M_{3+4} and the medial cross-vein pattern form the proximal and distal sides respectively of cell 10 (fig. 6, 35). The upper portion of the cell consists of the branch M_{1+2}. The branch of M_{1+2} forks distally, a portion of which joins to the medial cross-vein and completes the pattern.

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Fig. 21, Cupedidae-Adephaga comparative apical pattern; Series 1. 22, Cupedidae-Adephaga comparative apical pattern; Series 2. 23, Cupedidae-Adephaga comparative apical pattern; Series 3. 24, Cupedidae-Adephaga comparative apical pattern; Series 4. 25, Directional wing pattern. 26, *Hydrophilus triangularis* (Say) (Hydrophilidae); apical venation. 27, Polyphaga comparative apical pattern; Series 1. 28, Polyphaga comparative apical pattern; Series 2. 29, Polyphaga comparative apical pattern; Series 3. 30, *Telephorus* sp. (Lampyridae). Folding pattern. After Forbes, 1926.
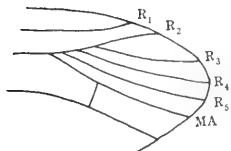
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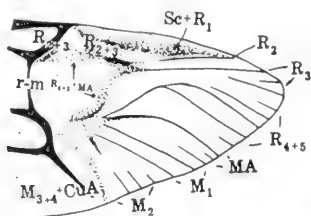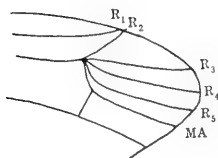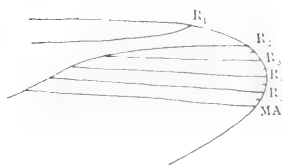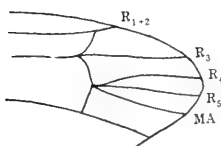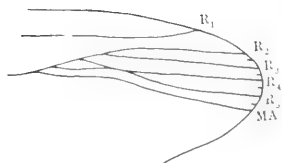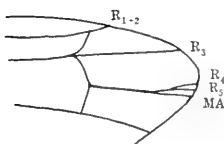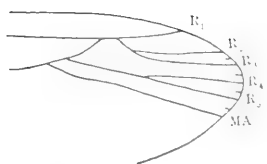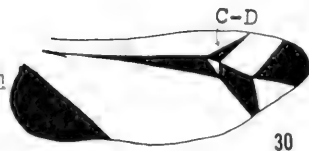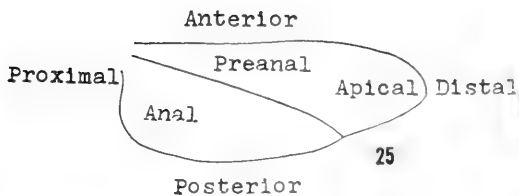
Much of the branching pattern of posterior media in the Coleoptera has as its parallel a condition found in the Corydalidae (fig. 37). This pattern consists of a branching of M_{1+2}, accompanied by a fusion of M_{3+4}. In Coleoptera, the single appearing M_{3+4} vein subsequently fuses with anterior cubitus as paralleled in the Sialidae (fig. 36). In addition to the Sialidae serving as a parallel pattern in interpreting the nature of media in the Cupedidae-Adephaga, there also emerges a parallel medial pattern in the Lepidoptera (fig. 38). This pattern in conjunction with the Sialidae is considered instrumental in constructing a medial pattern common to both the Cupedidae-Adephaga and Polyphaga specializations. In the Lepidoptera only M_4 is considered fused with CuA_1. In the Polyphaga there is the same fusion of M_{3+4} with CuA as in the Adephaga but in contrast to the Adephaga, there is the atrophy rather than the fusion of the proximal portion of M_{1+2}. Even though the nature of the fusion of M_2 may differ in Lepidoptera, as compared to the Coleoptera (fig. 38–39), the fact remains that Lepidoptera possesses the parallel specialization involving the fusion of M_2 to M_{3+4} with the subsequent fusion of this series to the branch CuA_1. M_2 is separate in the Hydrophilidae and partially fused with M_{3+4} in Scarabaeidae (fig. 39).

In some of the polyphagan families such as the Bostrichidae (fig. 40), an apical vein emerges from the distal side of the cross-vein. This in turn has been encountered on the proximal side of the cross-vein in the Chrysomeloidea (fig. 42). As a result of a comparison to the Lepidoptera, it becomes evident that the proximal spurious condition as noted in some Chrysomeloidea is the result of atrophy of a portion of the basal segment of M_{1+2}.

Thus the characteristic appearing cross-vein in the Polyphaga which connects the Rs to M is interpreted as consisting of an alignment of a r-m cross-vein to the proximal segment of M_2. In turn M_2 fuses with $M_{3+4} + CuA$. The distal spur of Chrysomeloidea and the vein in the Bostrichidae is therefore M_1.

Anterior Cubitus (CuA)—Several recent workers including Martynova (1952), Edmunds and Traver (1954), Adams (1958), and Carpenter (1966) recognize the investigations of Lameere (1922) involving the convex and concave nature of venation, as having

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Fig. 31, Hypothetical archetype venation; (modified from Snodgrass, 1935). 32, *Lemmatophora typica* Sellards (Protorthoptera; Lemmatophoridae); after Adams, 1958. 33, Sialidae cellular pattern. 34, Comparative coleopterous cellular pattern. 35, Cupedidae-Adephaga comparative cellular pattern. 36, *Sialis mohri* Ross (Megaloptera; Sialidae); after Adams; 1958. 37, *Protohermes davidi* Weele (Megaloptera; Corydalidae). 38, *Prionoxystus robiniae* Peck (Cossidae). 39, *Canthon probus* (Germ.) (Scarabaeidae); distal branching of M and CuA. 40, *Dinapate wrighti* Horn (Bostrichidae); after Forbes, 1922.
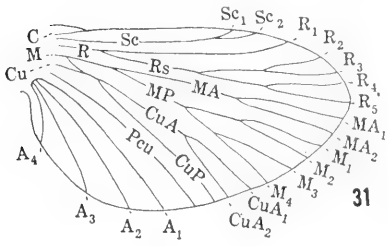
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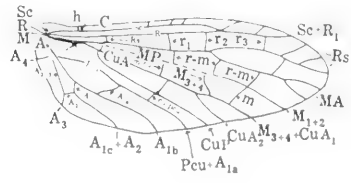
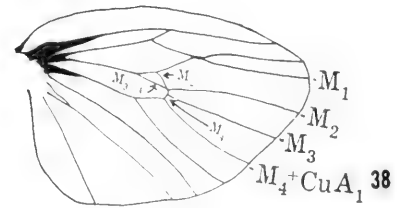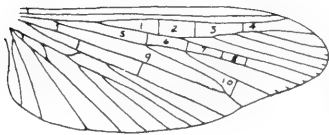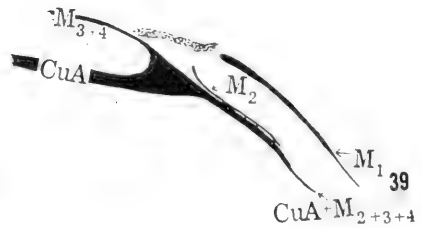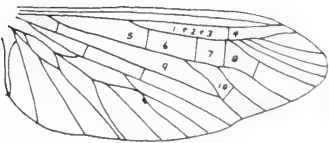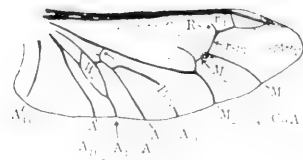36
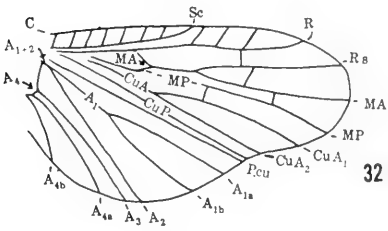
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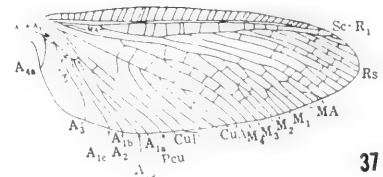
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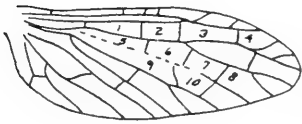
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comparative value in determining the homology of the principal veins. As interpreted by Forbes, cubitus is a strongly convex vein in Coleoptera and appears as a single distinctive vein, dividing the wing into the designated preanal and anal regions. It is in keeping with the nomenclature established by Lameere that this strongly convex vein of the Coleoptera in comparison to the Megaloptera, as well as the accumulated fossil evidence, be designated as CuA (i.e. Cu_1 by other authors). It is further recognized as paralleled in the hind wing of some Ephemeroptera (i.e. *Triplosoba pulchella* (Brongiart), Edmunds and Traver, 1954) that CuA occurs as a single convex vein. In regard to Megaloptera and Lemmatophoridae, this vein in its simplest pattern branches at the apex. As to whether this condition was branched originally in Coleoptera with the subsequent loss of this branching by atrophy or fusion or whether it was originally a single vein is uncertain. Following the above interpretation, account must be made for the loss of posterior cubitus (CuP, i.e. Cu_2 by other authors). There exists in the order Lepidoptera (fig. 43) a parallel specialization in which there is an emphasis placed on the atrophy of this vein. In addition Tillyard (1932) pointed out the atrophy of this vein in the fossil wing *Martynovia insignis* Till. of the family Sialidae (fig. 44). Therefore in order to establish a basis of nomenclature consistent with a paleoentomological and comparative morphological approach, the terms CuA and CuP are tentatively accepted. As recognized by Carpenter (1966), additional histological investigations are needed in order to determine the developmental nature of convex and concave venation in the Endopterygota.

Postcubitus (Pcu)—The vein designated as postcubitus follows the terminology proposed by Snodgrass (1935, fig. 31). This vein is the first anal of Forbes (1922). The recognition of this vein by Snodgrass (1935) as having the status of an independent vein is clearly seen in the fossil family Lemmatophoridae (fig. 4, 32) and Plecoptera (fig. 45). It is recognized further by Snodgrass (1935) that in the more generalized insects, the postcubitus is associated proximally with

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Fig. 41, *Lema trilineata* (Oliv.) (Chrysomelidae). 42, *Migodus tetropiodes* Fairm. (Cerambycidae); after Crowson, 1955. 43, *Synemon* sp. (Lepidoptera; Castniidae); after Tillyard, 1919. 44, *Martynovia insignis* Tillyard (Megaloptera; Corydalidae); after Tillyard, 1932; forewing. 45, *Perla languida* Needham and Claassen (Plecoptera; Perlidae); after Needham and Claassen, 1925. 46, *Corydalis cornutus* L. (Megaloptera; Corydalidae); generalized anal lobe. 47, *Corydalis cornutus* L. (Megaloptera; Corydalidae). 48, *Chauliodes pectinicornis* L. (Megaloptera; Corydalidae); pattern of individual variation in the species. 49, *Corydalis cornutus* L. (Megaloptera; Corydalidae); pattern of individual variation in the species. 50, *Corydalis cornutus* L. (Megaloptera; Corydalidae); pattern of individual variation in the species.
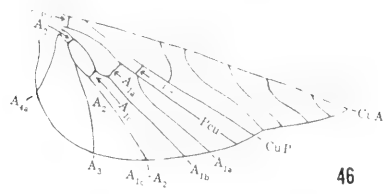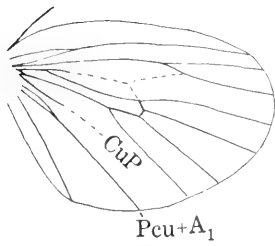
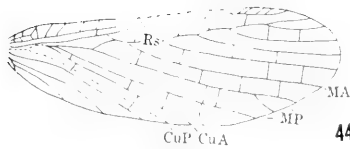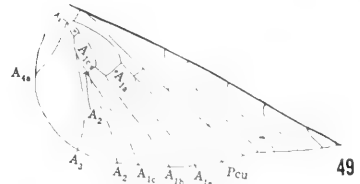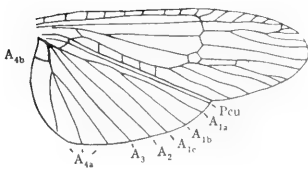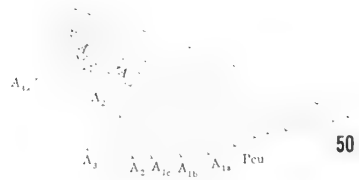the cubitus but its base is independent of both cubitus and the anal veins.

In the comparative coleopterous-megalopterous wing pattern, the vein labeled Pcu appears to fuse proximally with CuA. In the Megaloptera (fig. 46) there occurs a proximal cu-pcu cross-vein. In comparison to Coleoptera, there is a possibility of a serial alignment of Pcu to that of a proximal cu-pcu cross-vein. As to whether there is a direct fusion of Pcu with CuA or a connection of Pcu to CuA or a connection of Pcu to CuA via a cu-pcu cross-vein is uncertain.

Anal veins (A)—In order to gain a better understanding of the complicated anal venation of Coleoptera, we decided that evidence from a wing outside the order may be instructive. In the selection of such a wing the possession of a well developed anal lobe and venation was important. Such an anal lobe possessing the desirable venation was found in the Corydalidae and the fossil family Lemmatophoridae.

The basic pattern probably has much in common with the modified archetype venation (fig. 31) of Comstock and Needham as illustrated by Snodgrass (1935). The branches of CuA have been relabeled to conform to the venational terminology in line with that of the paleoentomological interpretations previously discussed.

Using the Lemmatophoridae as a basic pattern (fig. 4, 32), an anal pattern developed consisting of a single anal vein. This pattern further involved a branching of this single vein with the subsequent expansion of this area into a well developed anal lobe.

Thus for the suggested line of development leading to the Coleoptera, the maximum reached was four anals as noted in the archetype, all of which are primary branches of a single vein designated A_1, A_2, A_3 and A_4.

Specializations in Coleoptera begin with the addition of venation involving primarily the branching of A_1. This condition is noted as having its beginning in a pattern paralleling that of Lemmatophoridae and becoming a parallel part of the specialization trend in such orders as the Plecoptera (fig. 45) and Megaloptera (fig. 47).

The branching pattern of A_1 in Coleoptera consists basically of three secondary branches designated A_{1a}, A_{1b}, and A_{1c}. Further specialization resulted in the formation of a tertiary branching of A_{1b} (A_{1b_1}, A_{1b_2}, and A_{1b_3}) accompanied by a coalescence of these branches either with each other or with the main branches of the anal pattern. This is based upon studies within the Coleoptera, as well as comparative studies of the Lemmatophoridae, Plecoptera and Megaloptera. From such studies it becomes increasingly evident that the cross-vein appearing pattern in the Coleoptera resulted from coalescence of the longitudinal anal branches.

The following is a comparison between the cross-vein pattern proposed by Forbes (1922) in the construction of his hypothetical wing (fig. 1) and the concept that the anal pattern of present-day Coleoptera originated from a coalescence of the longitudinal anal branches.

1st-2nd cross-vein—As paralleled in the Megaloptera (fig. 46), this cross-vein is a partial fusion of the longitudinal branch of A_{1a} with Pcu. In both the Megaloptera and Coleoptera prior to the fusion of A_{1a} with Pcu, there is a retention of a free proximal segment of A_{1a}. In Coleoptera this pattern is characteristic of both Cupedidae (fig. 6–7) and the Adephaga (fig. 11–17).

1st-2nd a cross-vein—This cross-vein is interpreted as the distal segment of A_{1a} emerging from Pcu as a free branch. In general in the Corydalidae, A_{1a} continues as a free branch to the margin of the wing except as interpreted in the individual species variation in *Chauliodes* (fig. 48).

In the Coleoptera, A_{1a} emerges a short distance as a free branch, after which it fuses, as in the Cupedidae (fig. 6–7), with A_{1b_1}. It then continues as the fused vein $A_{1a} + A_{1b_1}$ to the margin of the wing.

2nd-3rd a proximal cross-vein of the wedge cell (W_1)—As a result of a study of the stages of Corydalidae (fig. 49–50), this condition, as paralleled in the Coleoptera, is the result of a fusion of the branches A_{1c} and A_2.

Further specialization of these branches is paralleled in the individual species variation occurring in both the Megaloptera (fig. 51–52) and *Priacma serrata* (Lec.) (fig. 53) of the family Cupedidae.
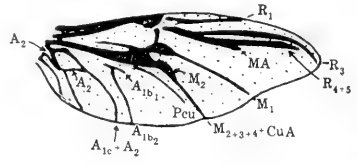
2nd-3rd a distal cross-vein of the wedge cell (W_1)—Forbes based this primarily on the pattern as it appeared in the Cebrionidae, Elateridae, Lampyridae line. As noted particularly in the Lampyridae (fig. 54–55), this is the result of the fusion of the branch A_{1b_3} with the fused vein $A_{1c} + A_2$.

There appears in the Megaloptera (fig. 46) an apparent proximal cross-vein labeled A_2. From a study conducted on the Scarabaeidae (fig. 56–58), there is evidence that this condition was not originally a cross-vein but rather a proximal fusion for a short distance of A_1 and A_2 (Lemmatophoridae fig. 32) after which A_2 emerges as a free branch and eventually fuses with A_3. The fusion of A_{2-3} continues for a short distance with the emergence again of A_2 as a free branch. Following this A_2 fuses with A_{1c}.
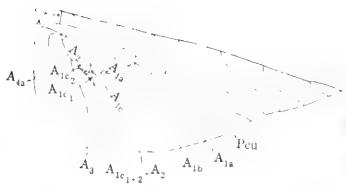
The Coleoptera share with the Megaloptera the possession of a number of preanal cross-veins. Although no one particular coleop-
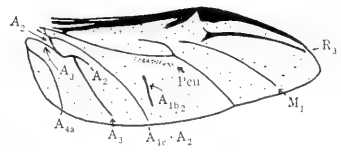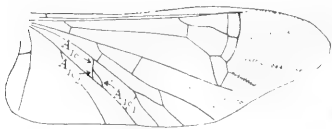
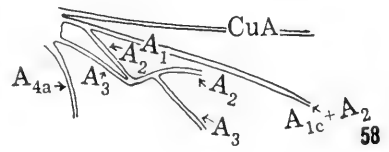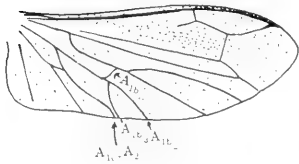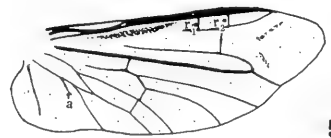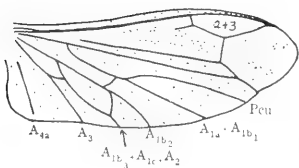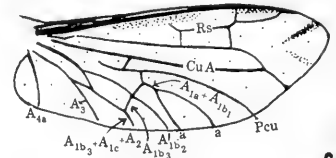terous family possesses the number of cross-veins established in the comparative pattern (fig. 2), the number illustrated is basic to interpreting the various cross-veins as they are discussed in relation to family specialization trends.
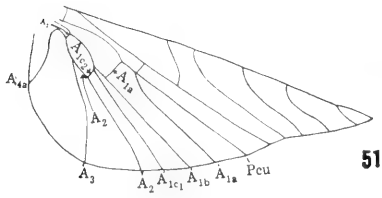
Cross-veins do vary in number and position. Although they may be treated as comparable cross-veins (i.e. the radial cross-veins), as a result of a parallel drawn between the Megaloptera and the Coleoptera or even certain family parallels within the Coleoptera, it cannot be stated with any certainty that such cross-veins are homologous.

A cross-vein lying proximally between C and Sc is designated as the humeral cross-vein (h) (fig. 6), and is by nature of comparison to the Corydalidae considered as a survival of a once numerous costal-subcostal cross-vein pattern.

Following the interpretation established in relation to the radial branching pattern, the comparative coleopterous-megalopterous pattern consists of at least three radial cross-veins. The first and second radial cross-veins occurring proximal to the C-D fold. This was based largely upon the condition as it occurs in the Polyphaga and particularly that of the Cebrionidae (fig. 59). As discussed previously in relationship to the adephagan radial sector patterns, the third radial cross-vein occurs distal to the C-D fold.

In comparing the Cupedidae-Adephaga to the Polyphaga, there are at least four radio-medial cross-veins. In the Cupedidae-Adephaga pattern the proximal radio-medial cross-vein connects the proximal portion of Rs to M. This cross-vein is believed to have as its counterpart a weakly appearing cross-vein in the Cebrionidae (fig. 60).

There is a prominent radio-medial cross-vein in the Polyphaga which forms the characteristic distal connection between Rs and M. As was discussed in connection with the media, this entire segment is the alignment of the radio-medial cross-vein with the proximal segment of M_2.

The Cupedidae possess three or possibly four r-m cross-veins, the distal one of which fuses with a proximal segment of $R_{1.5} + MA$ as noted particularly in the Carabidae (fig. 17).

In many coleopterous families, there is an apparent cross-vein

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Fig. 51, *Corydalis cornutus* L. (Megaloptera; Corydalidae); pattern of individual variation in the species. 52, *Corydalis cornutus* L. (Megaloptera; Corydalidae); pattern of individual variation in the species. 53, *Priacma serrata* (Lec.) (Cupedidae); pattern of individual variation in the species. 54, *Photinus pyralis* (L.) (Lampyridae); pattern of individual variation in the species. 55, *Photinus pyralis* (L.) (Lampyridae); generalized pattern. 56, *Pinotus carolinus* (L.) (Scarabaeidae). 57, *Xyloryctes jamaicensis* (Drury) (Scarabaeidae). 58, *Xyloryctes jamaicensis* (Drury) (Scarabaeidae). 59, *Scaptolenus lecontei* (Sallé) (Cebrionidae); pattern of individual variation in the species. 60, *Scaptolenus lecontei* (Sallé) (Cebrionidae); pattern of individual variation in the species.
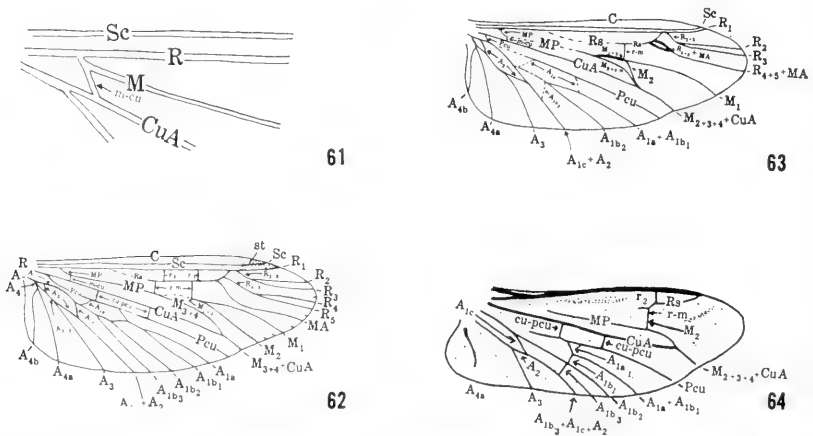
Fig. 61, *Chauliodes pectinicornis* L. (Megaloptera; Corydalidae); proximal rela-
tionship of media to radius and anterior cubitus. 62, Polyphaga comparative pat-
tern; Series 1. 63, Scarabaeoidea comparative pattern. 64, *Scaptolenus lecontei*
(Sallé) (Cebrionidae); pattern of individual variation in the species; after Forbes,
1922.

connecting the radius to the cubitus. This can be traced by com-
paring *Priacma* (fig. 6) as well as most of the Adephaga to an
arrangement noted in such megalopterous forms as *Chauliodes* (fig.
61). This condition involves a fusion of the proximal portion of the
longitudinal media with that of a proximal medio-cubital cross-vein.
Forbes (1922) in discussing this pattern used the term "arculus" in
reference to a similar arrangement which appears in the Odonata.

In a variation of the Sialidae pattern (fig. 36), there is a medial
cross-vein which connects M_2 to $M_{3+4} + CuA$. The parallel of this
condition forms the distal side of cell 10 of the Cupedidae-Adephaga
pattern (fig. 35). In Polyphaga this cross-vein atrophies with the
subsequent fusion of M_2 with $M_{3+4} + CuA$ (fig. 62, 63).

In the Megaloptera there are two cross-veins occurring between
the cubitus and postcubitus designated as cu-pcu cross-veins. The
possibilities involving the relationship of the very proximal emergence
of Pcu from CuA have already been discussed. Taking this into
consideration, there is present in the Cupedidae-Adephaga (fig. 17–
18) and Polyphaga (fig. 64) at least two cu-pcu cross-veins. Of
these two, the proximally occurring cu-pcu cross-vein in the Adephaga
is often in alignment with the branch A_{1a}. This condition was inter-
preted by Forbes as an "anal arculus," the composition of which was
the proximal portion of the vein designated as 1stA and the 1st-2nd
cross-vein. However, King (1956) pointed out in a discussion on

the Dytiscidae, that a portion of Pcu (1stA after Forbes) is retained proximal to the alignment of the cu-pcu cross-vein and the free branch of A_{1a}.

Therefore the approach followed in this investigation considers that the generalized comparative coleopterous-megalopterous pattern is not based upon any one particular wing but is a venational pattern which is shared with the Megaloptera and supported by parallel evidence from the Lepidoptera, Plecoptera, and the fossil family Lemmatophoridae. The selected comparative parallel patterns as exhibited by the orders other than Coleoptera serve as guides in an attempt to determine the path of development along which the present-day coleopterous venation became established.

Following the completion of this paper (unpublished dissertation, 1971) Hamilton (1971, 1972) published a series of papers using a similar type of approach. Ponomarenko (1972) published an account of a single fossil wing of a beetle from the Upper Permian deposits. Both recognize the close affinity of Coleoptera to Megaloptera. It is important to point out that our approach involved an in-depth study of the order Coleoptera and we differ mainly in our interpretation of the anal field of venation.

Because Ponomarenko has illustrated a fossil wing which on the basis of folding is considered to be that of a beetle wing, we believed it important to compare the ideas presented in Ponomarenko's paper to those already discussed. Ponomarenko emphasizes in his discussion the existence of compound veins. In particular he recognizes such possibilities as the anterior branch of media merging distally with the posterior branch of the radial sector. Furthermore he points out that as a result of the folding and unfolding of the wing, proximal parts of longitudinal veins may assume the role of former cross-veins and that an independent vein is frequently considered a branch of a completely different vein.

The primary difference between Ponomarenko's proposal and ours is in the interpretation of the anal venation. Therefore the following discussion is a comparison of the two proposals.

The vein labeled by Forbes as 1A is designated by Ponomarenko as a posterior branch of cubitus, Cu_2 or CuP. In our investigation this vein is postcubitus (Pcu) after Snodgrass (1935), the posterior branch of cubitus being lost. The acceptance of this vein as postcubitus (Pcu) rather than cubitus posterior (CuP) designates it as an independent vein corresponding to that of the Lemmatophoridae. As already emphasized the proposal of this vein as Pcu is necessary in making a comparison of the coleopterous pattern to that of Megaloptera. The basis of this comparison is the recognition of fused longitudinal veins in the anal area in place of cross-veins.
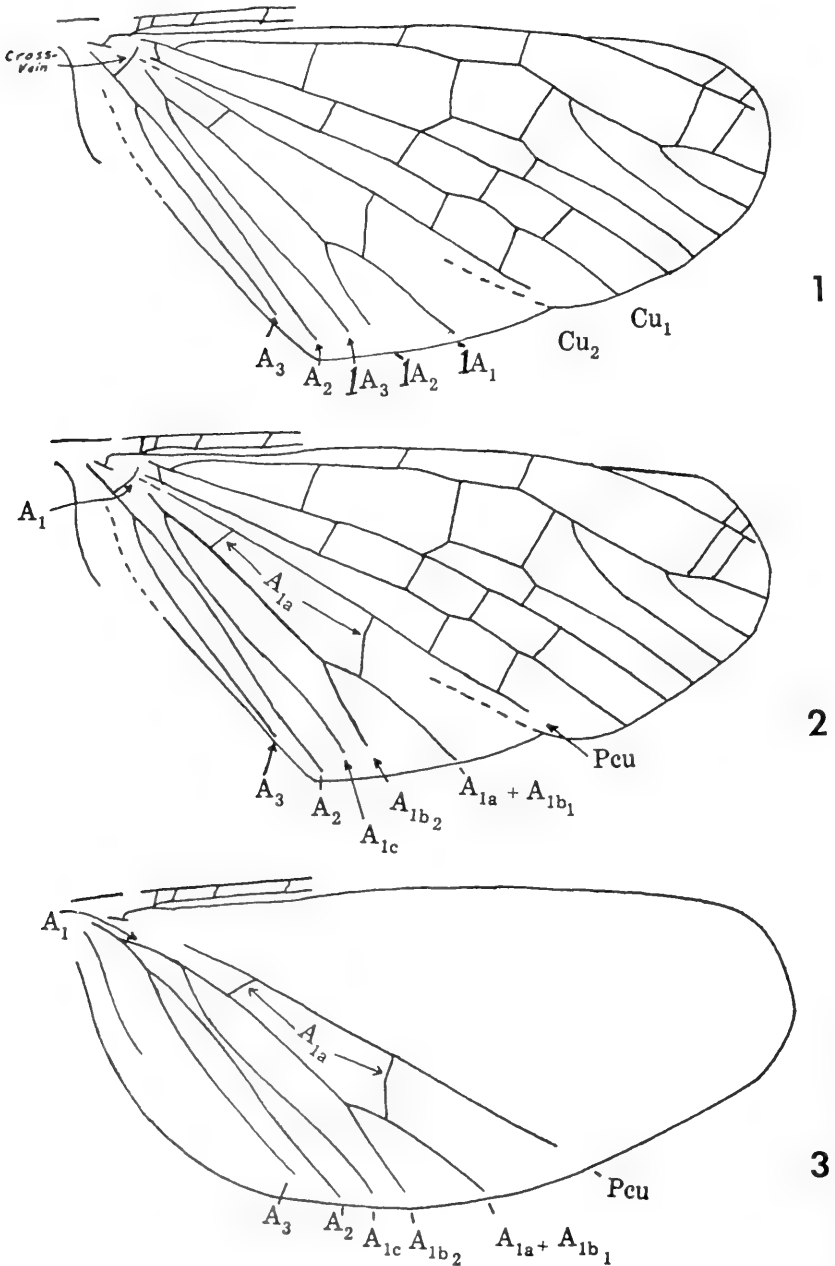
Plate II. 1, Hind wing of a beetle from Upper Permain deposits near the village of Chepanikha (Urals) after A. G. Ponomarenko, 1972. 2, The venational system proposed by Wallace and Fox. 3, The proximal arrangement of A_1 according to Wallace and Fox.

Ponomarenko, in discussing the basal area of the first and second anal veins, indicates the presence of a segment which he states could not be the anal arch as designated by Forbes but is simply a cross-vein. However, this segment would appear to be the broken proximal portion of A_1. This would be in keeping with the comparative patterns proposed in this investigation. In Plate 2 is illustrated a comparison of the two proposals.

It is significant to point out in the proposal set forth by Pono-marenko that the existence of compound veins, the pectinate nature of the radial sector and the presence of numerous cross-veins except in the anal area, are all in keeping with the present comparative morphological study.

CONCLUSIONS

From venational studies conducted within the order Coleoptera, it is apparent that the generalized pattern of this order exhibits a close affinity to the suborder Megaloptera. It is evident, however, that the coleopterous venation is not derivable from any single present-day venational pattern. Therefore, in order to establish a pattern which can be considered fundamental, other orders such as the Lepi-doptera and the fossil family Lemmatophoridae are used in addition to a comparative study of available families within the Coleoptera.

As a result of a comparative study involving the families of Coleop-tera, the suborder Megaloptera, and the fossil family Lemmato-phoridae, the following is interpreted as fundamental to the com-parative coleopterous-megalopterous venational line of development:

1. The preanal venational pattern consists of a costa, subcosta, radius, radial sector, anterior and posterior media, and anterior cubitus. Anterior media was included because of the close affinity the Coleoptera have to the Megaloptera and therefore was considered a remnant of the apical venation in present-day Coleoptera. The ordinal cross-vein pattern is unstable in number and position, the maximum number of which is not present in any single coleopterous family. Due to the stability of 3 radial cross-veins observed throughout most of the Megaloptera, the coleopterous ordinal pattern, originally consisted of 3, 2 of which occurred as a part of the original polyphagan pattern and one in the adephagan pattern. In comparison to the Lem-matophoridae, the coleopterous ordinal pattern is believed to possess originally a marginal thickening designated as the pterostigma.

2. The apical venation was originally pectinate in configuration, the nature of which was altered greatly as a result of folding. As discussed in relationship to the Hydrophilidae, this pattern

may have consisted originally of a variable amount of accessory branching, a specialization of which is common to many of the Megaloptera.

3. The anal venation consists of a postcubitus vein directly connected to anterior cubitus or indirectly connected by means of a serial cu-pcu cross-vein. As is a consistent feature of the Megaloptera, the anterior primary branch of the first anal fuses partially with postcubitus.

4. The anal venation was originally a single vein from which formed a basic pattern consisting of four primary branches designated A_1, A_2, A_3, and A_4.

5. An investigation into the nature of the individual patterns of variation within a megalopterous species as well as certain species of the Coleoptera, reveals that the basic primary branches have undergone secondary branching pattern. The secondary branching pattern established is restricted principally to the primary branch A_1 and to a lesser extent A_4 (a pattern often paralleled in the Plecoptera). A_1 branches three times forming secondary branches designated A_{1a}, A_{1b} and A_{1c}. In turn, as part of the ordinal pattern, a third or tertiary branching had taken place, which was restricted to the secondary branch A_{1b}. To these tertiary branches were given the terms A_{1b_1}, A_{1b_2}, and A_{1b_3}. The primary branch A_4 divides forming secondary branches A_{4a} and A_{4b}.

6. The line of development leading to the Coleoptera consists of an anal pattern in which there was a lack of any cross-vein development. In place of cross-vein patterns and possibly to add support to this area of the wing, there developed in the Coleoptera a characteristic pattern involving coalescence of anal veins. In many cases this has led to the development of a pattern which appears to possess cross-veins.

7. Coalescence of the anal branches consists principally of a fusion of A_1 and A_2 proximally for a short distance, after which A_2 emerges as a free branch distally. The anterior secondary branch A_{1a} fuses with Pcu, emerging as a free branch distally. The posterior secondary branch A_{1c} fuses with the distal free branch of A_2 and continues to the margin of the wing.

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NATURAL HISTORY OF THECOMYIA LIMBATA
(DIPTERA: SCIOMYZIDAE) FROM BRAZIL[1]

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ABSTRACT—Biological and morphological data are presented on *Thecomyia limbata* (Wiedemann) (Diptera: Sciomyzidae) from Brazil. The larva preys on aquatic, pulmonate snails of the genera *Aplexa, Drepanotrema, Gyraulus, Helisoma, Lymnaea, Physa, Succinea,* and *Taphius.* The egg, 3 larval instars, and the puparium are described and illustrated. These data are based on field observations conducted in Brazil and on laboratory rearings conducted there and in the United States. *Thecomyia longicornis* is removed from synonymy with *T. limbata* and is revived as type-species of *Thecomyia.* The relationships of *Thecomyia* to closely-allied Sciomyzidae are discussed.

The Sciomyzidae (= Tetanoceridae) are true flies placed in the section Acalyptrata of the order Diptera. The Acalyptratae constitute a large and diverse group, comprising at least 54 families, 48 of which occur in the Neotropical Region (Hennig, 1958; Papavero, 1966).

Hennig (1958) placed the Sciomyzidae in the superfamily Sciomyzoidea, along with the Helcomyzidae, Ropalomeridae, Coelopidae, Dryomyzidae, and Sepsidae. McAlpine (1968) also included the Eurychoromyiidae, known only from a single species from Bolivia, in the Sciomyzoidea.

Steyskal (1965) divided the Sciomyzidae into 5 subfamilies: Huttoninae, Salticellinae, Helosciomyzinae, Phaeomyiinae, and Sciomyzinae. Of these, only the latter, with its 2 large tribes Sciomyzini and Tetanocerini, occurs in the Neotropical Region, or for that matter in the entire Western Hemisphere.

The family Sciomyzidae probably contains about 65 described genera and about 600 species. Of these, 77 species in 23 genera occur in the Americas south of the United States. The taxonomy of the South American species is poorly known, but the genera *Dictyodes* and *Tetanoceroides* have been revised recently by Steyskal (1974) and Zuska and Berg (1974), respectively. These taxonomic and zoogeographic papers contain little biological information and no descriptions of immature stages.

The life histories of only 3 species of South American Sciomyzidae have been described. Neff and Berg (1966) provided biological data and descriptions of the immature stages of *Sepedomerus macropus* (Walker) (as *Sepedon macropus*), a species ranging from north-western South America to southern Texas. Kaczynski, *et al.* (1969) described one new species in each of the exclusively South American genera *Perilimnia* and *Shannonia* and presented the life histories and morphological descriptions of the immature stages of *Perilimnia albifacies* Becker and *Shannonia meridionalis* Zuska.

This paper presents the first published information on the life history and morphology of the immature stages of a member of the large Neotropical genus *Thecomyia*. This information on *T. limbata* (Wiedemann) is also the first such data provided for any species of Sciomyzidae from Brazil. Like the 3 other South American species whose life histories have been reported, *T. limbata* belongs to the subfamily Sciomyzinae, tribe Tetanocerini.

MATERIALS AND METHODS

Individual rearings of *Thecomyia limbata* were begun with living adult flies, larvae, and puparia collected by us in Brazil. The rearings were carried out at the Departamento de Zoologia, Secretaria da Agricultura, Estado de São Paulo, São Paulo (now the Museu de Zoologia, Universidade de São Paulo) and later at the Department of Entomology, Cornell University, Ithaca, New York.

Laboratory temperatures ranged between 16° and 30°C; relative humidity, from 16% to 70%. Several types of breeding jars were used in this study. Forty-dram plastic vials with a living area of approximately 115 cm³ were used most commonly. The vials were covered with tight-fitting polyethylene caps, each with a 3-cm hole covered with 21-mesh screen. Four types of glass jars, having volumes of approximately 79, 97, 113, and 190 cm³, were also used. These were covered with fine nylon marquisette.

Whatever the type of jar, the bottom was covered to a depth of approximately 2 cm by cotton. This substrate, kept moist by adding tap water daily, provided higher and more constant relative humidities in the jars than those recorded for the laboratory. Two medical applicator sticks were placed in each breeding jar to provide additional oviposition and resting sites. Females of *T. limbata* oviposited on the sticks or, more often, on the walls of the breeding jars. Adults were frequently removed and transferred to new breeding jars. The eggs were allowed to hatch, and the larvae dropped to the wet substrate. The jar was flooded with water and the larvae floated to the surface where they were picked up with a camel's-hair brush and placed in larval rearing containers.

The flies were provided with crushed snails and prepared food. The former served as a source of protein and probably resulted in higher egg production (Chock, *et al.*, 1961). The prepared food consisted of a mixture of honey, powdered milk, and yeast, with a small amount of Tegosept M[3] mold inhibitor.

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[3] Manufactured by Inolex Corp., Philadelphia, Pennsylvania, U.S.A.

This was pressed to the sides of the jars near the top. Flies were frequently seen feeding on the prepared food and crushed snails.

Larvae were usually reared in small, transparent, plastic specimen boxes with tight-fitting lids. Aquarium gravel, used as a substrate, was moistened to create a thin film of water which adhered to the pebbles and left many interstices of air. Larvae and snails were placed directly on the gravel. Dead and decaying snails were removed daily and living snails were added. The lids were kept tight since the larvae frequently crawled out of the water when it became fouled with dead snail tissue.

Larvae pupated among the pebbles. Puparia were removed and placed on moist cotton in glass vials fitted with cotton stoppers. The puparia were held in a closed chamber where humidity was maintained at high levels by a saturated salt solution (Peterson, 1964).

Genus *Thecomyia* Perty

Thecomyia Perty, 1833, Insecta Brasiliensa, p. 189. Type-species: *Thecomyia longicornis* Perty, 1833:189 (single originally included species).

Thecomyia is the largest genus in the Neotropical Tetanocerini. It includes 4 nominal species and 9 undescribed species recently recognized by Steyskal (1973). For many years, *T. longicornis* was the only known species. Then Frey (1919) transferred *Tetanocera limbata* Wiedemann to *Thecomyia* and Hendel (1932) described *Thecomyia trilineata* based on 2 males from Pozo del Tigre, Bolivia. Steyskal (1966) transferred *Tetanocera lateralis* Walker to the genus. Walker (1858) had based his description on a single male from the valley of the Amazon.

Cresson (1920) placed *Thecomyia* in his tribe Sepedontini, along with *Sepedon* and *Cylindrica* (= *Dichetophora*). Malloch (1928) followed Cresson's classification. Verbeke (1950), using characters of the male genitalia, removed *Thecomyia* and *Dichetophora* from the group and elevated this tribe (the Sepedontini) to subfamily rank, the Sepedoninae. He declined to place *Thecomyia* in any subfamily, stating that it was intermediate between Tetanocerinae and Sepedoninae. Steyskal (1965) considered *Thecomyia* and other genera around *Sepedon* to be in the tribe Tetanocerini of the subfamily Sciomyzinae. Steyskal (1973) later placed *Thecomyia* in "the *Sepedon* group" of Tetanocerini, along with *Sepedon, Sepedonella, Sepedoninus, Sepedomerus,* and *Sepedonea.*

The following combination of characters may be used to distinguish *Thecomyia* from other members of the Tetanocerini: vallar bristles absent; ocellar and postocellar bristles lacking; 2 scutellar bristles; sternum above third coxae closed, not divided by a membranous area; face strongly produced; palpi not developed.

Thecomyia limbata (Wiedemann)

Tetanocera limbata Wiedemann, 1819, Zool. Mag. 1(3):54.

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Thecomyia limbata (Wiedemann). Hendel, 1932, Konowia. 11:98.

Thecomyia longicornis Perty. Hendel, 1932, Konowia. 11:98.

Wiedemann (1819) described *Tetanocera limbata* from a single male, giving only Brazil as the type locality. Frey (1919) moved the species to *Thecomyia* and listed it from "Rio Janeiro," Brazil. Hendel (1932) synonymized *Thecomyia longicornis* with *T. limbata* and reported that it occurred not only in Brazil but also in French Guiana, Colombia, Bolivia, and Paraguay. Examination of material in the U.S. National Museum (USNM) by us and by G. C. Steyskal reveals that *T. longicornis* is a distinct species and it is revived here as type-species of the genus. *Thecomyia longicornis* is distinguished by having fronto-orbital bristles laterad of the posterior ocelli, and by having the anterior and posterior surstyli fused in the male genitalia. *Thecomyia limbata* lacks fronto-orbital bristles and the anterior and posterior surstyli are separate. Hendel's locality data are unreliable until his material can be re-examined.

Our collections and museum specimens show that *T. limbata* is known from the following localities, all in Brazil: GUANABARA: Rio de Janeiro, 1 ♂, coll. Wheeler (USNM); Rio de Janeiro: Jardim Botànico, 10-12-IV-1967, 13-VI-1967, 10 ♂, 8 ♀, 2 larvae, 2 pupae, coll. Berg (Cornell University (CU)); Rio de Janeiro: Instituto Oswaldo Cruz, 5-6-IV-1967, 6-VI-1967, 2 ♂, 4♀, 4 larvae, coll. Berg (CU). PARAÍBA: Areia, VII-1955, 1 ♂, coll. Pereira (USNM). PARANÁ: Praia do Leste, 4, 17-V-1967, 2 ♂, 2 ♀, coll. Berg and Abercrombie (CU). SANTA CATARINA: Nova Teutonia, 27° 11′ lat., 52° 23′ long., 8-IV-1948, 1 ♂, coll. Plaumann (American Museum of Natural History). SÃO PAULO: Andes, 28-II, 1 ♂, coll. Carrera (USNM); Araçatuba, Rio Jacarecatinga, X-1961, 2 ♂, coll. Lane and Rabello (USNM); São Vicente, Parque Bitaru, 29-V-1967, 7 ♂, 2 ♀, 7 larvae, coll. Berg and Abercrombie (CU). "Chapada," 1 ♂, coll. Wheeler (probably Serra da Chapada in Mato Grosso) (USNM). "Estado do Rio, Araruama," VI-1948, 1 ♂, coll. Vanzolini (USNM). Additional record from the literature: "Rio Janeiro," I-1839, 1 specimen, coll. Sahlberg (Frey, 1919).

NATURAL HISTORY

Biological observations are based on rearings initiated with the following: 4 females, 2 males, and 4 larvae collected on the grounds of the Instituto Oswaldo Cruz, Rio de Janeiro, Guanabara, Brazil, 5–6 April and 6 June 1967; 8 females, 10 males, 1 larva, and 1 puparium

collected 10–12 April and 13 June 1967 at the Jardim Botânico, Rio de Janeiro, Guanabara, Brazil; 2 females and 2 males from Praia do Leste, Paraná, Brazil, 4 and 17 May 1967; and 2 females, 7 males, and 5 larvae from Parque Bitaru, in São Vicente, São Paulo, Brazil, 29 May 1967. Genetic compatibility of widely separated populations was demonstrated by the successful mating of a virgin, laboratory-reared female from Rio de Janeiro and a collected male from Praia do Leste.

Adults were swept by insect net from hydrophilous grasses, reeds, water lilies, *Sagittaria* sp., and *Typha* sp. in roadside ditches and channels, and from similar vegetation above wet mud with occasional shallow pools in an old canal. Larvae were discovered by pushing down the emergent vegetation and causing them to float free. Puparia and 2 exuviae of 2nd-instar larvae were collected in the same way.

Larvae of *T. limbata* fed on 12 different species of Gastropoda in laboratory trials. These represented 8 genera and 4 families, and included snails from both North and South America. These were: Succineidae: *Succinea meridionalis* d'Orbigny and *S. pusilla* Pfeiffer, both Neotropical; Lymnaeidae: *Lymnaea* (*Stagnicola*) *palustris* (Müller), Nearctic; Planorbidae: *Drepanotrema* (*Fossulorbis*) *kermatoides* (d'Orbigny), *Taphius glabratus* (Say) (= *Australorbis glabratus* (Say) or *Biomphalaria glabrata* (Say) of authors), *T. helophilus* (Say), *T. tenagophilus* (d'Orbigny), all Neotropical, *Gyraulus parvus* (Say), *Helisoma duryi* (Wetherby), and *H. trivolvis* (Say), all Nearctic; Physidae: *Aplexa* (*Stenophysa*) *marmorata* (Guilding), Neotropical, and *Physa gyrina* Say, Nearctic. All 3 species of *Taphius* are proven or potential vectors of the blood fluke *Schistosoma mansoni* Sambon. *Taphius glabratus* is the most important intermediate host of *S. mansoni* in the Americas; *T. tenagophilus* is a highly susceptible intermediate host in the state of São Paulo; and *T. helophilus* is susceptible to laboratory infection with *S. mansoni* (Pan American Health Organization, 1968).

Adults did not live very long in the laboratory. Thirteen wild-caught males lived 6, 6, 7, 7, 9, 10, 10, 12, 14, 16, 19, 21, and 28 days; 12 field-collected females lived 3, 4, 4, 6, 12, 17, 23, 28, 28, 28, 36, and 58 days. Adults emerged in the laboratory 22 May–4 August 1967 and died 5 June–13 August 1967 after living 3–28 days (9 females: 3, 5, 6, 8, 9, 11, 13, 15, and 28 days; 3 males: 6, 8, and 9 days).

Flies which emerged on 23 May, 22 May, and 1 June were first observed to mate 6, 7, and 16 days after emergence, respectively. Eight other laboratory-reared females were never observed in copula.

Prior to mating, the male frequently stands about 5–7 cm in front of the female, waving his forelegs while resting on his mid- and hind-legs. At the same time, he holds his wings obliquely upward and outspread. During mating in the laboratory, the male assumed the

dorsal position. His fore tarsi rested along the inner margins of the female's eyes, his middle legs were spread wide apart, not resting on anything, or occasionally they were placed on the female's middle femora, and his hind tibiae grasped the female's abdomen so that his hind tarsi hung suspended beneath her. Matings lasted from 15 to 95 minutes.

Two laboratory-reared females lived 8 and 12 days before laying their first egg. Eight other reared flies did not produce eggs.

During oviposition, the female extended and retracted the tip of the abdomen, feeling the substrate for a suitable site. When a satisfactory spot had been found, she extruded half of the egg, held it to the substrate for 22–26 seconds, and then retracted her abdomen, leaving the egg in place. She then often moved sideways and felt for another oviposition site. After 8–24 seconds of exploration, she extruded another egg.

Females of *T. limbata* placed eggs both singly and in clusters. Single eggs were usually laid on the moist cotton at the bottom of the breeding jar, on the gauze covering of the jar, or inside the aperture of dead snails. Clusters were always more or less fan-shaped and each contained 40–60 eggs. A long, curving row of eggs (with the long axes of the eggs perpendicular to the long axis of the row) was first put down by the fly. This was followed by a shorter row inside the curvature of the first, then another shorter row, then another, and so on until 1 or 2 eggs were finally placed at the apex of the triangle thus formed. The end result roughly resembled the semicircular rows of an amphitheater which narrows toward the stage.

The 2 laboratory-reared females which laid eggs had short lives, so egg totals were quite low. One female which emerged 22 May laid 43 eggs between 3 and 6 June, the day she died. Another female emerged 23 May and laid 28 eggs between 30 May and 5 June, when she died. A feral female laid 158 eggs during the 58 days of her captivity. Egg totals for 4 more wild-caught females were 91, 169, 209, and 248. The incubation period was 3 or 4 days.

Larvae quickly killed snails placed in the rearing boxes. They sometimes remained feeding on the dead flesh for 10–12 hours although shorter times were more common.

Larvae were observed swallowing air both while resting on moist substrates and while floating at the surface film. This undoubtedly increases their buoyancy. Larvae of *T. limbata* swim with the dorsum uppermost by extending the anterior body segments forward, and then bringing them downward and backward quickly. The anterior end is returned to a horizontal position, parallel to the surface, before the next downward stroke. Swimming was observed in nature as well as in the laboratory.

Larvae reared by us spent 4–6 days in the first stadium; 1–8 days

in 2nd; and 7–14 days in the 3rd. The total larval period was 12–25 days long. One larva was noted which passed through each stadium in the shortest observed time (and hence spent only 12 days feeding), and then remained in the pupal stage for the shortest observed time (10 days).

In the laboratory, puparia were formed among the wet stones of the rearing boxes. The pupal period ranged from 10 to 18 days.

A preoviposition period of 8–12 days added to an egg incubation period of 3–4 days, a larval life of 12–25 days and a pupal period of 10–18 days totals 33–59 days required for a complete life cycle. It is theoretically possible for as many as 11 generations to occur each year.

Adults have been collected in January (Frey, 1919), February, April, May, June, July, and October. Considering the very equable climate which these flies inhabit and the fact that no diapause was encountered during laboratory rearings, it seems likely that breeding is continuous throughout the year and that generations overlap each other in time. Immature stages have been collected only in May and June, but this is almost certainly because these are the only months in which collecting effort has been expended.

Snails collected in the same habitat as *T. limbata* include: *Ampullarius* sp., *Taphius tenagophilus*, *Drepanotrema kermatoides*, and *Aplexa marmorata*. Larvae fed on the last 3 species in laboratory trials.

Other Sciomyzidae that occur with *T. limbata* include: *Protodictya apicalis* Steyskal, *P. brasiliensis* (Schiner), *P. guttularis* (Wiedemann), *Sepedomerus bipuncticeps* (Malloch), *Sepedomerus* n. sp., and 2 new species of *Sepedonea*.

MORPHOLOGY OF THE IMMATURE STAGES[1]

Egg: (fig. 11). Dull white. Length 1.12–1.22 mm (average = 1.17); greatest width 0.26–0.42 mm (average = 0.33). Ovoid, tapering at both ends. From 21 to 25 low, longitudinal ridges visible dorsally, occasionally diverging, anastomosing or terminating, and intersected at random by much lower transverse ridges. Micropyle shielded dorsally by a more or less truncate tubercle with minute punctations. Posterior end upturned in lateral view; subglobular, more rounded than anterior end; bearing minute punctations. Lateral and ventral surfaces ridged as on dorsal surface. (Based on 20 specimens laid by flies collected at Jardim Botânico, Rio de Janeiro, Guanabara, Brazil).

First-instar larva: (fig. 1, 5, and 12). Very light brown; integument trans-

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[1] The indentation index is given for the cephalopharyngeal skeleton of each larval instar. This ratio, as used by Kaczynski, *et al.* (1969), is the length of the ventral border of the dorsal cornua of the pharyngeal sclerite, as measured from its posterior tip to the greatest depth of the concavity that separates the dorsal from the ventral cornua, divided by the length of the entire dorsal cornua, and multiplied by 100.
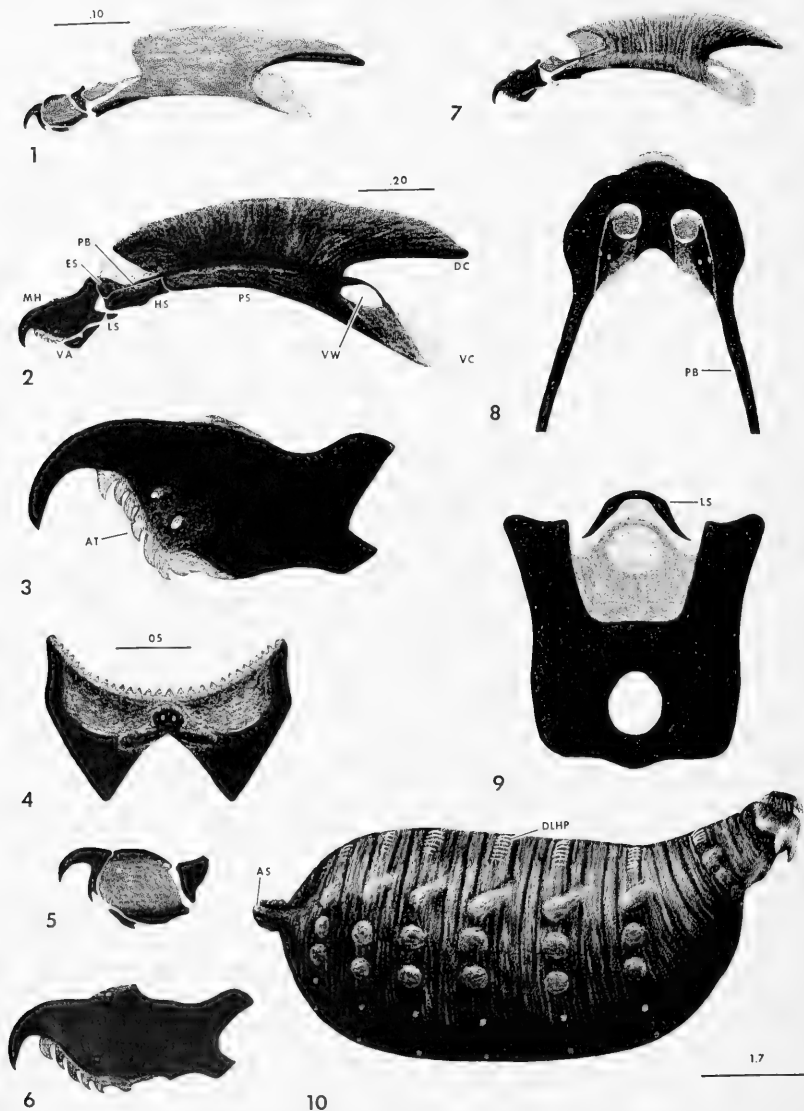
Fig. 1–10. *Thecomyia limbata.* Fig. 1–2. Cephalopharyngeal skeletons, lateral views. 1, First-instar larva. 2, Third-instar larva. Fig. 3–4. Third-instar larva. 3, Mouthhook, lateral view. 4, Ventral arch, ventral view. Fig. 5. First-instar larva, mouthhook and ventral arch, lateral view. Fig. 6–7. Second-instar larva, lateral views. 6, Mouthhook. 7, Cephalopharyngeal skeleton. Fig. 8–9. Third-instar larva. 8, Epistomal sclerite, dorsal view. 9, Hypostomal sclerite and ligulate sclerite, ventral view. Fig. 10. Puparium, lateral view. Abbreviations: AS, anterior spiracle; AT, accessory tooth; DC, dorsal cornua; DLHP, dorsolateral hair patch; ES, epistomal sclerite; HS, hypostomal sclerite; LS, ligulate sclerite; MH, mouthhook; PB, parastomal bar; PS, pharyngeal sclerite; VA, ventral arch; VC, ventral cornua; VW, ventral window.

parent. Length 1.7–4.5 mm (average 2.2); greatest width 0.3–1.0 mm (average = 0.5). Cephalopharyngeal skeleton (fig. 1) 0.44–0.46 mm long, with paired mouthhooks 0.08–0.10 mm in length. Each mouthhook (fig. 5) with 3 component parts, with small ventral arch lying ventrad. Epistomal and hypostomal sclerites fused to paired pharyngeal sclerite; latter very light brown, with dark ventral border on dorsal cornua; no obfuscation anterodorsally; ventral window indistinct. Indentation index 43–47. Segment 1 bilobed anteriorly, each lobe bearing a sensory papilla. Segment 2 with 1 lateral and 1 ventral bristle. Segment 3 with 1 dorsolateral, 1 lateral, and 1 ventral bristle. Segment 4 with 1 dorsolateral bristle. Segments 5–11 each with transverse row of hairs dorsally, with longest hairs dorsolaterally; lateral tubercle group of 3 contiguous tubercles more or less in a vertical row but with the middle one slightly anterior to others; each bearing a tuft of hairs; main ventral tubercle group of 4 small tubercles in a transverse row, each with a small tuft of short hairs. Posterior spiracular disc (fig. 12) with 4 pairs of lobes: ventral pair short, subconical; ventrolateral pair two-segmented, with basal portion produced ventrally and distal portion digitiform and subequal to it, thus entire lobe appearing bifid; lateral lobes very low, inconspicuous; dorsolateral pair also very low, but marked by prominent tuft of hairs. Entire disc thickly covered with long hairs on lobes and outer sections and with short, thick hairs between the stigmatic tubes; ventral and ventrolateral lobes appearing annulate. Two stigmatic tubes separate, each with a spiracular plate bearing 1 large spiracular slit (usually divided in such a way as to appear to be 2 separate slits) and 4 large, dark, semitransparent, irregularly branched float hairs, 0.148–0.153 mm long. Anal plate large, light in color. Anal proleg small, inconspicuous, covered with hair. (Based on 21 specimens reared from flies collected at Instituto Oswaldo Cruz, Rio de Janeiro, Guanabara, Brazil).

Second-instar larva: (fig. 6, 7, and 15). Light brown; integument diaphanous, thickly covered with hair. Length 2.8–6.7 mm (average = 4.6); greatest width 0.8–2.2 mm (average = 1.2). Cephalopharyngeal skeleton (fig. 7) 0.66–0.76 mm long, with paired mouthhooks (fig. 6) 0.16–0.17 mm in length, each with 4–6 accessory teeth directed ventrally. Ventral arch similar to that in third-instar larva. Epistomal and hypostomal sclerites fused to paired pharyngeal sclerite; latter with dorsally-radiating dark lines and a prominent ventral window. Indentation index 34–40. Segment 1 as that of first-instar larva. Segments 2 and 4 each with 1 dorsolateral, 1 lateral, and 1 ventral bristle. Segment 3 with 1 long, white, dorsolateral bristle, 1 lateral bristle, 1 ventrolateral bristle, and 1 short, brown, ventral bristle. Segments 5–11 each with prominent dorsolateral hair patch; lateral tubercles arranged as those in first-instar larva, each with single, long, white bristle; main ventral tubercle group of 4 small tubercles in a transverse row, each with a tuft of short, stout hairs; followed posteriorly by 2 transverse rows of even smaller tubercles, posteriormost row with tubercles bearing short, stout hairs as main group. Posterior spiracular disc (fig. 15) with 4 pairs of lobes: ventral pair short, subconical, annulate; ventrolateral pair two-segmented with basal portion produced ventrally and with distal portion longer and narrower; both sections annulate; lateral and dorsolateral pairs low, rounded, inconspicuous. Lobes thickly covered with hairs but center of disc glabrous. Two stigmatic tubes separate, each with a spiracular plate bearing a large stigmatic scar, 3 small spiracular slits, and 4 large, dark, semitransparent, irregularly branched float
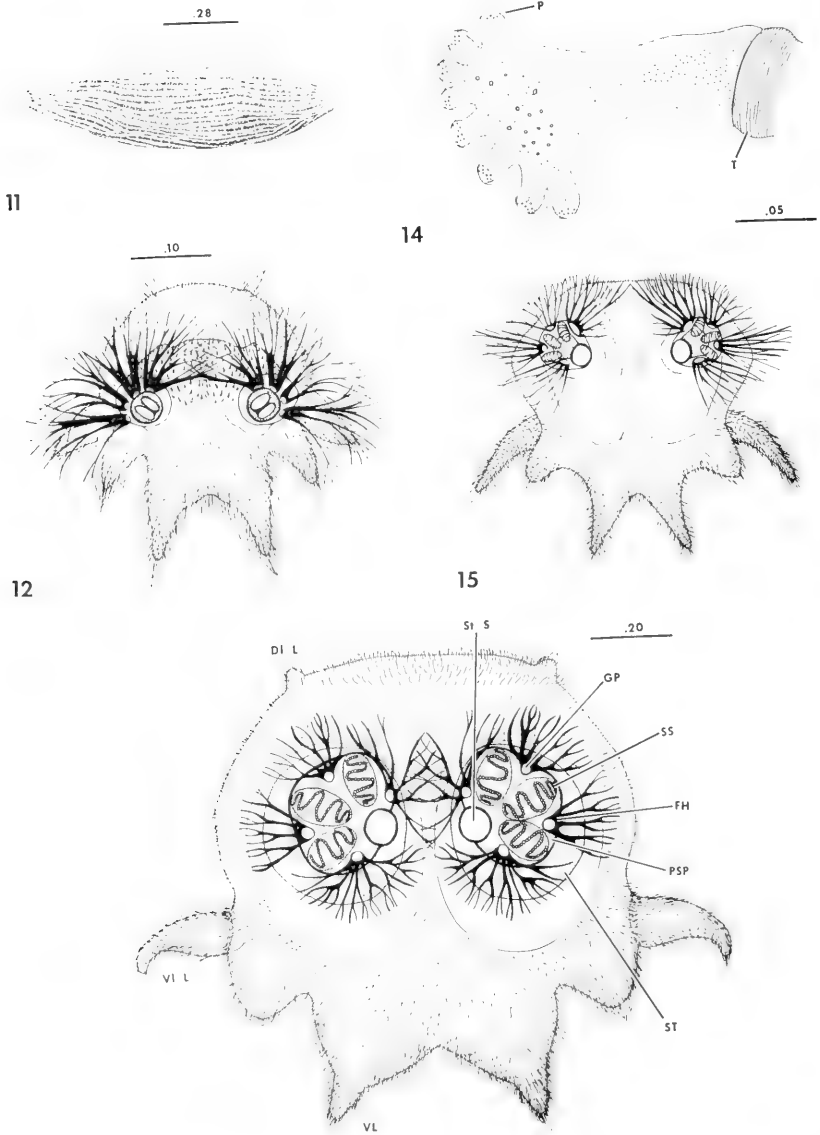
Fig. 11–15. *Thecomyia limbata*. Fig. 11. Egg, dorsal view. Fig. 12–13. Posterior spiracular discs, caudal views. 12, First-instar larva. 13, Third-instar larva. Fig. 14. Third-instar larva, anterior spiracle, lateral view. Fig. 15. Second-instar larva, posterior spiracular disc, caudal view. Abbreviations: Dl L, dorsolateral lobe; FH, float hair; GP, glandular pore; P, papilla; PSP, posterior spiracular plate; SS, spiracular slit; ST, stigmatic tube; St S, stigmatic scar; T, trachea; VL, ventral lobe; Vl L, ventrolateral lobe.

hairs. Anal plate large, light brown, covered with hairs. Anal proleg very small, covered with long hairs. (Based on 12 specimens reared from flies collected at Instituto Oswaldo Cruz, Rio de Janeiro, Guanabara, Brazil).

Third-instar larva: (fig. 2, 3, 4, 8, 9, 13, and 14). Dark brown; integument opaque, covered densely with hair. Length 6.8–13.3 mm (average = 8.9); greatest width 1.8–3.2 mm (average = 2.3). Cephalopharyngeal skeleton (fig. 2) 1.04–1.10 mm long with paired mouthhooks, each with 5–7 accessory teeth directed ventrally; mouthhook sclerite (fig. 3) 0.20–0.25 mm long. Ventral arch (fig. 4) deeply emarginate medially, bearing 25–27 anterior denticles. Epistomal sclerite (fig. 8) lying within dorsal extensions of hypostomal sclerite, with parastomal bars connected to paired pharyngeal sclerite. Ligulate sclerite (fig. 9) closely appressed to median projection of hypostomal sclerite; latter (fig. 9) unique in having lightly sclerotized lateral projections extending dorsally almost to upper margin of dorsal cornua (fig. 2). Pharyngeal sclerite dark brown with very prominent ventral window; indentation index 30–34. Segment 1 as that in 1st-instar larva. Segment 2 with 1 dorsolateral, 1 lateral, and 1 ventral, long, white bristle. Segment 2 also bearing laterally a prominent anterior spiracle (fig. 14) 0.19–0.23 mm long, with 8 papillae anteriorly. Segments 3 and 4 each with 1 dorsolateral and 1 ventral bristle. Segments 5–11 each bearing a very conspicuous dorsolateral hair patch with brown hairs 0.34–0.42 mm long; lateral tubercle group of 3 separate tubercles of subequal size in a vertical row, each bearing a dense mat of hairs and middle one often bearing a long, protruding bristle as well; main ventral tubercle group of 4 small tubercles in a transverse row, each with a tuft of short hairs, followed posteriorly by 2 transverse rows of much smaller tubercles, each with a small hair patch. Posterior spiracular disc (fig. 13) with 3 pairs of lobes: ventral pair quite wide at base, tapering sharply distally, annulate; ventrolateral pair two-segmented, both sections annulate; dorsolateral pair small. Two stigmatic tubes separate, large, and long, each bearing a spiracular plate with a large stigmatic scar, 3 unique, sinuous spiracular slits, and 4 large, dark, semitransparent, irregularly branched float hairs, with glandular pores at their bases. Anal proleg small, inconspicuous, covered with dense hairs. (Based on 8 specimens reared from flies collected at Instituto Oswaldo Cruz, Rio de Janeiro, Guanabara, Brazil).

Puparium: (fig. 10). Black; opaque. Length 7.3–8.3 mm (average = 7.8); greatest width 3.0–3.8 mm (average = 3.4). Barrel-shaped, with ends of cephalic caps projecting anteriorly slightly above the main longitudinal body axis and roughly parallel to it. Anterior spiracles protruding from anterolateral corners of dorsal cephalic cap. Segments 5–11 each with dorsolateral hair patch on each side of the median line; hairs not appressed to surface; lateral tubercle group persisting as slight protrusions somewhat lighter in color than surrounding integument, some bearing stiff bristles; main ventral tubercles persisting as lightened, roughened areas, some bearing small, stiff bristles. Posterior end upturned, forming an angle of 130–160 degrees with the main longitudinal body axis. Ventral and ventrolateral lobes of posterior spiracular disc fleshy, flexible, hirsute, and light in color, especially in alcoholic specimens. Stigmatic tubes separate, each bearing prominent float hairs. Anal plate invaginated. Anal proleg lacking. (Based on 5 specimens reared from flies collected at Jardim Botânico, Rio de Janeiro, Guanabara, Brazil).

DISCUSSION

Eggs of *Thecomyia limbata* are quite similar to the eggs of most species of North and Central American species of *Sepedon* described by Neff and Berg (1966). They lack the 4 prominent longitudinal ridges characteristic of the eggs of *Sepedomerus macropus* (Neff and Berg, 1966) and of all known eggs of *Sepedonea* (Abercrombie and Berg, unpublished data). These 3 genera are the only members of the "*Sepedon* group" of Steyskal (1973) that occur in South America. There seem to be no morphological characters common to eggs of all species of the *Sepedon* group that will distinguish them from eggs of other Sciomyzidae.

Mature larvae resemble other known larvae of the *Sepedon* group from other parts of the world (Neff and Berg, 1966; Knutson, *et al.*, 1967). They are distinguished by lacking the dorsal and lateral lobes of the posterior spiracular disc, so that the disc bears 6 lobes on its circumference instead of 10. In addition, *T. limbata* has 5–7 accessory teeth, directed ventrally, on the mouthhook. All known larvae of other species in the *Sepedon* group have 3 or 4 accessory teeth. In the South American *Sepedomerus* and *Sepedonea*, the accessory teeth are directed mesally, but in other members of the group the teeth may be directed either mesally or ventrally (Neff and Berg, 1966; Knutson, *et al.*, 1967; Abercrombie and Berg, unpublished data).

The feeding behavior of larvae of *Thecomyia limbata* is similar to that described for most other members of the *Sepedon* group (Neff and Berg, 1966). The larvae are aquatic predators, attacking and quickly killing pulmonate snails, feeding for a short time, and then leaving the prey. Young, first-instar larvae were fed freshly-killed snails in the laboratory, but living snails appeared to be preferred. The large size and aggressive behavior of mature larvae make them efficient predators.

The puparia of *Thecomyia limbata* show few distinguishing characters except those found in the cephalopharyngeal skeletons of the third-instar larvae, which are enclosed.

Adults of *Thecomyia* are unique morphologically from other members of the *Sepedon* group. Their strongly produced face and their almost total lack of hairs or bristles readily distinguish them from other genera in the group. This would indicate that *Thecomyia* is rather highly specialized. Characters of the male genitalia, however, show different degrees of specialization. In *T. longicornis*, for example, the anterior and posterior surstyli are fused. In *T. limbata*, the surstyli are separate, indicating a generalized species (Steyskal, 1957). Indeed, this conclusion is substantiated by morphology of the pre-imaginal stages and behavior of the larvae of *T. limbata*. They are little different from most other members of the *Sepedon* group.

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NEW SAWFLIES OF THE GENERA DIELOCERUS CURTIS AND THEMOS NORTON FROM SOUTH AMERICA (HYMENOPTERA: ARGIDAE)

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ABSTRACT—Three species of Argidae are described: *Dielocerus diasi*, n. sp., both adult and larva, reared from *Sclerolobium aureum* in Brazil; *Themos olfersii* (Klug) reared from *Eriotheca pubescens* in Brazil; and *Themos boliviensis*, n. sp. from Bolivia.

Few Neotropical sawflies have been reared and the host recorded; consequently, it is a pleasure to describe a new species and redescribe another from bred material. The 2 species represent 2 genera of Argidae, *Dielocerus* Curtis and *Themos* Norton, both sent to me for identification by Braulio F. de Souza Dias, Universidade de Brasília, Brasília, D. F., Brasil, who is doing biological work on them. I also take this opportunity to describe a new *Themos* from Bolivia, the specimen of which is in the U. S. National Museum collection. Both genera discussed here are restricted to the New World tropics.

Dielocerus Curtis

Dielocerus Curtis, 1844. Trans. Linn. Soc. London 19:248. Type-species: *Dielocerus ellisii* Curtis. Desig. by Rohwer, 1911.
Dielocera Cameron, 1878. Trans. R. Entomol. Soc. London, p. 147. Emend.
Dieloceros Konow, 1905. *In* Wytsmann, Gen. Ins., fasc. 29, p. 23. Emend.

This genus is a member of the Dielocerinae which is distinguished from other subfamilies of Argidae by the following combination of characters: absence of preapical spines on the hindtibia, presence of intercostal vein in the forewing, radial cell of forewing closed at apex, palpi shorter than eye length, eyes far apart with distance between eyes below longer than length of an eye. Three other genera are included in the Dielocerinae: *Topotrita* Kirby, *Mallerina* Malaise, and *Digelasinus* Malaise. *Dielocerus* may be separated from all of them by the partially obliterated anal cell of the hindwing; the other genera have this anal cell complete. About 9 species have been included in *Dielocerus*, though a number may belong to other genera of Argidae. The most discussed species has been *Dielocerus formosus* (Klug) (syn.: *Dielocerus ellisii* Curtis, *Dielocera curtisi* Cameron). The following species reared by Mr. Dias is allied to *formosus*.

Dielocerus diasi Smith, new species

Female: Length, 14.0 mm. First and second antennal segments orange, third segment black with small spot of orange at extreme base. Head and mouthparts

orange; apex of each mandible black. Thorax orange except for black metanotum with small orange spot behind each cenchrus. Legs all orange except for longitudinal black stripe on outer surface of hindtibia. Abdomen black with basal sternites pale orange, apical three sternites black; sheath black with pale spot at base. Forewing fasciate, hyaline with dark black area at base, broad black band at center extending width of wing and black spot at extreme apex; costa yellow, veins and stigma black. Hindwing more uniformly lightly infuscated, paler toward apex; veins and stigma black.

Length of antenna subequal to head width; third segment laterally flattened; first and second segments each longer than broad. Clypeus circularly incised for half its medial length; malar space equal to diameter of front ocellus. Head broadened behind eyes in dorsal view; postocellar area elevated, about one and a half times broader than long, with deep furrows. Tarsal claws simple. Forewing with notch at apex of radial cell, not evenly rounded (fig. 1); hindwing with vein 2A obliterated. Sheath uniformly slender from above, small scopa at apex; in lateral view, straight above, rounded below (fig. 5). Lancet long, with 29 to 32 segments, apical segments very narrow with annuli crowded close together; each serrula flat, with 5 to 7 coarse basal teeth (fig. 6).

Male: Length, 11.5 to 12.0 mm. First and second antennal segments orange, third segment black, sometimes with extreme base pale orange. Head orange, apex of each mandible black. Thorax orange with metanotum, mesoscutellum, mesonotal lateral lobes, and spot on posterior of mesoprescutum black. Legs entirely orange. Abdomen black with sternites 1 to 6 mostly orange. Wings uniformly hyaline to very slightly infuscated; costa and upper margin of stigma of forewing white, remainder of stigma and remaining veins black. Third antennal segment furcate; length of antenna a little longer than head width. Hypandrium truncated at apex. Harpe and parapenis as in fig. 8; penis valve narrow, curved at base, as in fig. 9. Other structural features as for female.

Larva (Last feeding stage): Length, 25 to 32 mm. Head amber; amber-spotted on yellow background on top and in front, solid amber on sides, around and below eye; eyespot and apex of each mandible black. Body whitish (preserved specimens) with tubercles and body plates dark brown to black. Body ornamentation consisting of large to small dark plates with small tubercles arising from most of them.

Head with short, scattered setae, longer and more numerous between each mandible and eye. Antenna with single segment round, flat. Clypeus with 2 long setae on each side; labrum with 2 long setae on each side; labrum with deep emargination at center; epipharynx with 14 to 17 spines on each half, some of inner spines furcated at apices, spines arranged semi-circularly (fig. 15). Maxillary palpus 4-segmented, first segment appearing as lobe on inner margin of second segment; second maxillary segment, palpifer, and stipes each with 1 seta; lacinia with 5 or 6 groups of spines, each group with one or more stout stems, branching into 5 or 6 spines (fig. 16). Labial palpus 3-segmented; pre-

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Fig. 1, forewing of *Dielocerus diasi*. Fig. 2, apex of forewing of *D. formosus*. Fig. 3, mandible of *D. formosus*. Fig. 4, mandible of *Themos olfersii*. Fig. 5, sheath of *Dielocerus diasi*, dorsal and lateral. Fig. 6, lancet of *D. diasi*, showing
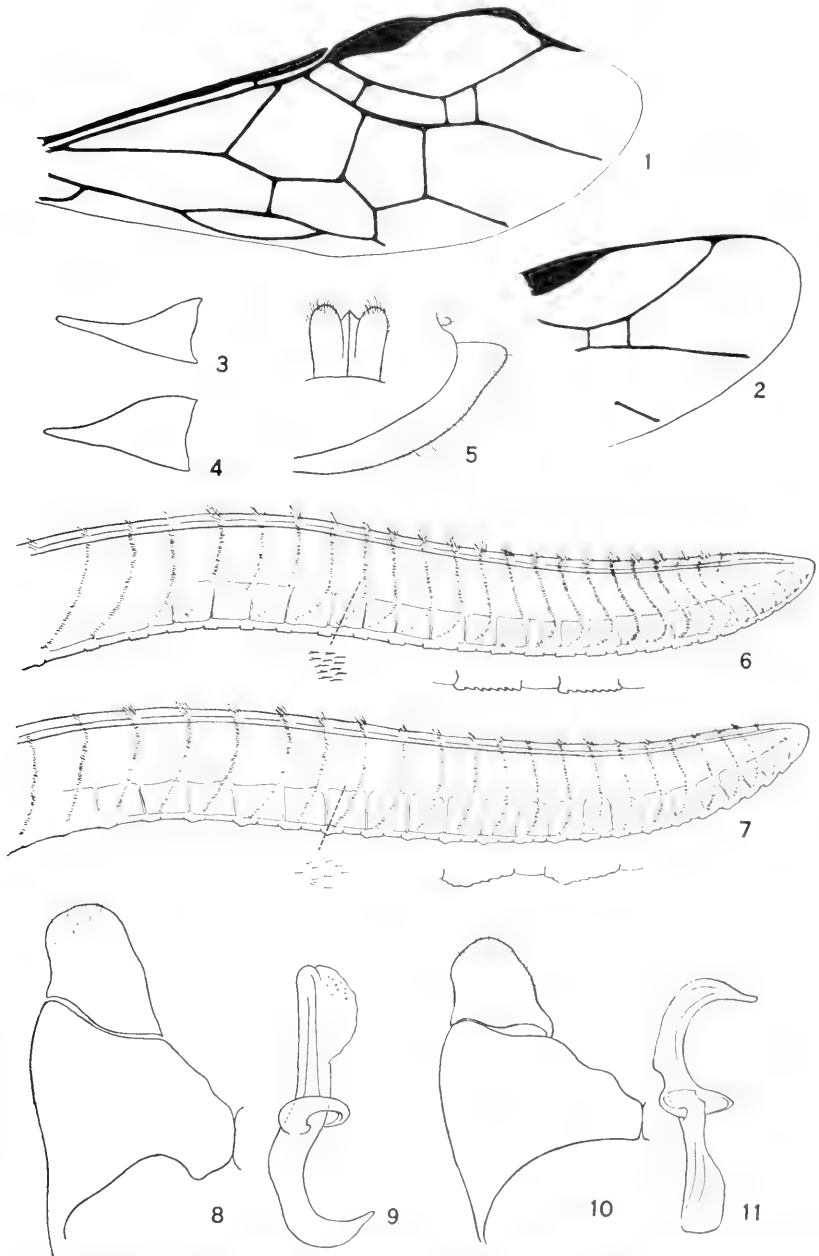
closeup of texture and closeup of 2 serrulae. Fig. 7, lancet of *D. formosus*, showing closeup of texture and closeup of 2 serrulae. Fig. 8, harpe and parapenis of *D. diasi*. Fig. 9, penis valve of *D. diasi*. Fig. 10, harpe and parapenis of *D. formosus*. Fig. 11, penis valve of *D. formosus*.
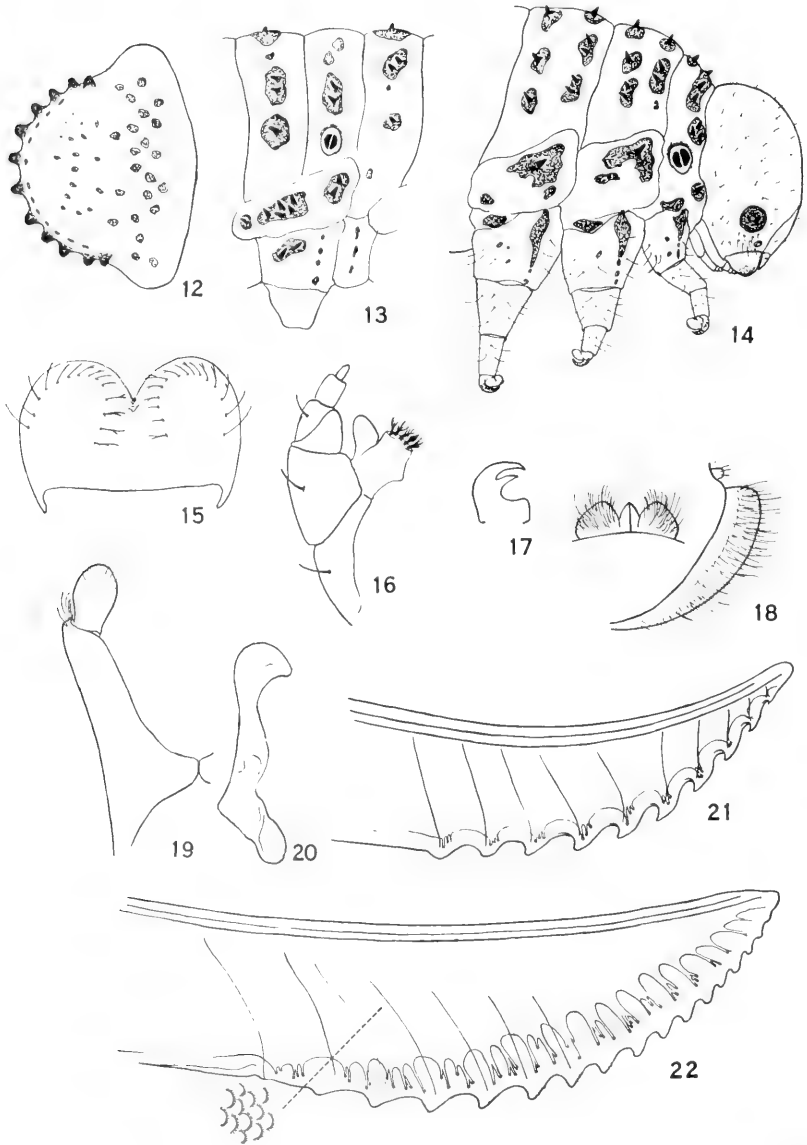
Fig. 12–16, larva of *Dielocerus diasi*. 12, 10th tergum, dorsal view. 13, 3rd abdominal segment, lateral view. 14, head and thorax. 15, epipharynx. 16, maxilla. Fig. 17, tarsal claw of *Themos olfersii*. Fig. 18, sheath of *T. olfersii*, dorsal and lateral views. Fig. 19, harpe and parapenis of *T. olfersii*. Fig. 20, penis valve of *T. olfersii*. Fig. 21, lancet of *T. boliviensis*. Fig. 22, lancet of *T. olfersii* and closeup of texture. Figures 21 and 22 drawn to same scale.

mentum without setae. Mandible worn, teeth not discernible; each mandible with 1 seta on outer surface.

Ornamentation of thorax as in fig. 14. Prothoracic spiracle winged. Each thoracic leg normal, 5-segmented; each leg with tarsal claw; large lobe adjacent to each tarsal claw. Segments of each leg with scattered long setae.

Abdominal segments 1 to 9 each 3-annulate; tubercles arranged as in fig. 13. Spiracles on segments 1 to 7 each winged, and each set in circular depression. Prolegs present on abdominal segments 2 to 6, largest on segment 2, decreasing in size toward apex. Tenth tergum with about 14 stout tubercles at apex (fig. 12).

Holotype: Female, Brasília, D. F., Brasil, reared, emerged in lab XIII–IX 1972, B. Dias, collector. Deposited in the Laboratório de Zoologia, Universidade de Brasília, Brasília, D. F., Brasil.

Paratypes: Same data as for holotype (5 ♀ ♀, 6 ♂ ♂); same locality, 21-IV-1973 (8 larvae). Deposited in the U. S. National Museum and Universidade de Brasília.

Host: These specimens were reared from larvae feeding on *Sclerolobium aureum* (Tul.) (Leguminosae-Caesalpinae), a common savanna tree around Brasília (Dias, 1974).

Discussion: This species is similar to *Dielocerus formosus* (Klug) in both size and coloration; however, the female of *formosus* has the hindtarsus black and the costa of the forewing black, and the male of *formosus* has the head above the antennae black, the mesonotum entirely black, the costa of the forewing black, and the apex of the hindtarsus black. Structural features separating the two species are the contour of the apex of the forewing (compare fig. 1 and 2), the lancets (compare fig. 6 and 7), and the male genitalia (compare fig. 8 to 11).

Although other species have been described in *Dielocerus, diasi* is very unlike any of them. These other are *D. carbonarius* (Cameron) (Brazil), *D. consors* (Kirby) (Brazil), *D. crassus* Cameron (Mexico), *D. fasciatus* (Enderlein) (Ecuador), *D. imitatrix* (Cameron) (Guatemala), *D. serratus* (Kirby) (Brazil), *D. sulcicornis* (Cameron) (Brazil), and *D. violaceus* (Kirby) (Brazil). I doubt that all of these actually belong in *Dielocerus*.

The larva cannot be compared with those of other South American Argidae since none is known. The larva keys to the genus *Arge* in my key to North American larvae (Smith, 1972), a genus to which it is remarkably similar. It differs from *Arge* larvae that I have examined by the flat antennal segment, more numerous dark plates with small tubercles on the body, and many-branched spines of the lacinia. The Arginae and Dielocerinae may be more closely related than indicated in the classification based on adults, a scheme which may have to be revised when more larvae are known.

Mr. Dias, for whom the species is named, intends to publish on the biology of this species and may indicate it as "*Dielocerus* sp. a."

Themos Norton

Themos Norton, 1867. Trans. Amer. Entomol. Soc. 1:58. Type-species: *Themos hyalinus* Norton. Monotypic.

Themus Enderlein, 1920 (1919). Sitz. Gesell. Naturf. Freunde Berlin 9:118. Emend.

This genus, along with *Adierna* Enderlein, forms the subfamily Theminae. The subfamily is separated from other Argidae by the absence of preapical spines on the hindtibia, absence of an intercostal vein in the forewing, the extremely broad mandibles appearing inflated at their bases (fig. 4), reduced mouthparts with the labium having no lobes and the maxillary and labial palpi each three-segmented, and the presence of bifid tarsal claws on at least one pair of legs. The main distinction between the genera is that *Themos* has each tarsal claw bifid and *Adierna* has only the front tarsal claws bifid, the claws on the midlegs and hindlegs being simple with a large basal lobe.

Malaise (1955) gave a key to four species of *Themos*. One species, *T. olfersii* (Klug) was reared by Mr. Dias and is briefly described below, and another species from Bolivia is described as new.

Themos olfersii (Klug)

Hylotoma olfersii Klug, 1834. Jahrb. Ins. 1:249.

?*Themos hyalinus* Norton, 1867. Trans. Amer. Entomol. Soc. 1:58. Type lost; synonymy questionable.

Female: Length, 14–15 mm. First and second antennal segments red, third segment black. Head orange; apex of each mandible black. Thorax orange. Legs orange with extreme apex of each tibia and each tarsus entirely black; outer surface of front tarsus pale orange. Abdomen and sheath black, basal sternites partly orange. Wings darkly infuscated except for hyaline apex beyond apex of stigma; veins and stigma black.

Smooth and shining with punctures only on clypeus, supraclypeal area, and paraantennal fields. Clypeus subtruncate, malar space distinct but less than diameter of front ocellus. Head from above expanded behind eyes; postocellar area only a little broader than long, convex. Each tarsal claw bifid. Sheath in lateral view short and rounded, from above broader than long. Lance extremely broad at base; lancet short and triangular with 17 to 18 serrulae; each serrula moderately deep, narrow, rounded at apex and without distinct subbasal teeth (fig. 22).

Male: Length, 10–11 mm. Antenna pale orange, third segment black at extreme apex; black hairs contrasting with pale color. Head pale orange, black from middle fovea, lateral ocelli, and posterior margin of eye to occiput; black extending on genal area to base of eye. Thorax black with pronotum, peraptera, mesoscutellum, and metascutellum pale orange. Legs black with outer surface of apical half of

front femur and each tarsus except for extreme apex pale orange. Abdomen black, basal sternites sometimes pale orange. Wings uniformly hyaline; veins and stigma black. Third antennal segment furcate. Other structural features as for female. Genitalia as in figs. 19, 20.

Distribution: Known only from Brasil: São Paulo (Ypiranga and Campinas) (Malaise, 1955); Brasília.

Host: *Eriotheca pubescens* (Mart. and Zucc.) (Bombacaceae), a common plant in Brasília (Dias, 1974).

Discussion: A distinctive species, separated by the infuscated wings, black abdomen, and pale orange femora and tibiae in the female. The description of the female is based on my examination of the type through the courtesy of E. Königsmann, Zoological Museum of Berlin.

Themos boliviensis Smith, new species

Female: Length, 14 mm. First antennal segment orange, second and third antennal segments brownish to infuscated black. Head orange; apex of each mandible black. Thorax and abdomen entirely orange. Legs orange with each tibia and tarsus infuscated black, darker at apex of each tibia. Wings darkly infuscated except for hyaline apex beyond apex of stigma; stigma and veins black, costa of forewing pale orange toward basal third.

Smooth and shining species, punctures distinct only on clypeus, supraclypeal area, and paraantennal fields. Length of antenna slightly greater than head width. Clypeus subtruncate, supraclypeal area elevated, malar space distinct but less than diameter of front ocellus; head from above expanded behind eyes; postocellar area convex, a little broader than long. Each tarsal claw bifid (fig. 17). Sheath short and rounded in lateral view; in dorsal view broader than long (fig. 18). Lance extremely broad at base; lancet short and triangular, with 10 to 11 serrulae; each serrula deep, apex pointed and directed anteriorly, without subbasal teeth (fig. 21).

Holotype: Female, "Rosario, Lake Rogagua, Bolivia, Nov., M. R. Lopez, coll." Lake Rogagua is in the state of Beni. U. S. National Museum type no. 73062.

Discussion: This striking species is separated from *laqueatus* Enderlein and *nigronotum* Malaise by the darkly infuscated wings and from *olfersii* and *concinnus* Mocsary by the orange abdomen. The lancets of *olfersii* and *boliviensis* are compared in figs. 21 and 22.

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A REDESCRIPTION OF AMORPHOCOCCUS MESUAE GREEN
WITH NOTES ON ITS SYSTEMATIC POSITION
(HOMOPTERA: COCCOIDEA: ASTEROLECANIIDAE)

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ABSTRACT—The adult female of *Amorphococcus mesuae* Green has been redescribed and illustrated. The systematic position of the genus is discussed and the genus subsequently transferred to the family Asterolecaniidae.

While revising the family Lecanodiaspididae, the authors found *Amorphococcus mesuae* Green to be in need of redescription and taxonomic re-evaluation. There have been no significant contributions to the study of the genus since its establishment. The original species description was short and omitted several morphological characters essential for species identification. It is for these reasons that the genus has undergone an unstable taxonomic past.

Presented in this paper is a redescription and illustration of the adult female of *A. mesuae* Green. Measurements were made by using a Zeiss RA phase contrast microscope (160 × to 2000 ×). Measurements are given in microns and are given in the text as an average followed by the range in parentheses. Lengths and widths in the text represent the longest and widest part of the measured structure.

Amorphococcus Green

Amorphococcus Green, 1902:261; 1909:342; Kirkaldy, 1904:257; Brain, 1918: 107,112; Ferris, 1919:250; MacGillivray, 1921:189; Morrison and Morrison, 1927:2; 1966:8; Lindinger, 1937:179; Russell, 1941:3; Borchsenius, 1959:841; 1960:221; Afifi and Kosztarab, 1969:3; Williams and Kosztarab, 1970:4; Howell and Kosztarab, 1972:1,3; Lambdin and Kosztarab, 1973:2,4,54.

This aberrant genus was originally described and placed by Green (1902) in the subfamily Asterolecaniinae. He later (1909) indicated that the nymphs showed similarities with species in the genus *Asterolecanium* Targoni-Tozzetti and that *Amorphococcus* was probably related to *Frenchia* Maskell. Subsequent workers maintained the genus in the family *Asterolecaniidae* until Borchsenius (1959) included it in his new family Lecanodiaspididae. After comparison with the

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Fig. 1, Galls on twig of *Mesua ferrea* L. caused by *Amorphococcus mesuae* Green.

type species of other genera in Lecanodiaspididae, it is concluded that the genus *Amorphococcus* should be transferred back to the family Asterolecaniidae. This decision is based on the general body form, absence of cribriform plates and an anal cleft, type and position of the anal plates, shape of the tubular ducts, the reduction in the number of ducts and pores in the derm, the absence of transverse abdominal rows of multilocular pores, the absence of a submarginal band of flat 8-shaped pores and of setae on the ventrum, and the gall-making habit of species.

At present the genus is considered monotypic with *A. mesuae* Green restricted to the Oriental Region. The species *A. leptospermi*, originally included in the genus, was retained in the family Lecanodiaspididae (Lambdin and Kosztarab, 1973) because of its close relationship with other members of that family. A third species, *A. acaciae* Brain was found not to be related to *A. mesuae* and was placed in a new genus (Lambdin and Kosztarab, 1975).

The generic characteristics which distinguish this genus from other asterolecaniids are: the turbinate body, sparse tubular ducts (most numerous in posterior abdominal segments), minute fused anal plates with needlelike setae on posterolateral margin and the absence of 8-shaped pores on dorsum; ventrum with 5- to 10-locular pores in cluster laterad of spiracles, and the absence of transverse abdominal rows of multilocular pores.

Type-species: *Amorphococcus mesuae* Green.

Amorphococcus mesuae Green

Amorphococcus mesuae Green, 1902:261; 1909:343; 1918:144; 1937:286; Fernald, 1903:57; Ferris, 1919:250; MacGillivray, 1921:190; Ayyar Ramakrishna, 1921:342; Lindinger, 1937:179; Mani, 1938:82; 1959:107; Pruthi and Mani, 1940: 11; Fulmek, 1943:8; DeSilva, 1961:117.

Type-material: From the syntype series we have chosen and marked a lectotype and 2 paralectotype adult females, all on 1 slide deposited
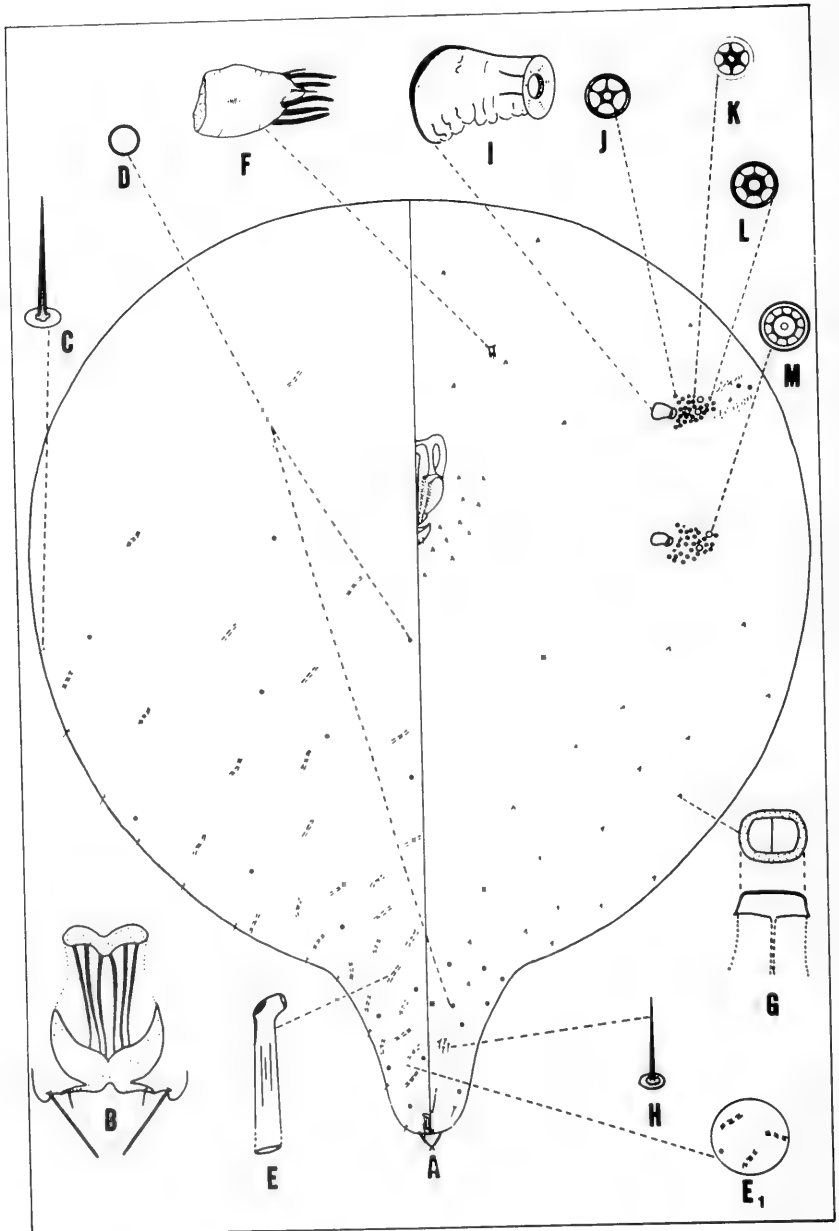
Fig. 2 (A–M), *Amorphococcus mesuae* Green, Adult female (fig. 2 E₁ represents an enlargement of the derm about 38.3 μ in diameter).

in the British Museum (BM). Other paralectotypes: 8 on 1 slide (BM); 4 on 2 slides (BM); 1 on 1 slide (U. S. National Museum); 3 on 2 slides (VPI & SU, No. PL 158 a–b); all from *Mesua ferrea* L. (Guttiferae = Clusiaceae), at Peradeniya, Ceylon, 7 Aug. 1905 (Rec. by E. E. Green).

Habit: Green (1909) noted that the scales occupied rounded or conical galls (fig. 1) closely spaced on the terminal twigs of *M. ferrea*. Each gall has a conical chamber at its base where the scales are found and a minute aperture at its apex. Mani (1959) reported that the galls appear similar to those produced by *Lecanium domesticum* Jack. in Java. Empty galls of *A. mesuae* were found to be occupied by a diaspidid, *Gomphaspidiotus cuculus* (Green) and occasionally by thrips. Usually 3 or 4 adult diaspidid females are found around the exuviae of *A. mesuae*. In addition the chalcid parasite, *Eupelmus amorphococci* Ashmead, (Eupelmidae), has been obtained from this scale by several investigators.

Description: Body (fig. 2A): Turbinate, derm membranous; 1569 (1237–1853) long, 1189 (902–1402) wide; sparse accumulation of tubular ducts and simple pores on dorsum, most numerous in abdominal and posterior cephalothoracic regions.

Dorsal Surface: Anal plates (fig. 2B): Reduced, fused medially, 24.7 (19.5–29.3) long, 26.0 (22.2–30.2) wide; with a stout posterolateral seta on each side 7.1 (4.9–8.7) long.

Anal ring (fig. 2B): Positioned anterior to anal plates, oval, 14.5 (12.7–17.6) long, 13.2 (10.7–17.6) wide; with 6 setae, each 26.4 (19.5–30.3) long. Setae bordered by a lateral row of pores, and occasionally a few pores spaced irregularly on inner margin.

Setae: Abdominal segments with a few needlelike setae (fig. 2C) in a marginal row on abdominal segments, each 8.3 (5.8–9.8) long; anal apex with a pair of stout apical setae, 49.6 (39.1–58.5) long, and an associated seta 10.5 (5.1–13.6) long; other setae on derm rare.

Simple pores (fig. 2D): Usually absent in cephalothoracic region, spaced throughout abdominal segments, 1.85 (1.71–1.95) in diameter.

Tubular ducts (fig. 2E): Most numerous in posterior abdominal segments, cylindrical, terminal filament reduced or absent; each duct 33.6 (28.3–39.1) long, 2.1 (1.4–2.9) wide at the invagination.

The distribution of pores and ducts is shown in fig. $2E_1$ and represents the posterior region of the abdomen.

Ventral Surface: Antennae (fig. 2F): Reduced, 1-segmented, 12.8 (7.4–19.7) long, width of base 9.8 (7.4–12.3); with 4 to 6 fleshy and 2 or 3 slender setae.

Bilocular pores (fig. 2G): Distributed throughout derm, most numerous in abdominal segments and around clypeolabral shield; each 2.0 (1.7–2.2) long, 1.3 (0.9–2.0) wide.

Clypeolabral shield: Length 166 (98.8–198), width 122 (74.1–156).

Labium: Triangular, 45.5 (34.6–56.8) long, 57.8 (49.4–68.1) wide; each half with 2 or 3 slender setae, each 14.6 (10.7–19.5) long.

Setae (fig. 2H): A group of 4 or 5 setae near vulva, each 4.8 (3.9–5.8) long; other setae on derm rare.

Spiracles (fig. 2I): Submarginal, 56.1 (50.7–61.7) long, 26.0 (21.5–34.5) wide, atrium 11.1 (6.83–14.9) in diameter. Each anterior spiracular furrow

contains 65 (47–87) pores, primarily 5-locular; 1 (0–3) 3-locular, 1 (0–4) 4-locular, 50 (37–70) 5-locular (fig. 2J), 2 (1–4) 6-locular (fig. 2K), 4 (0–7) 7-locular (fig. 2L) and 5 (1–10) multilocular pores (fig. 2M); each posterior furrow contains 57 (44–71) pores, primarily 5-locular; with 1 (0–3) 3-locular, 1 (0–2) 4-locular, 46 (33–64) 5-locular, 2 (0–7) 6-locular, 3 (0–6) 7-locular and 4 (1–9) multilocular pores; each 5-, 6-, 7-, and multilocular pore 3.2 (2.9–3.9), 3.3 (2.9–4.2), 3.6 (2.7–4.4) and 4.5 (3.6–4.9) in diameter respectively.

Acknowledgment

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TAXONOMIC NOTES ON NORTH AMERICAN MEGASELIA
(DIPTERA: PHORIDAE)

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ABSTRACT—Examination of type-material resulted in the synonymy of *Megaselia dakotensis* Borgmeier with *M. halterata* Wood. The latter is recorded as a pest of cultivated mushrooms in North America. A lectotype is designated for *Megaselia agarici* Lintner. The male genitalia of the *M. agarici* lectotype and of a specimen of *M. halterata* are figured.

Recent examination of type-specimens (syntypes and holotypes) in the U.S. National Museum and the New York State Science Museum has resulted in taxonomic changes in the following *Megaselia* species.

Megaselia (*Megaselia*) *halterata* Wood
Fig. 1

Megaselia halterata Wood, 1910, p. 196, 202 (male, female).
Megaselia (*M.*) *dakotensis* Borgmeier, 1966, p. 99. NEW SYNONYM.

Borgmeier described *M. dakotensis* from a series of 7 specimens from South Dakota, California, and Maryland. The specimens from Maryland were taken in a mushroom house. The holotype from South Dakota (USNM) is in poor condition; the wings have been removed from the thorax, the legs and abdomen are missing. The paratypes (USNM) are in good condition.

The holotype and available paratype of *M. dakotensis* were compared with specimens of this species. Representative specimens of *M. halterata* were supplied by E. S. Binns, Glasshouse Crops Research Institute, England. *Megaselia halterata* is an important pest of commercial mushrooms in Europe.

I find no significant differences between the type-specimens of *M. dakotensis* and the representative specimens of *M. halterata*. I therefore conclude that *M. dakotensis* is a synonym of *M. halterata*.

Megaselia halterata is here reported from North America and is a pest of cultivated mushrooms.

Megaselia (*Megaselia*) *agarici* Lintner
Fig. 2

Phora agarici Lintner, 1895, p. 401.
Megaselia (*M.*) *bovista*: Borgmeier, 1966, p. 102, not Gimmerthal.

Through the courtesy of John Wilcox, New York State Museum and Science Service, Albany, I was able to examine numerous speci-
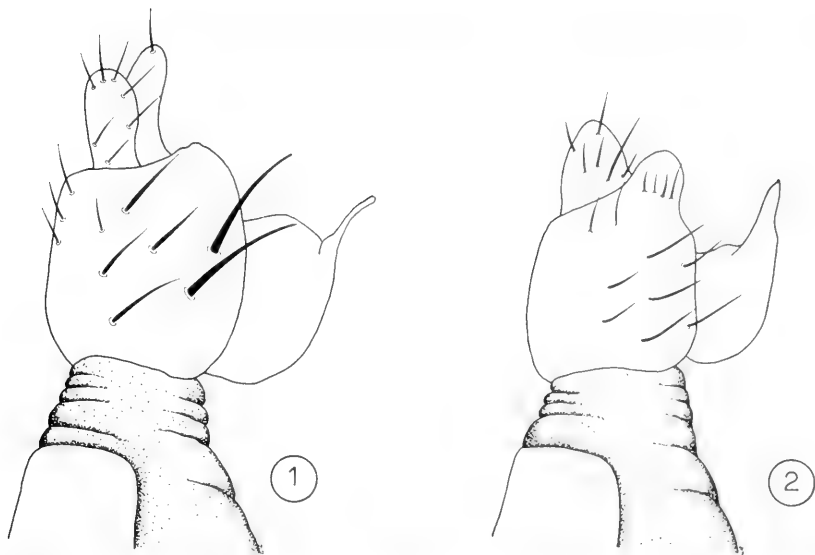
Fig. 1, *Megaselia halterata*, male epandrium and hypandrium. Fig. 2, *Megaselia agarici*, lectotype male.

mens of *M. agarici* and designate a lectotype for the taxon. A lectotype is designated herein, since Lintner stated that *M. agarici* (as *Phora*) was described from about 75 specimens of both sexes. There are about 22 specimens (on 5 pins) bearing labels in Lintner's hand that correspond to the information accompanying the original description. The lectotype male, here designated, is labeled: (first label) "October 9, 1894, Mushrooms."

Borgmeier (1966) considered *M. agarici* "provisionally" (but in fact) as a synonym of *M. bovista* Gimmerthal. The latter is known only from Europe. Later, after consulting with Ch. N. Colyer, Borgmeier (1967) concluded that the 2 species were valid.

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MEGASELIA (M.) SCALARIS (DIPTERA: PHORIDAE) ASSOCIATED WITH LABORATORY COCKROACH COLONIES

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ABSTRACT—*Megaselia* (*M.*) *scalaris* (Loew) is a frequent pest of laboratory cockroach colonies. The phorid larvae infest the food and dead, decaying cockroaches in the rearing containers. They have also been reported feeding on living cockroaches. Gravid females oviposit on organic debris in the containers. The eggs hatch in about 24 hours, and the larvae develop rapidly. The 1st larval stadium lasts 1–2 days and the 2nd and 3rd larval stadia last 2–4 days each. The adult emerges after a 14–15 day pupal period. Larval feeding habits are varied. The presence of pharyngeal ridges in the pharynx indicates the larvae are saprophagous.

Methods for controlling this pest in laboratory cockroach colonies include reducing the number of oviposition sites in the rearing containers, increasing ventilation in each container, and using a small vacuum cleaner to remove adult flies.

Phorids are small, brownish-yellow to black flies that usually go unnoticed and uncollected by most entomologists. But 1 species, *Megaselia* (*M.*) *scalaris* (Loew) is probably known by entomologists around the world. Adults and larvae of this phorid are frequent pests in laboratory insect colonies. Larvae infest the food, dead insects, and accumulated debris in the rearing containers. The adults are often observed in the containers and flying about the laboratory room. This phorid has been reported infesting colonies of house flies and sciomyzids (O'Neill, personal communication), tobacco hornworms (Eaton, personal communication), and European corn borers (Hawkins and Devitt, 1953). In addition, larvae of *M. scalaris* have been reported as parasitic (Brunetti, 1912; Pierce *et al.*, 1912), phytophagous (Walter and Wene, 1951), malacophagous (Smedley, 1928), and scatophagous (Roberg, 1915). A summary of the known larval feeding habits of this species was presented by Robinson (1971).

Recently, larvae of *M. scalaris* have been reported as pests of laboratory cockroach colonies in California, New York, and Virginia (Reierson, Gray, O'Neill, personal communication). They have infested laboratory colonies of *Blaberus craniifer* Burm., *B. discoidalis* Serv., *B. giganteus* (L.), *Blatta orientalis* L., *Byrsotria fumigata* (Guerin), *Eublaberus posticus* (Erichson), *Eurycotis florida* (Walker), *Gromphadorhina portentosa* (Schaum), *Leucophaea maderae* (F.), *Periplaneta americana* (L.), *P. brunnea* Burm., and *P. fuliginosa* (Serv.).

In spite of its wide distribution and varied feeding habits, there have been few life history studies of *M. scalaris*. Patton (1922) described the immature stages and presented some life history data. Semenza (1953) studied some aspects of the internal and external anatomy of adults and immatures. Some of the information in these and other papers is incomplete, and not applicable to current problems. There is no published information on controlling *M. scalaris* in laboratory insect colonies.

Concise information on the life history and control of this fly is necessary. In this article, I describe and figure specific diagnostic characters of the adults and immatures, and outline the life history, feeding habits, and control as they pertain to infestations of *M. scalaris* in laboratory cockroach colonies.

Materials and Methods

Life history data are based on observations of laboratory rearings at Virginia Polytechnic Institute and State University, Blacksburg, during 1974. Information on the parasitism of the American cockroach by *M. scalaris* was provided by D. A. Reierson and Alice Gray in personal communications. Live adults and larvae were obtained from cockroach rearing containers at Virginia Polytechnic Institute and State University. Preserved material (eggs, larvae, pupae, and adults) from infested colonies in California and New York were also examined.

Phorid cultures were maintained at room temperatures (20–25°C). Adults were confined to small baby-food jars (bottoms removed) set in a syracuse dish containing moist towelling. The top of each jar was covered by a piece of nylon mesh. Larvae were reared on dead cockroaches in petri dishes. Larvae either were reared individually to obtain data on feeding habits and stadia lengths or were maintained in mass colonies. Puparia were held on moist towelling in the baby-food jars.

Larval and adult structures, such as cephalopharyngeal skeleton and genitalia, were dissected and studied in temporary glycerine mounts. All material was killed in hot water, then preserved in 80% ethyl alcohol.

Voucher specimens of all stages of *M. scalaris* were designated and deposited in the Insect Collection of the Entomology Department at Virginia Polytechnic Institute and State University.

The structures and figures of the male and female postabdomen are easily visible under a dissecting microscope. No special preparation of the adults is required.

Results and Discussion

Descriptions of Adults and Immatures

Adult: The adult is small (1.7–2.3 mm), with yellowish-brown body and light brown wings. The abdominal tergites are dark brown, except for a yellow to orange median band. The adult female is best recognized by the saddle-shaped 6th abdominal tergite (fig. 2). This tergite extends ventrolaterally to encompass the spiracle on the 6th

abdominal segment. The shape of the epandrium and hypandrium of the genitalia (fig. 1) help distinguish the male from other small flies.

Egg: The egg is small (0.5–0.6 mm long) with an opaque white chorion. A series of bract-like projections ring the egg longitudinally slightly above the middle. Dorsal to this ring the chorion is produced into small, club-shaped projections. The chorion is sculptured in a honeycomb pattern ventrally.

Larvae (fig. 3): The larvae are elongate, subcylindrical, and conically tapered anteriorly. The mouthparts are heavily sclerotized and visible through the translucent cuticle. The 8th abdominal segment of the 3rd-stage larvae is truncate, with 6 large cone-shaped papillae posteriorly. Thoracic and abdominal segments bear a dorsal row of cone-shaped papillae.

Puparium (fig. 4): The puparium is boat-shaped, and about ⅔ the length of the 3rd-stage larva. The cuticle is light brown, but translucent. The dark brown respiratory horns appear about 24 hours after pupariation.

Life History and Habits

Adults of *M. scalaris* are usually observed running on tables, walls, and windows in the laboratory. Adjacent rooms and laboratories may also be infested. Like other phorids, *M. scalaris* adults run about in a characteristic quick, jerky fashion. They seem reluctant to fly even when disturbed. They are attracted to dead cockroaches and decaying food material that accumulate in the rearing containers. Males and females often gather at the cotton or sponge plugs of the watering vials. Adults enter the rearing containers through gaps or holes in ventilation screens and covers.

Eggs are usually laid directly on dead cockroaches, moist food material or the watering-vial plugs. Rarely are they laid on living cockroaches. Gravid females can lay about 20 eggs at one time, and about 40 eggs over a 12-hour period. Eggs hatch in about 24 hours.

The larval stadia lengths are variable. The usual stadium length can be increased 3–4 days if an acceptable food is not available. The 1st stadium usually lasts 1–2 days, but the larva can live for 5–6 days without feeding. The 2nd stadium lasts 2–3 days, and the 3rd stadium lasts 3–4 days. When full-grown, 3rd-stage larvae usually seek a dry site, and may leave the rearing container to pupariate. Formation of the puparium takes about 3 hours. The pupal period last about 14 days. The adult form, including eyes, legs, abdomen, and setae is usually visible through the puparium after about 12 days.

→

Fig. 1–4. *Megaselia scalaris.* 1, Epandrium and hypandrium of male. 2, Terminal segments of female. 3, Third-stage larva. 4, Puparium.
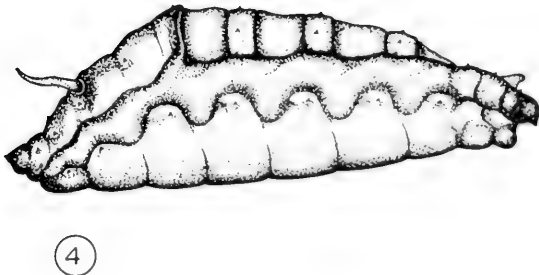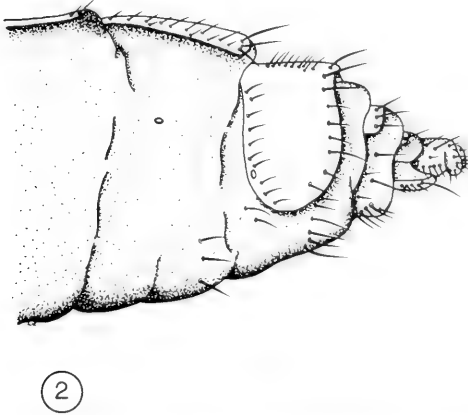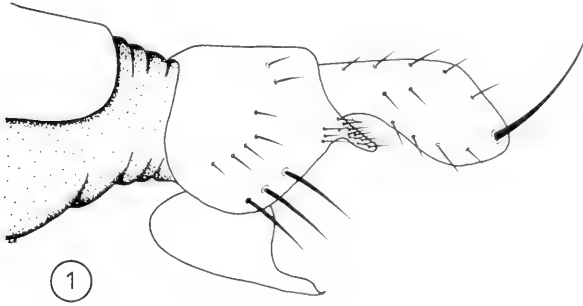
Under some laboratory conditions the phorid population is seasonal. The adults and larvae are more abundant in the late spring and summer months and nearly disappear in winter.

The larval feeding habits of *M. scalaris* are extremely varied. In addition to dead and decaying debris in laboratory cockroach colonies, larvae have been reported feeding on onion bulbs, culture media, animal feces, and boot polish (Robinson, 1971). This phorid has been considered parasitic on at least 10 different insects, including the gypsy moth, cotton leafworm, and boll weevil. Gray and Reierson (personal communications) found larvae attacking living cockroaches in their respective laboratory colonies. Gray discovered larvae feeding in the wing pads of cockroach nymphs. She thought the larvae were killing some of the nymphs before they developed to adults.

Berland (1933) suggested that phorid larvae (in general) may attack only wounded insects and that this may be the reason for the reports of parasitism by some of the species. The feeding habits of *M. scalaris* larvae are best considered saprophagous. In spite of several reports of parasitism, close examination of internal structure of the larval mouthparts reveals the presence of pharyngeal ridges. Keilin (1912) and Dowding (1967) concluded that ridges in the floor of the pharnyx indicate saprophagy. Combining morphological and behavioral studies, Dowding (1967) found that pharyngeal ridges are present only in cyclarrhophous Diptera larvae that feed on dead plant and animal material and feces. The food of a saprophage is particulate material in a liquid. The ridges act as a filter to concentrate food and eliminate excess liquid. *Megaselia scalaris* larvae have well-developed pharyngeal ridges and are capable of feeding on a wide variety of decaying material.

The cotton plugs of the watering vials are favorite oviposition sites for this fly. The moist cotton is an excellent substrate for eggs and larvae, and in heavy infestations the plugs may be covered with maggots. When visiting the vials for water, cockroaches may take viable eggs into their mouths. However, there is no evidence that larvae hatch to infest the host. In this study, American cockroaches fed *M. scalaris* eggs did not become infested. Macfie (1922) also fed *M. scalaris* (as *Aphiochaeta xanthina* Speiser) eggs to American cockroaches and had the same results.

Control Measures

Infestations of *M. scalaris* in laboratory cockroach colonies usually occur when conditions become crowded and excess debris accumulates in the rearing containers. The odor of dead and decaying material attracts adult females to the variety of oviposition sites. Under laboratory conditions this phorid can complete development in a short time

and heavy infestations can develop rapidly. Measures to control this pest should center on eliminating or reducing potential oviposition sites.

Maintaining clean conditions in the cockroach rearing containers was the important factor in controlling this fly. Dead cockroaches and other debris were removed regularly from the containers to reduce potential oviposition sites for adult flies. Particular attention was given to the dead bodies of large cockroaches, such as *Gromphadorhina portentosa*. Increasing ventilation in each rearing container helped to keep debris and food scraps dry and less attractive to gravid female flies. The cotton or sponge plugs in the watering vials were changed often and kept clean. This moist and frequently moldy substrate is an excellent oviposition site.

A small, portable vacuum cleaner was found helpful in removing adult flies from heavily infested rearing containers. Running and free-flying adults were easily caught and removed in the vacuum cleaner bag. A daily vacuuming for several consecutive days effectively reduced the fly population.

From the foregoing information, it is evident that *M. scalaris* as a laboratory pest can be effectively controlled without resorting to the use of insecticides. However, this small fly is always a potential threat to all laboratory insect colonies. Its wide distribution and catholic feeding habits make it nearly impossible to eliminate from the laboratory.

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INSECT FAUNA OF SOME VIRGINIA THERMAL STREAMS

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ABSTRACT—Virginia has a number of natural thermal springs and streams. The best-known of these, Hot Springs Baths and Warm Springs Pools, are located in Warm Springs Valley in northwestern Virginia. There has been little or no biological study of these natural thermal waters.

Warm Springs Pools consists of 4 individual springs. The water temperature of the springs and the streams flowing from the spring pools is 34–35°C. The insect fauna of the 3 streams includes the orders: Coleoptera (8 species), Diptera (10 species), Hemiptera (1 species), and Odonata (1 species). Other invertebrates collected in the streams included species of Arachnida, Oligochaeta, Gastropoda, and Plecypoda. The animals associated with the thermal streams are frequently found in nearby cold water streams. The presence of *Dictya texensis* Curran (Diptera: Sciomyzidae) at Warm Springs Pools is the 1st record of a sciomyzid occurring in thermal waters.

Warm and hot springs are probably best known from areas in western United States. But there are natural thermal springs and streams in other parts of the U. S., including the southeastern states of West Virginia, North Carolina, Georgia, and Virginia. Although some of these spring locations have been converted into health baths and resorts, others remain relatively undisturbed and accessible for study. Virginia has a number of thermal springs and streams. The best known of these are located in Warm Springs Valley in Bath and Allegheny counties. Within this valley are a series of thermal springs with temperatures that range from 18–23°C at Falling Springs, to 37–40°C at Hot Springs. At 2 locations in the valley the springs are the focus of the well-known resorts of Hot Springs Baths and Warm Springs Pools. Those springs with water temperatures greater than 39°C are generally considered hot, while those with a lower mean annual temperature are referred to as warm.

Nearly all the major thermal springs and streams in the U. S. have attracted investigations of their invertebrate fauna. However, there has been little or no biological study of Virginia's natural thermal waters. The objective of the research reported here was to elucidate the invertebrate fauna of the thermal streams of Warm Springs Pools, Virginia. Once this basic fauna list is compiled and made available, other workers may be encouraged to study the biology of individual species, and, eventually, the structure and energetics of the stream community.

Virginia's thermal springs have been known for many years. Some

have been used as health baths since the mid-1700's; however, the waters have received little scientific attention. Lea (1839) described some aquatic snails (*Physa* sp. and *Paludinia* sp.) from a thermal stream in Bath County, Virginia. Based on his description of the habitat, the material was taken at Hot Springs. Skinner (1921) reported some Lepidoptera from the Hot Springs area, but his collections were not restricted to the thermal stream habitat. Fall (1922, 1923) reported *Agabus ambiguus* Fall and *Hydroporus wickhami* Zaitzev (Coleoptera: Dytiscidae) from Warm Springs. Information on the geology, chemical composition, and other physical properties of these and other thermal springs in Virginia is available in the geologic survey of Reeves (1932).

Considerable information is available on the fauna of thermal springs in western North America, and other parts of the world. The papers by Brues (1924, 1928, 1932) provide a comprehensive list of the thermal fauna of springs in western U. S. He also included a summary of what had been previously reported from thermal waters of other regions. Since his coverage of early works is nearly complete, there is little need to duplicate it here.

DESCRIPTION OF THE STUDY AREA

Warm Springs Valley lies in the Allegheny Mountains, 38°4'N, 79°45'W. The thermal springs lie in the northern part of the valley, where the spring-bearing rock (lowville limestone) is brought near the surface by anteclinal folding (Reeves, 1932). The elevation of the springs is about 2,330 ft. The various theories on the source of heat for the springs in the valley are discussed by Reeves (1932).

Warm Springs Pools consists of 4 individual springs; 3 of which issue within 100 ft. of each other, and a 4th which emerges about 800 ft. to the southwest. The water from the 3 adjacent springs is impounded in individual buildings designated: Gentleman's Pool, Ladies' Pool, and Children's Pool or Drinking Fountain. These buildings make up the resort of Warm Springs Pools. The run off from each of the 3 pools is channeled into streams. The 4th spring (Meadow Spring) and its stream lie undisturbed in a small pasture. This spring and stream are not included in the research presented in this paper.

The 3 adjacent springs have a flow rate of 1,000–2,000 gallon per minute according to Reeves (1932). The streams produced by all 4 springs are thermal tributaries of Warm Springs Run, a natural cold stream in origin.

Gentleman's Pool: The temperature of the pool and stream is 34–35°C. The stream is relatively free of debris during the spring and summer, but covered by algae and dead leaves during most of the winter months. Resort maintenance crews remove debris from the stream in March or April, and the pool is drained at least once a year. Soap is frequently used by the bathers, and it often clouds the stream water. A small, cold (15–17°C) stream empties into the thermal stream about 50 ft. below the pool.

Ladies' Pool: The temperature of the pool and stream is 34–35°C. The stream travels only a short distance before joining with the 1 from the Gentleman's Pool.

There are extensive algal growths in the Ladies' Pool stream. Soap is also used in this pool, and the pool is emptied yearly.

Children's Pool: The temperature of the stream varies from 30–35°C; however, it remains about 35°C during most of the year. In the spring season, a small, cold stream empties into the thermal 1, cooling the latter to about 30°C. A household sink drains directly into the Children's Pool stream.

Materials and Methods

The 3 streams that drain the Warm Springs Pools were sampled regularly during the study period. Insects and other invertebrates were taken from the streams by means of aquatic insect nets, mesh-bottomed buckets, and a small kitchen strainer. Rocks and large pieces of algae were removed from the stream for closer examination.

Samples of algae, dead leaves, rocks, and stream water were removed to the laboratory in Blacksburg, Virginia. In the laboratory, some of the live material was maintained at or near the thermal stream temperature by the use of 1 or more aquarium heaters. Much of the laboratory material was reared at room temperatures (21–24°C).

Aquatic invertebrates were killed and preserved in 80% ethanol. Some adults collected in the field or reared in the laboratory were mounted on insect pins. Voucher specimens of all the invertebrates are in the Entomology Department Insect Collection at Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

All water temperature readings were made by immersing a mercury centigrade thermometer directly in the water. No other physical or chemical properties of the water were measured at this time.

Results

Of the 25 species of invertebrates collected from the thermal streams, a majority were present in large numbers and available nearly year round. Some of the insect and snail records were based on just 1 or 2 specimens, and may represent accidental invaders from nearby cold streams.

Table 1 lists all the invertebrates collected from the 3 streams during the study period. Emphasis was placed on the stream insects to the extent that some of the non-insect fauna may have been overlooked. Notes on individual species, including feeding habits, seasonal occurrence, and laboratory records are presented alphabetically by family below.

CHIRONOMIDAE: In terms of numbers of individuals, this was the dominant family of the stream community. Larvae of *Polypedilum scalaenum* (Schrank) and *Tanytarsus glabrescens* Edwards were abundant in the submerged algae of all 3 streams. Adults of these 2 species were not common along the stream banks but were obtained from immatures maintained in the laboratory at room temperature. *Chironomus* sp. larvae were collected only from the Children's stream,

Table 1.   Invertebrate fauna of thermal streams at warm springs pools.

Insecta

COLEOPTERA

	Dytiscidae	*Hydroporus wickhami* Zaitzev
		Hydroporus niger Say
	Psephenidae	*Ectopria* sp.
	Hydrophilidae	*Enochrus pygmaeus nebulosus* Fabricius
		Enochrus perplexus (LeConte)
		Anacaena limbata Fabricius
	Elmidae	*Stenelmis fuscata* Blatchley
		Microcylloepus pusillus pusillus (LeConte)

DIPTERA

	Tipulidae	*Tipula furca* Walker
	Chironomidae	*Polypedilum scalaenum* (Schrank)
		Chironomus sp.
		Tanytarsus glabrescens Edwards
	Stratiomyidae	*Odontomyia borealis* James
	Sciomyzidae	*Dictya texensis* Curran
	Ephydridae	*Hydrellia griseola* (Fallen)
		Parydra quadrituberculata Loew
		Lytogaster gravida (Loew)
		Scatella obsoleta Loew

HEMIPTERA

| | Veliidae | *Rhagovelia obesa* Uhler |

ODONATA

| | Coenagrionidae | *Argia sedula* (Hagen) |

Arachnida

ARANEIDA

| | Lycosidae | *Pirata insularis* Emerton |

Oligochaeta

PLEISOPHORA

| | Naididae | *Pristina* sp. |

PROSOPHORA

| | Lumbriculidae | 2 undetermined species |

Gastropoda

PULMONATA

| | Physidae | *Physa* sp. |

Pelecypoda

HETERODONATA

| | Sphaeriidae | *Sphaerium* sp. |

and only in small numbers. Adults were also obtained from laboratory-reared larvae.

COENAGRIONIDAE: Nymphs of the damselfly, *Argia sedula* (Hagen), were found in the submerged algae and debris adjacent to the banks of all 3 streams. Adults were not common around the streams, but a few were reared in the laboratory.

PSEPHENIDAE: Larvae of *Ectopria* sp. were collected from mud and algae along the banks of the Children's Pool stream and were reared on algae in the laboratory. Adults were collected in the water and on vegetation along the bank.

DYTISCIDAE: Single specimens of *Hydroporus wichhami* and *H. niger* Say were collected in December and May, respectively, from the Children's Pool stream.

ELMIDAE: Riffle beetles were a common group in all 3 streams. Adults and larvae of *Stenelmis fuscata* Blatchley were abundant on the bottom gravel and submerged algae. *Microcylloepus pusillus pusillus* (LeConte) was similarly distributed, and nearly as abundant as *S. fuscata*. Both species were encountered year round.

EPHYDRIDAE: Adult shore flies were swept from grassy areas along the 3 streams, but they were not abundant. No larvae were discovered.

HYDROPHILIDAE: Of the 3 species representing this family, only *Enochrus pygmaeus nebulosus* Fabricius was collected in numbers. This small water beetle was abundant in the floating and submerged algae of all 3 streams. Adults and larvae were encountered year round. The other hydrophilids, *E. perplexus* (LeConte) and *Anacaena limbata* Fabricius were represented by single specimens.

LUMBRICULIDAE: At least 2 species of earthworms were collected from the stream banks.

LYCOSIDAE: *Pirata insularis* Emerton was common on the stream banks and floating algal mats. Adults and immatures of this spider were taken year round.

NAIDIDAE: *Pristina* sp. were abundant year round in all 3 streams.

PHYSIDAE: The floating and submerged algae in all 3 streams supported a large population of the aquatic snail, *Physa* sp. There was no noticeable fluctuation in the snail population during the year.

SCIOMYZIDAE: Larvae of *Dictya texensis* Curran were found on the stream banks and floating algal mats. Puparia collected in early spring (March) contained fully-developed adults. Adults were present along the stream banks by mid-April.

The larvae of this fly were predators on the *Physa* sp. snails that inhabitated the stream edge and floating algae. Larvae were reared in the laboratory at room temperatures.

SPHAERIIDAE: Fingernail clams, *Sphaerium* sp., were collected in small numbers from along the edge of all 3 streams.

STRATIOMYIDAE: Larvae of *Odontomyia borealis* James were abundant in the mud and algae along the banks of the 3 streams. Full-grown larvae were frequently found exposed while feeding on the floating algae. Adults and larvae were taken from mid-April to October. This species was also reared in the laboratory at room temperatures.

TIPULIDAE: Crane fly larvae were collected from dead leaves and algae floating along the banks of the Gentleman's Pool stream. Full-grown larvae of *Tipula furca* Walker were collected in February. Adults were observed along the stream banks in August.

VELIIDAE: *Rhagovelia obesa* Uhler was the only hemipteran found associated with the thermal waters. Adults and nymphs were collected in quiet pools in the streams during winter and spring.

<div align="center">DISCUSSION</div>

Thermal waters are frequently considered as those having temperatures high enough to exclude members of the general freshwater fauna. But few, if any, of the animals associated with Warm Springs Pools could be considered as "thermal fauna." For the most part, they are taxa with a widespread distribution and could be found in normal cold-water streams. The taxa found in this investigation are noteworthy because of their similarity to the results of related studies. The Virginia fauna has many species in common with the fauna of other thermal waters studied in the U. S. (Brues, 1924, 1928; Stockner, 1971), as well as some studied in New Zealand (Winterbourn and Brown, 1967). Parallels between the Virginia fauna and the above studies include species in the genera: *Argia, Chironomus, Enochrus, Odontomyia, Pirata,* and *Physa.* Species found in this study that were not previously reported from North American thermal waters include the psephenid beetle *Ectopria* sp. and the sciomyzid fly *Dictya texensis.*

Sciomyzids are well known for the malacophagous habits of their larvae; they are common predators and parasitoides of gastropod and plecypod molluscs around the world (Berg, 1961). Species in several sciomyzid genera, including *Atrichomelina, Elgiva, Hedria, Sepedon, Pherbellia,* and *Dictya,* have been reported feeding on *Physa* spp. snails (Foote *et al.,* 1960; Knutson and Berg, 1964; Foote, 1971; Neff and Berg, 1966; Bratt *et al.,* 1969; Valley, 1974). These aquatic snails are abundant in most thermal waters in the U. S. and other countries. The presence of *Dictya texensis* at Warm Springs Pools is the 1st North American record of a sciomyzid feeding on a *Physa* snail in thermal waters. Nielsen *et al.* (1954) reported a *Tetanocera robusta*

Loew larva from an Icelandic hot (24°C) spring, but he provided no other biological information.

The genus *Dictya* is Holarctic-Neotropical in distribution and contains 27 described species. *Dictya texensis* is the most widespread of the 20 species described from America north of Mexico. This species is found in the southeastern and several of the western states known to have thermal springs. The larvae of *D. texensis* feed on a variety of freshwater, non-operculate snails, including *Physa* spp. This sciomyzid has adapted to the thermal waters of Bath County, Virginia, where it utilizes a large snail (*Physa* sp.) population.

Other sciomyzids with distribution and general feeding habits may have adapted to thermal waters. Perhaps they have been overlooked in earlier investigations. The thermal springs and streams in southeastern U. S. have not been thoroughly investigated. A survey of the invertebrate fauna of these thermal waters will probably produce more records of *D. texensis* or other sciomyzids.

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A Bibliography And A Keyword-In-Context Index Of The Ceratopogonidae (Diptera) From 1758 To 1973. W. R. Atchley, W. W. Wirth, and C. T. Gaskins. 1975. Texas Tech Press, Lubbock, 300 pp. $4.00. (Available from Exchange Librarian, Texas Tech University, Lubbock, Texas 79409).

To assist researchers in maintaining adequate control of the large body of primary literature dealing with the economically important biting midges, the authors have taken a completely modern approach by computerizing their very useful bibliography. Dealing with such a large and widely scattered body of publication demands that one have entry to the information in it by means of a greater variety of entry points than the traditional alphabetical arrangement of authors will permit. Computer capabilities have made possible a presentation, along with the bibliography itself, of significant subject-matter words in a Key Word In Context (KWIC) index, giving the user quick access to all titles in the bibliography that deal with any subject or concept represented by a given KWIC index term. Each entry is tagged by its unique alphanumeric code for reference use in the subject indexes. Proper processing of the file also makes possible the construction of a Key Word Out of Context (KWOC) index using descriptor words as entry points. The senior author (Department of Biological Sciences, Texas Tech University, Lubbock, Texas 79409) offers, on request, a computer tape containing the bibliography itself, the KWIC and KWOC indexes, and author list for a charge of only $50.00.

Approximately 1950 references spanning the years 1758 through 1973 are presented, using the traditional alphabetization by senior author. The authors have followed the Fourth Edition (1963) of the World List of Periodicals for abbreviations. They might have been better advised to use the increasingly popular standards published or proposed by the International Standards Organization or the American National Standards Institute, Inc., in order to eliminate confusion arising from the World List conventions, facilitate handling of abbreviations by the computer, and conform more closely to the proposals of the Council of Biology Editors.

The authors introduce their work with the words, "We have tried to make this bibliography as complete and accurate as possible," and their attempts in this direction have met with a great deal of success. As a taxonomist at one time involved in research on the ceratopogonid genus *Culicoides*, this reviewer heartily commends the authors' bibliography as indispensable to anyone concerned with the multifaceted aspects of this important fly family.

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EDITORIAL NOTE

Please note that the June, 1975 issue of the Proceedings of the Entomological Society of Washington (Vol. 77, No. 2) was complete with page 268. The Table of Contents for that issue erroneously included a book review on page 269.

SOCIETY MEETINGS

819th Regular Meeting—December 12, 1974

The 819th Regular Meeting of the Entomological Society of Washington was called to order by President Burks at 8 p.m. on December 12, 1974 in Carmichael Auditorium of the National Museum of History and Technology. Thirty-four members and 14 guests were present. Minutes of the previous meeting were read and approved.

The Treasurer, T. J. Spilman, gave a report on the Society's finances. With the increases in dues, subscriptions, page charges and other fees he felt the Society's financial situation was better than in previous years.

Membership Chairman Kingsolver read the name of a new applicant for membership: Donald D. Miller, APHIS, USDA, Greenbelt, Maryland. He also noted that the present membership is 527 regular members, a net gain of 16 over the previous year.

The names of the new slate of Officers for 1974, 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 1975 slate of officers was declared elected, effective at the close of the meeting.

Vic Adler noted the recent passing on Honorary Member Avery S. Hoyt and President Burks suggested that the new President appoint a committee to write an obituary for him.

The main speaker for the evening was Dr. John Buck, of the National Institutes of Health, who gave an informative talk on lightning bugs and their synchronous flashing patterns. A lively discussion period followed.

Notes and Exhibitions: John Horne displayed an old post he had found with some 27 carpenter bees (*Xylocopa* sp.) in it. L. G. Davis displayed some separates on the African Bee. Neal Morgan talked about and showed some slides of *Hippobosca longipennis*, an ectoparasitic fly recently introduced into this country on Cheetahs. Ivan Rainwater mentioned the program for the forthcoming meetings of the Insecticide Society of Washington. W. E. Bickley displayed the new Maryland Suburban Telephone Directory, the cover of which depicts the State Flower and a butterfly, *Speyeria cybele*. He noted that it was unfortunate that this butterfly was used instead of the official state butterfly, *Euphydryas phaeton*.

After the introduction of visitors, the meeting was adjourned at 10:10 p.m. Punch and cookies were served following the meeting.

F. Christian Thompson, *Recording Secretary*

820th Regular Meeting—January 2, 1975

The 820th Regular Meeting of the Entomological Society of Washington was called to order by President Rainwater at 8 p.m. on January 2, 1975 in the Baird Auditorium of the National Museum of Natural History. Forty-one members and 16 guests were present. Minutes of the previous meeting were read and approved with one correction.

President Rainwater made a call for volunteers to help with the refreshments for future meetings.

400

The main speaker for the evening was Dr. Donald H. Colless of the Common-
wealth Scientific and Industrial Research Organization, Canberra, Australia, who
gave an informative talk on Classification and the Biological Species Concept.

After the introduction of visitors, the meeting was adjourned at 9:30 p.m.
Punch and cookies were served following the meeting.

F. CHRISTIAN THOMPSON, *Recording Secretary*

821st Regular Meeting—February 6, 1975

The 821st Regular Meeting of the Entomological Society of Washington was
called to order by President Rainwater at 8 p.m. on February 6, 1975 in the Baird
Auditorium of the National Museum of Natural History. Thirty-three members
and 11 guests were present. The minutes of the previous meeting were read and
approved.

President-elect Steyskal reported on the preparation for the Annual Banquet.
Membership Chairman Kingsolver read for the first time the names of the fol-
lowing new applicants for membership:

F. Martin Brown, Colorado Springs, Colorado

Jerome E. Freier, Walter Reed Army Institute of Research, Washington, D.C.

Thomas J. Henry, Pennsylvania Dept. of Agriculture, Harrisburg, Pennsylvania

Harry M. Savage, USEPA, Cincinnati, Ohio

Charles L. Staines, Jr., Maryland Department of Agriculture, Baltimore, Mary-
land

President Rainwater reported on the recent Executive Committee Meeting. He
noted that Mortimer D. Leonard was nominated by the Committee for Honorary
Membership and asked for a vote of approval. The election was unanimous and
it prompted a discussion of Dr. Leonard's long and distinguished career in the
advancement of Entomology.

Notes and Exhibitions: Ted Bissell showed a recent copy of *Natur og Museum*
devoted to aphids and their biology. Louise Russell reported on the status of
the Greenhouse Whitefly in Japan and the first record of the Strawberry Whitefly
from that country, a species previously unknown outside the United States.
George Steyskal told of the tremendous increase in the number of described flies
in the past few years, about 2,000 species having been added to the North
American Diptera fauna since 1965. Vic Adler read an article from a local news-
paper, which identified DDT as the chemical responsible for saving more human
lives than anything else, including such drugs as penicillin and digitalis.

The principal speaker for the evening was the Past-President, Dr. Barnard D.
Burks, of the Systematic Entomology Laboratory, who gave an informative talk
on Insect Collecting in Bolivia. The talk was illustrated with many beautiful
kodachrome slides.

After the introduction of visitors, the meeting was adjourned at 10:05 p.m.
Punch, cookies and other sweets were served following the meeting.

F. CHRISTIAN THOMPSON, *Recording Secretary*

822nd Regular Meeting—March 6, 1975

The 822nd Regular Meeting of the Entomological Society of Washington was called to order by President Rainwater at 8 p.m. on March 6, 1975 in the Baird Auditorium of the National Museum of Natural History. Thirty-three members and 6 guests were present. The minutes of the previous meeting were read and approved with one correction.

President-elect Steyskal announced that the annual banquet would be held Thursday June 5, 1975 at the C.P.O. (Chief Petty Officers) Club at the Navy Yard with tickets priced at $6.50.

Membership Chairman Kingsolver announced that no new membership applications were received.

President Rainwater discussed possible participation by Society members in local science fairs, particularly the Fairfax County Schools Science Fair to be held in Alexandria, Virginia. He also announced that Phoebe Knipling expressed a desire for the Society members to participate in local science fairs.

Notes and Exhibitions: R. J. Gagne read a communication from John Lane of the London School of Hygiene and Tropical Medicine. In his house outside London, John Lane had found a reduviid bug which subsequently was identified as *Sinea rileyi* Montandon, a native of southwestern U.S. Five weeks earlier, he had returned from a holiday in the U.S., spent mainly in Tucson, Arizona, and had brought back a length of Cholla skeleton. He assumes that the bug had been overwintering in the cactus, yet another example of how insects get around. Vic Adler showed examples of postage stamps from Hungary depicting colorful Lepidoptera. Examples of the night peacock, day peacock, and thistle butterflies were shown.

Ashley Gurney mentioned the occurrence of two genera of crickets in Hawaiian lava tube caves. They are part of a rather extensive and distinct fauna studied in the field by Francis G. Howarth of the Bishop Museum. Specimens of the genera, *Thaumatogryllus* and *Caconemobius*, were exhibited, and Gurney discussed several new species and their surface-living relatives.

C. G. Rowher announced the establishment of a scholarship fund by the Georgia Entomological Society in honor of Horace Lund. The Society desires all past presidents (including Ted Bissell) to attend the meeting at which the fund will be established.

The principal speaker for the evening was Dr. Frank Hanson, University of Maryland, Catonsville, who gave an interesting talk on the physiological basis of host specificity and selectivity in lepidopterous larvae. He discussed experiments demonstrating the induction of food preference in larvae by feeding young instars on particular plant hosts and demonstrated by alternating hosts, that feeding behavior is modified by experience. He also showed that host selection is mediated by chemoreceptors on the head.

After introduction of visitors, the meeting was adjourned at 9:50 p.m. Punch and cookies were served following the meeting.

F. CHRISTIAN THOMPSON, *Recording Secretary*

823rd Regular Meeting—April 3, 1975

The 823rd Regular Meeting of the Entomological Society of Washington was called to order by President-elect Steyskal at 8 p.m. on April 3, 1975 in the Baird

Auditorium of the National Museum of Natural History. Thirty-two members and 17 guests were present. The 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:

Gordon Gordh, Systematic Entomology Laboratory, Washington, D.C.
Jarret L. Cross, Wheaton, Maryland
J. A. Burnett, University of California, Riverside
Mark Ebertz, Department of Entomology, Smithsonian Institution

Notes and Exhibits: President-elect Steyskal announced again the date and place of the Annual Banquet and mentioned some of the door prizes to be given at that function. Kellie O'Neil displayed the front page of the day's *Washington Post*, which showed Steve Nakahara, a Society member, inspecting a $4,000,000 collection of Japanese Bonsai trees for insects. President-elect Steyskal displayed some SEM pictures of the ovipositor of *Paracantha culta* Wiedemann, a fruit fly, taken by Brian Stoltzfus, of William Penn College, Iowa. Ted Bissell showed some slides taken at a special meeting of the Georgia Entomological Society in honor of Horace Lund at St. Simon Island, Georgia. Curtis Sabrosky discussed the progress being made on the forthcoming XV International Congress of Entomology.

T. J. Spilman announced the death of a member, Merton C. Lane (Sept. 4, 1893–Mar. 13, 1975), at Medford, Oregon. Lane worked from 1917 to 1959 for Truck Crop Insects, USDA, principally at Walla Walla, Washington. His speciality was the biology and control of wireworms of economic importance, but he was also a recognized authority on the systematics of North American Elateridae; he published many articles on both subjects. He amassed a collection of more than 50,000 specimens, of which approximately 41,000 elaterids were given to the USDA and are now in U.S. National Museum of Natural History in Washington, D.C.; the remaining specimens were given to the University of Massachusetts in Amherst.

The principal speaker for the evening was Dr. Paul Opler of the Office of Endangered Species, U.S. Fish and Wildlife Service, who gave an informative talk on the ecology of tropical insects in Costa Rica. The talk was illustrated with numerous beautiful kodachrome slides.

The meeting was adjourned at 9:15 p.m. Punch and cookies were served following the meeting.

F. CHRISTIAN THOMPSON, *Recording Secretary*

BOOK REVIEWS

THRIPS, THEIR BIOLOGY, ECOLOGY AND ECONOMIC IMPORTANCE. Trevor Lewis. 349 pages. Academic Press London and New York, 1973. $22.00.

Thrips, the Thysanoptera, the smallest of the winged insects, formerly little known even to general entomologists, are now becoming one of the best studied groups of insects. Summaries of the recently accumulated knowledge have been briefly treated in a few faunal monographs, but the compilation by Trevor Lewis in his latest work, *Thrips*, is the first, thorough, up-to-date review and analysis of the scattered and occasionally obscure literature to be made available to biologists and naturalists.

The book *Thrips* covers all aspects of the natural history of these diminutive arthropods. The taxonomic and morphological features, although summarized in the introduction are interspersed throughout the text and figures so that the reader can come to know the relationships and appearance of the genera and complexes imperceptibly as he learns of their complicated habits and place in their natural environment. The coverage is world-wide from the Asian jungles to the Russian steppe, and from the New to the Old World, and to Australia. All statements are documented from the literature or from Dr. Lewis' own observations, and for still easier reference, a number of appendices are added to give lists on faunal monographs by world regions, names of thrips' parasites and their respective hosts, lists of plant hosts, and effective insecticides used for various pest species of thrips. Many good line drawings, charts, and photographs, including some taken through scanning electron microscopes, illustrate the text for clarity and heightened interest.

Dr. Lewis' own extensive involvement in the development of modern ecological studies of thrips and his obvious first-hand acquaintance with them make this book authoritative and definitive. He treats the behavioral patterns of thrips from an evolutionary and physiological viewpoint, tracing the feeding of thrips from their early history when they probably emerged as pollen feeders to plant juice and fungus feeders to outright predators; analyzing the physical factors that affect flight and other movements, overwintering hibernacula, and survival under harsh conditions (much of which is taken from his own investigations); and reviewing their relationship to their own parasites, to other animals and plants and to pathogens. Attention is also given to thrips as economic pests and vectors of plant viruses, as well as their role as pollinators of crops and as beneficial predators of other pests. Furthermore, methods for collecting, sampling, and raising thrips in the field and in the laboratory are presented in detail.

Among the oddities of thrips' life dealt with in this book are of thrips that live under water on occasions, thrips that mimic ants and wasps, thrips that make galls, thrips that have evolved protective coloration by means of zebra striping of black and white, and those thrips that jump to avoid danger.

Ecologists, naturalists, and most certainly entomologists, will find *Thrips* by Trevor Lewis a welcome addition to their reference library, as a guide to the lives of one of the world's littlest creatures whose importance to the total environment belies their tiny size, written by a life-time thysanopterist, whose empathy and affection for his subjects shows through the clear prose.

LEWIS J. STANNARD, *Taxonomist, Illinois Natural History Survey, Urbana, Illinois 61801.*

PROCEEDINGS OF THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

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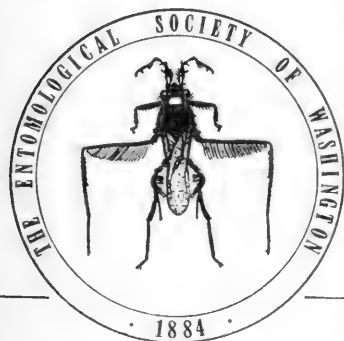
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PROCEEDINGS

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REDESCRIPTION OF EUTOGENES VICINUS SUMMERS AND PRICE, A PREDATORY POLYMORPHIC, CHEYLETID MITE WITH DESCRIPTIONS OF MALES AND IMMATURE STAGES (ACARINA: CHEYLETIDAE)

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and

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ABSTRACT—*Eutogenes vicinus* Summers and Price is redescribed. Illustrations and descriptions are presented for the first time of the male and immature stages of this polymorphic species. Variation in length of palpi of the heteromorphic males is discussed.

The mite *Eutogenes vicinus* was described by Summers and Price (1970) from 2 females collected from leaf mold beneath *Acer macrophyllum* Pursh in California. Subsequently, Moser and Roton (1971) and Moser (unpublished) recorded it from *Pinus taeda* L. infested with the bark beetles *Dendroctonus frontalis* Zimmerman and *Ips avulsus* (Eichhoff); 176 specimens were collected from outer surfaces of loblolly pine and the beetles' boring dust in rearing containers. Individuals were seen feeding on 2 other mites, *Histiogaster arborsignis* Woodring and *Paraleius* n. sp., commonly associated with pine bark beetles. Both males and females of *Eutogenes vicinus* were reported phoretic on *Ips avulsus* by Moser and Roton (1971).

Because all stages of the mite were collected, and because the males exhibit marked polymorphism, we believe that a redescription of *E. vicinus* is warranted. The redescription is based on a sample of specimens consisting of 22 larvae, 28 protonymphs, 25 deutonymphs, 45 females, 19 homeomorphic males, 16 heteromorphic males (small form) and 21 heteromorphic males (large form).

Oudemans (1906) was first to note that species of Cheyletidae had

heteromorphic males, i.e. a male form larger than the normal male with elongated palpi. The polymorphism exhibited by *E. vicinus* males is of the type defined by Wilson (1953) as "allometry occurring over a sufficient range of size variation within a normal mature colony to produce individuals of detectably different form at the extremes of the size range." It is not the discontinuous polymorphism described by Woodring (1969) where distinct, genetically determined, heteromorphs are present. In this study we particularly noted the gradation in size of the palpi of the heteromorphic male and arbitrarily designated a small and a large form based on variations in the palpi length. The variation in palpal length is noted.

Eutogenes vicinus Summers and Price

Larva (fig. 1–6): Palpal femur longer than wide; dorsal seta serrated and spatulate, ventral seta absent; genu seta spatulate-serrate dorsally and without setae ventrally; tibial setae simple; tibial claw without teeth; palpi tarsus with 2 sicklelike and 2 comblike setae; outer comb large with 9 strong teeth and about ⅓ longer than inner comb; inner comb with about 12 teeth. Stylophore with striae and tubercles as figured. Peritreme simple, composed of 2 pairs of segments. Propodosomal shield subrectangular, with tuberculate striae and 5 pairs of spatulate-shaped serrate setae. Humeral setae similar in size and shape. Hysterosoma with elongate median shield bearing a single pair of spatulate-serrate setae, with 4 pairs of subequal spatulate-serrate setae adjacent and below median shield. Venter as figured. Leg I longest; legs II and III similar in size and length. Coxa I with 1 simple seta; trochanter without setae; femur with 2 spatulate-serrate setae; genu with 1 spatulate-serrate seta and 1 capitate solenidion; tibia with 3 spatulate-serrate setae, 1 simple and 1 elongate solenidion; medial surface of tarsus with 1 simple seta ventrally and 1 serrate seta and 1 whiplike simple seta dorsally; distally with 2 parallel short simple setae; and terminally with 1 outer long simple seta and 1 long whiplike seta on inner surface; below this seta, a shorter simple seta. Coxa II without setae; trochanter without setae; femur with 2 spatulate-serrate setae; genu with 1 spatulate-serrate seta; tibia with 1 simple and 3 spatulate-serrate setae; tarsus with 1 mediolateral long solenidion; distally with 1 pair subequal simple setae; terminally with 2 finely serrate setae and 1 saberlike seta. Chaetotaxy for leg III same as for leg II, except femur with 1 spatulate-serrate seta and tarsus without solenidion. All tarsal claws smooth and with a padlike empodium with tenent hairs. Anal area with 4 pairs of simple setae; distal pair longest. Length of body, excluding gnathosoma, 140 μ; width 134 μ.

Protonymph (fig. 7–13): Palpal femur longer than wide, dorsally with 1 spatulate-serrate seta; ventral seta simple; genu with 1 dorsal spatulate-serrate seta; tibia with 3 simple setae; tibial claw without teeth; palpal tarsus with 2 sickle-like and 2 comblike setae; outer comb large with 4–5 strong teeth; inner comb

→

Fig. 1–6. *Eutogenes vicinus*, larva. 1, gnathosoma. 2, dorsum. 3, venter. 4, right leg I. 5, right leg II. 6, right leg III.
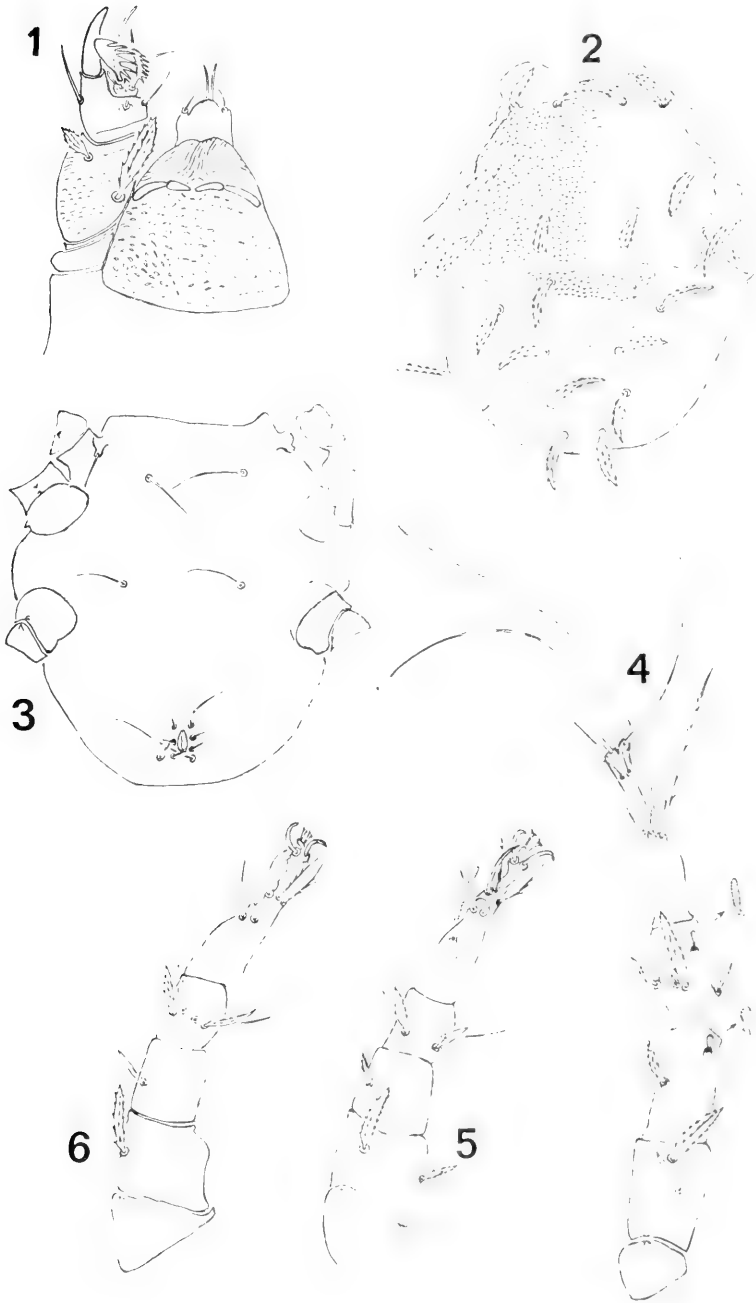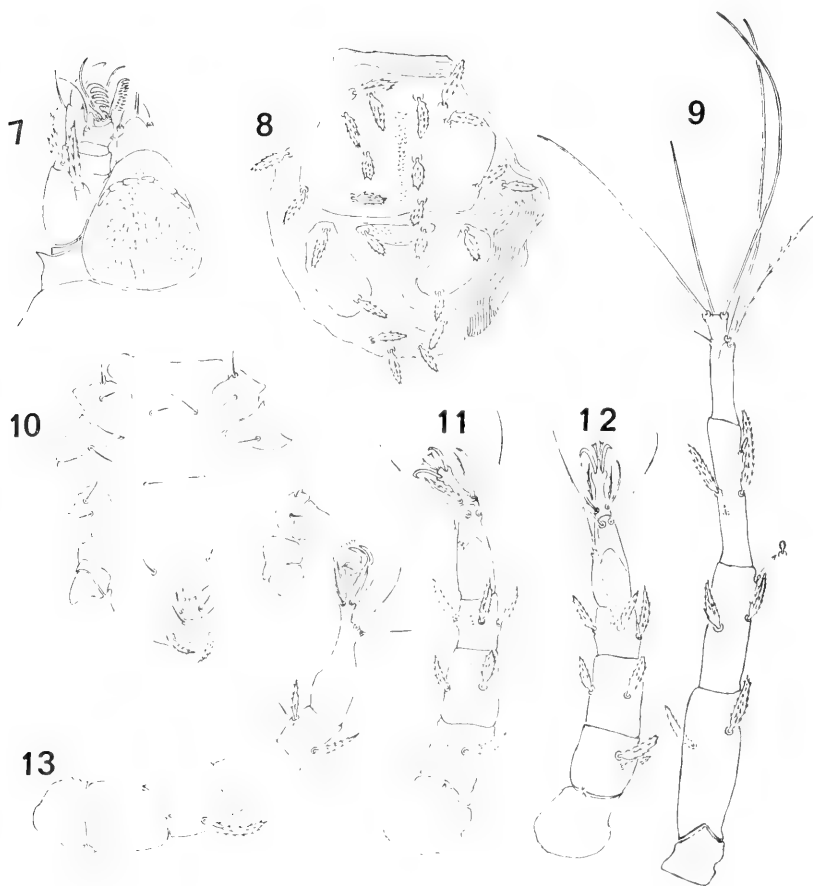
Fig. 7–13.   *E. vicinus*, protonymph. 7, gnathosoma. 8, dorsum. 9, right leg I. 10, venter. 11, right leg III. 12, right leg II. 13, right leg IV.

with about 12 teeth. Stylophore distally (protegmen) with microtuberculate striae; proximally (tegmen) with striae broken into small rods near midline; gradually becoming rotund tubercles laterally; venter with 1 pair long simple setae. Peritreme simple, composed of 3 pairs of segments. Propodosomal shield subrectangular; with tuberculate striae and 6 pairs spatulate-serrate setae. Humeral setae similar in size and shape to other dorsal setae. Hysterosoma with 1 elongate median shield and 1 pair lateral shields. Each shield bearing 1 pair of setae as figured; below lateral shield 2 pairs of spatulate-serrate setae medially. Leg I longest; legs II–IV similar in size and length. Coxae I with 2 simple setae; trochanter without setae; femur with 2 spatulate-serrate setae; genu with 2 spatulate-serrate setae and 1 peglike solenidion; tibia with 3 spatulate-serrate setae, 1 simple seta and 1 solenidion; tarsus medial surface with 1 simple setae
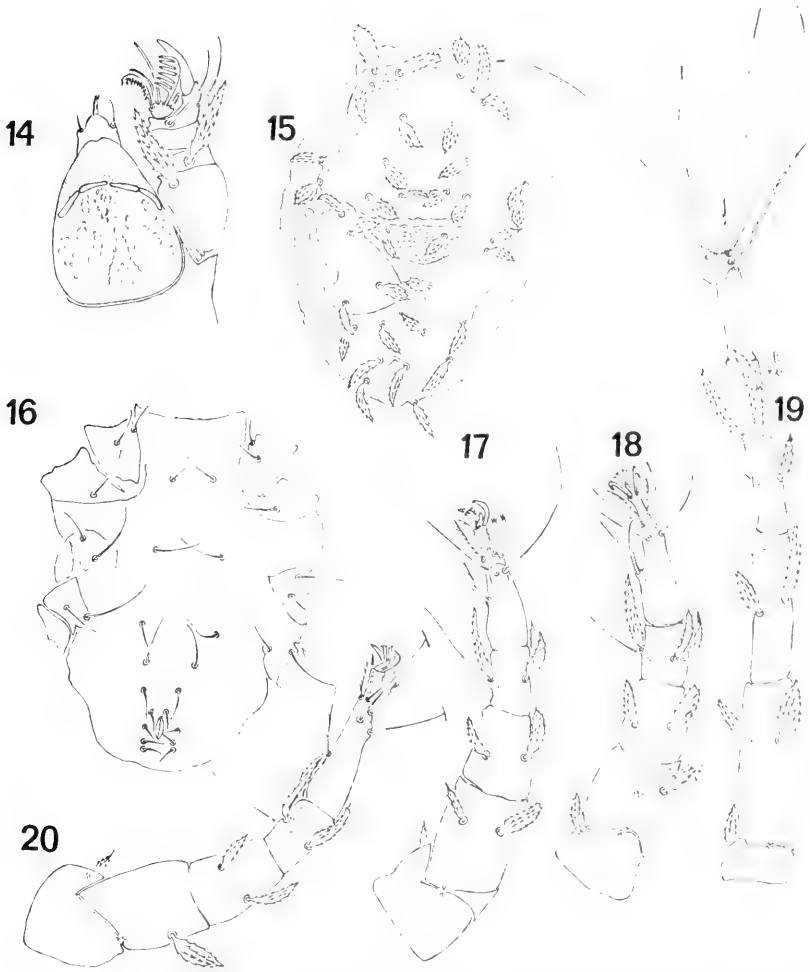
Fig. 14–20.   *E. vicinus*, deutonymph. 14, gnathosoma. 15, dorsum. 16, venter. 17, right leg III. 18, right leg II. 19, right leg I. 20, right leg IV.

ventrally and 1 serrate seta and 1 whiplike seta dorsally; distally with 2 parallel, subequal, long simple setae; and 1 short simple seta medially. Coxa II with 1 simple seta; trochanter without setae; femur with 2 spatulate-serrate setae; genu with 2 spatulate-serrate setae; tibia with 3 spatulate-serrate setae and 1 simple seta; tarsus with 1 mediolateral simple seta and 1 elongate solenidion; dorsomedially with 2 parallel simple setae; terminally with 2 serrate setae and 2 saberlike setae. Coxa III with 2 simple setae; trochanter without setae; femur with 1 spatulate-serrate seta; genu with 2 spatulate-serrate setae; tibia with 3 spatulate-serrate setae and 1 simple seta; tarsus with 1 medioventral simple seta; dorso-
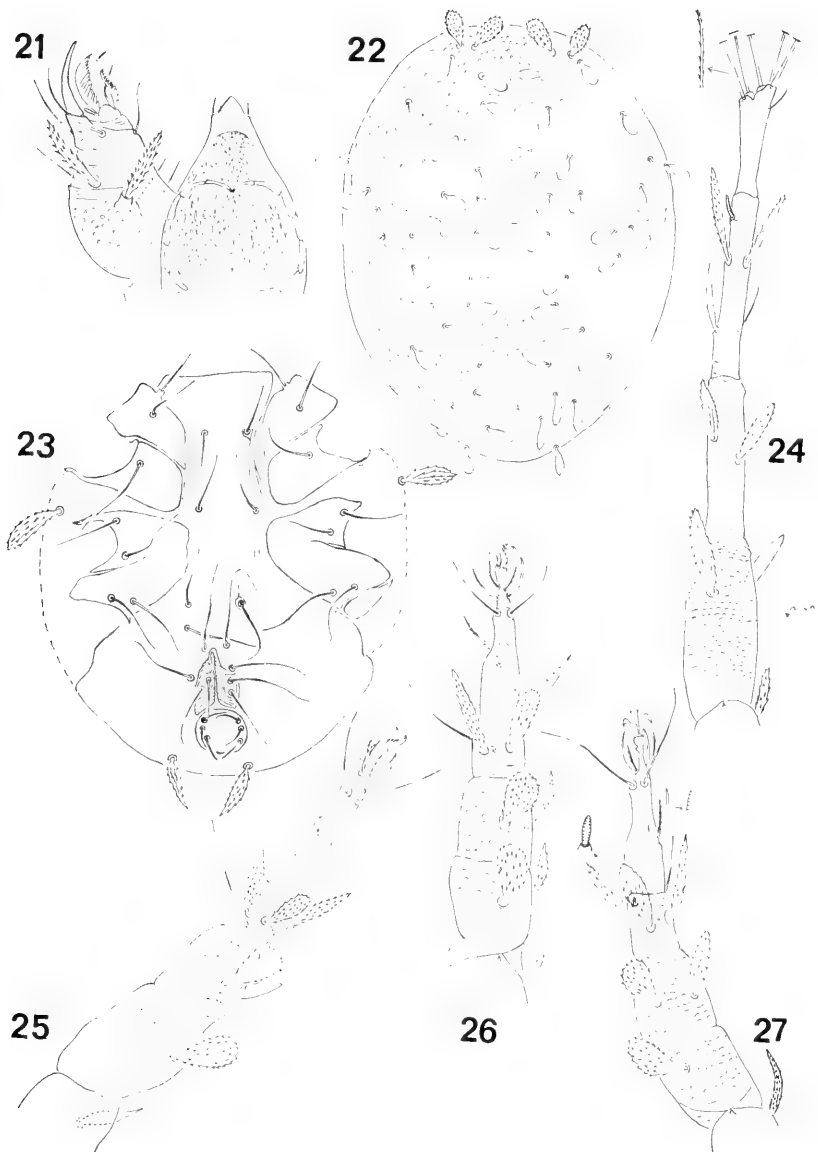
Fig. 21–27.   *E. vicinus*, female. 21, gnathosoma. 22, dorsum. 23, venter. 24, left leg I. 25, left leg IV. 26, left leg III. 27, left leg II.

medially with 2 parallel simple setae; terminally with 2 serrate setae and 2 saber-like setae. Coxa IV without setae; trochanter without setae; femur with 1 spatulate-serrate setae; genu without setae; tibia with 2 spatulate-serrate setae and 1 simple seta; tarsus dorsomedially with 2 parallel simple setae; terminally with 2 serrate setae and 2 saberlike setae. Tarsi II–IV with 2 smooth claws and padlike empodium with tenent hairs. Venter of idiosoma with 4 pairs of setae medially; posterior distal pair serrate. Anal area with 3 pairs of simple setae. Length of body, excluding gnathosoma, 185 μ; width 165 μ.

Deutonymph (fig. 14–20):   Gnathosoma same as for protonymph except inner comb of palpal tarsus bears 14 teeth, and the outer comb has 7 strong teeth; and 2 segmented peritreme. Dorsal idiosoma same as protonymph except the pro-podosomal shield bears 9 pairs of spatulate-serrate setae; and the hysterosoma lateral shield bears 2 pairs of setae; with 4 medial pairs of setae below lateral shields. Legs similar in size and shape to those of protonymph; chaetotaxy similar except trochanter I–IV each with 1 seta; tarsus II has 6 setae; femur III has 2 setae, whereas there is only 1 on this segment in the protonymph. Ventral idiosoma dissimilar from protonymph; with 5 pairs of median simple setae and 4 pairs of anal setae. Length of body, excluding gnathosoma, 223 μ; width 165 μ.

Female (fig. 21–27):   Palpal femur robust, wider than long; dorsal seta situated on protuberance, spatulated and serrated; ventrally with 2 simple setae; setae of genu spatulate-serrate dorsally, ventral seta simple; tibia with 3 simple setae; tibial claw without teeth; inner comb with 18 teeth; outer comb with 12 strong teeth. Stylophore protegmen with microtuberculate striae; tegmen with striae broken into small rods, becoming larger on lateral margins; venter with 1 pair long, slender, simple setae. Peritreme simple, composed of 5–6 segments. Pro-podosomal and hysterosomal shields roughened with tuberculate striae varying in size and shape. Each shield with 12 pairs dorsal fan-shaped serrate setae. Hu-meral setae similar in shape, but slightly larger than other dorsal setae; situated on lateroventral platelets. Leg I longest; legs II–IV alike in size and length. Coxa I with 2 simple setae; trochanter with 1 spatulate-serrate seta; femur with 2 spatulate-serrate setae; genu with 2 spatulate-serrate setae; tibia with 1 simple seta. 1 solenidion, and 3 spatulate-serrate setae; tarsus with 1 medioventral simple seta; dorsomedially a protuberance bearing 1 long acuminate solenidion and 1 serrate guard seta; terminally with 2 subequal finely serrate setae and 1 long medial acuminate solenidion. Coxa II with 1 simple seta; trochanter with 1 spatulate-serrate seta; femur with 1 palmate-serrate and 1 spatulate-serrate seta; genu with 1 palmate-serrate and 1 spatulate-serrate seta; tibia with 1 peglike solenidion, 1 spatulate-serrate seta dorsally, 1 simple seta ventrally and spatulate-serrate setae laterally; tarsus with 1 finely serrate seta and 1 acuminate solenidion lateroventrally; dorsodistally with 2 parallel simple setae; terminally with 2 ser-rate and 2 saberlike setae. Coxa III with 2 simple setae; trochanter with 1 spatulate-serrate seta; femur with 1 palmate-serrate and 1 spatulate-serrate seta; genu with 1 palmate-serrate and 1 spatulate-serrate seta; tibia with 1 simple seta ventrally, 1 palmate-serrate seta dorsally and 2 spatulate-serrate setae laterally; tarsus with 1 finely serrate seta ventrally, dorsally with 2 parallel simple setae, terminally with 2 serrate and 2 saberlike setae. Coxae IV with 2 simple setae; trochanter with 1 spatulate-serrate seta; femur with 1 palmate-serrate seta; genu with 1 palmate-serrate and 1 spatulate-serrate seta; tibia with 1 simple seta ven-trally, 1 palmate-serrate seta dorsally and 2 spatulate-serrate setae laterally, tarsus
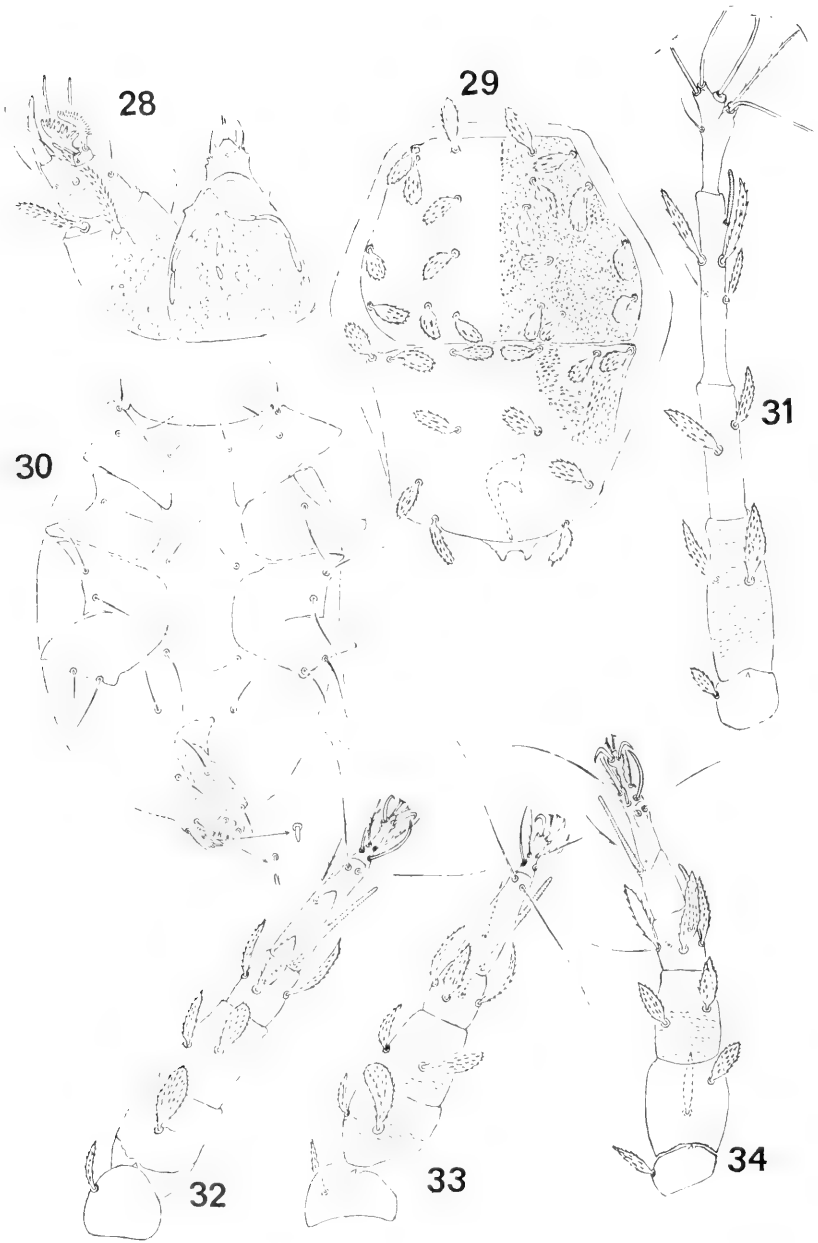
Fig. 28–34. *E. vicinus*, male. 28, gnathosoma. 29, dorsum. 30, venter. 31, right leg I. 32, right leg IV. 33, right leg III. 34, right leg II.

with 1 finely serrate seta ventrally, dorsally with 2 parallel simple setae, terminally with 2 serrate and 2 saberlike setae. Tarsi II–IV with 2 smooth claws and pad-like empodium with tenent hairs. Venter of idiosoma as figured. Length of body, excluding gnathosoma, 319 μ; width 268 μ.

Male (fig. 28–34): Similar to female by having palmate-serrate setae on the dorsum and by having identical chaetotaxy for leg I. Palpal femur robust (63 μ long and 51 μ wide), dorsal setae situated on protuberance, rodlike, stout, long and serrated, ventrally with 2 simple setae; genu dorsal seta rodlike, stout, long and serrated, ventrally with 1 simple seta; tibia with 3 simple setae, tibial claw without teeth, inner comb with 18 teeth, outer comb with 10 stronger teeth. Stylophore protegmen and tegmen striae as found in female. Peritreme simple, composed of 3–5 segments. Propodosomal and hysterosomal shields roughened with tuberculate striae varying in size and shape. Propodosomal shield with 9–10 pairs of palmate-serrate setae. Hysterosomal shield with 6 pairs of palmate-serrate setae. Humeral setae similar in size and shape to other dorsal setae. Leg I longest; legs II–IV alike in size and length. Coxa I with 2 simple setae; trochanter with 1 spatulate-serrate seta; femur with 2 spatulate-serrate setae; genu with 2 spatulate-serrate setae; tibia with 1 simple seta, 1 long rodlike solenidion and 3 spatulate-serrate setae; tarsus with 1 medioventral simple seta, dorsomedially with a protuberance bearing 1 long acuminate solenidion and 1 serrate guard seta, terminally with 2 subequal finely serrate and 1 long medial acuminate solenidion and 1 minute simple seta. Coxa II with 1 simple seta; trochanter with 1 spatulate-serrate seta; femur with 1 palmate-serrate and 1 spatulate-serrate seta; genu with 1 palmate-serrate and 1 spatulate-serrate seta; tibia with 1 long rodlike solenidion, 1 ventral simple seta and 3 spatulate-serrate setae; tarsus with 1 long, stout, rod-like solenidion and 1 serrate seta ventrally, dorsodistally with 2 parallel simple setae, terminally with serrate and 2 saberlike setae. Coxa III with 2 simple setae; trochanter with 1 spatulate-serrate seta; femur with 1 palmate-serrate and 1 spatulate-serrate seta; genu with 1 palmate-serrate and 1 spatulate-serrate seta; tibia with 1 simple seta ventrally and 3 spatulate-serrate setae; tarsus with 1 stout, long, rodlike solenidion ventroproximally and 1 medioventral serrate seta, dorsodistally with 2 parallel simple setae, terminally with 2 serrate and 2 saber-like setae. Coxa IV with 2 simple setae; trochanter with 1 spatulate-serrate seta; femur with 1 palmate-serrate and 1 spatulate-serrate seta; tibia with 1 simple seta ventrally and 3 spatulate-serrate setae; tarsus with 1 stout, long rodlike solenidion ventroproximally and 1 medioventral serrate seta, dorsodistally with 2 parallel simple setae, terminally with 2 serrate and 2 saberlike setae. Tarsi II–IV with 2 smooth claws and padlike empodia with tenent hairs. Venter as figured. Genital cleft flanked on each side with a row of 4 pairs of setae, 1st anterior pair simple, 2nd and 3rd fish-tail or Y-shaped, 4th pair bullet shaped. Length of body, excluding gnathosoma, 255 μ; width 204 μ.

Heteromorphic male, small form (fig. 35–41): Gnathosoma same as for normal male except palpal tarsus inner comb bears 14 teeth and the outer comb bears 11 strong teeth. Palpal femur 70 μ long and 38 μ wide, larger than femur of normal male; protuberance bearing rodlike serrate seta, exceeding the length of protuberance and seta on normal male; rodlike setae may be forked or normal in some specimens; usually unforked; or vary (i.e. normal on 1 palpal femur and forked on the other). Peritreme varying with 4–5 segments. Dorsal propodosomal and hysterosomal shields with same number of serrate setae as shields of normal
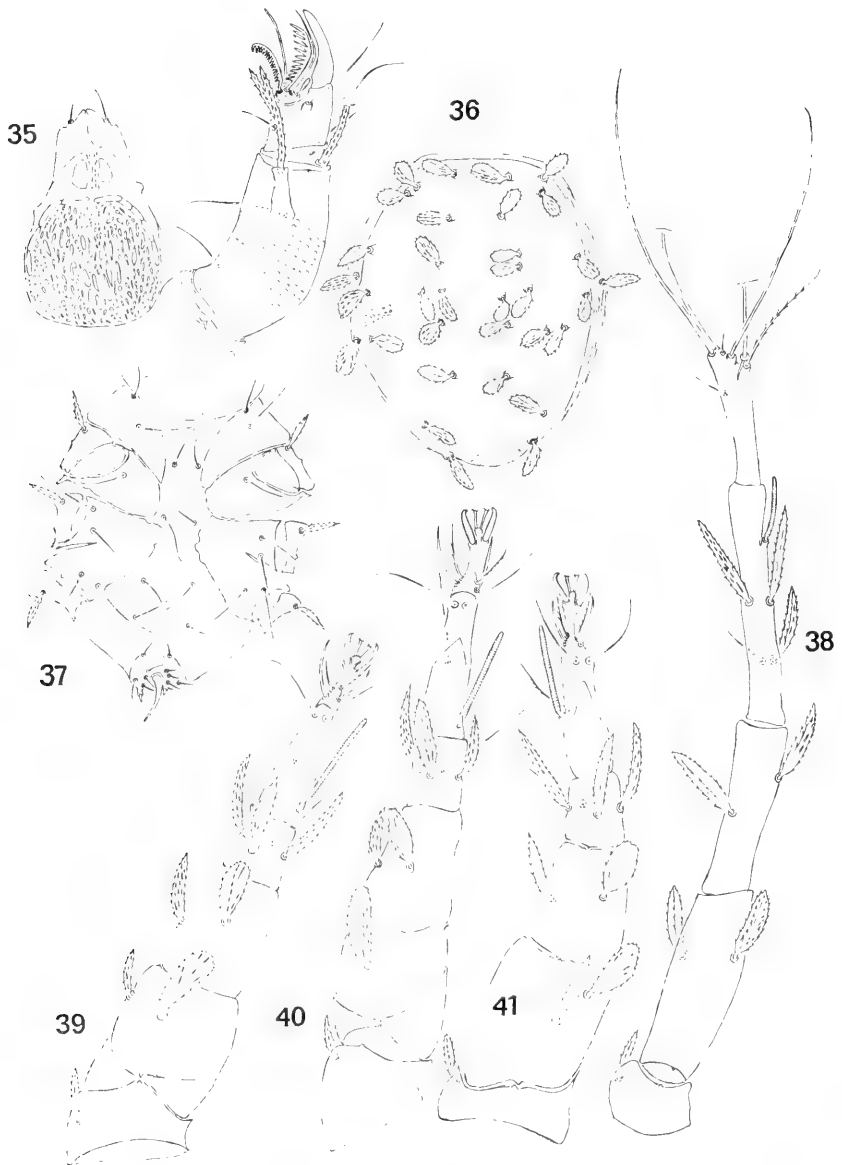
Fig. 35–41. *E. vicinus*, heteromorphic male, small form. 35, gnathosoma. 36, dorsum. 37, venter. 38, right leg I. 39, right leg IV. 40, right leg III. 41, right leg II.
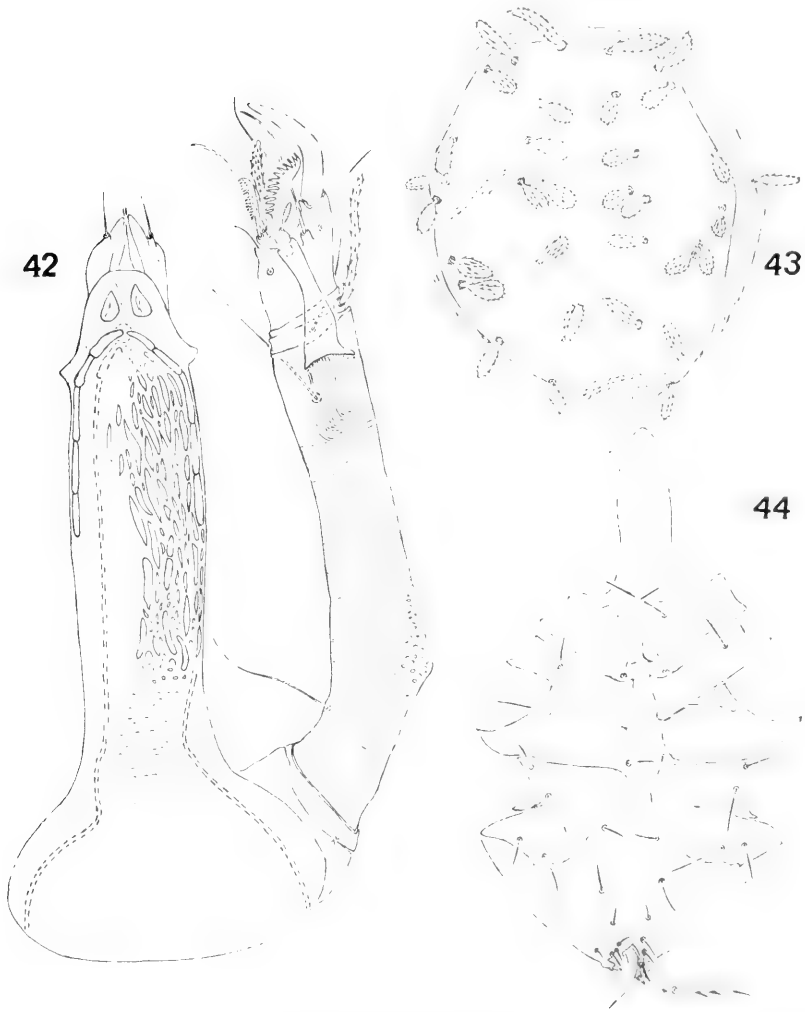
Fig. 42–44. *E. vicinus*, heteromorphic male, large form. 42, gnathosoma. 43, dorsum. 44, venter.

male. Legs like those of normal male, similar in size and shape, chaetotaxy same as those of normal male. Ventral idiosoma same as normal male and as figured. Length of body, excluding gnathosoma, 255 μ; width 204 μ.

Heteromorphic male, large form (fig. 42–44): Gnathosoma similar to normal male and heteromorphic male small form except being conspicuously elongated. Inner comb of palpal tarsus with 18 teeth; outer comb with 15 stronger teeth. Palpal femur 172 μ long and 70 μ wide; protuberance bearing rodlike serrate seta
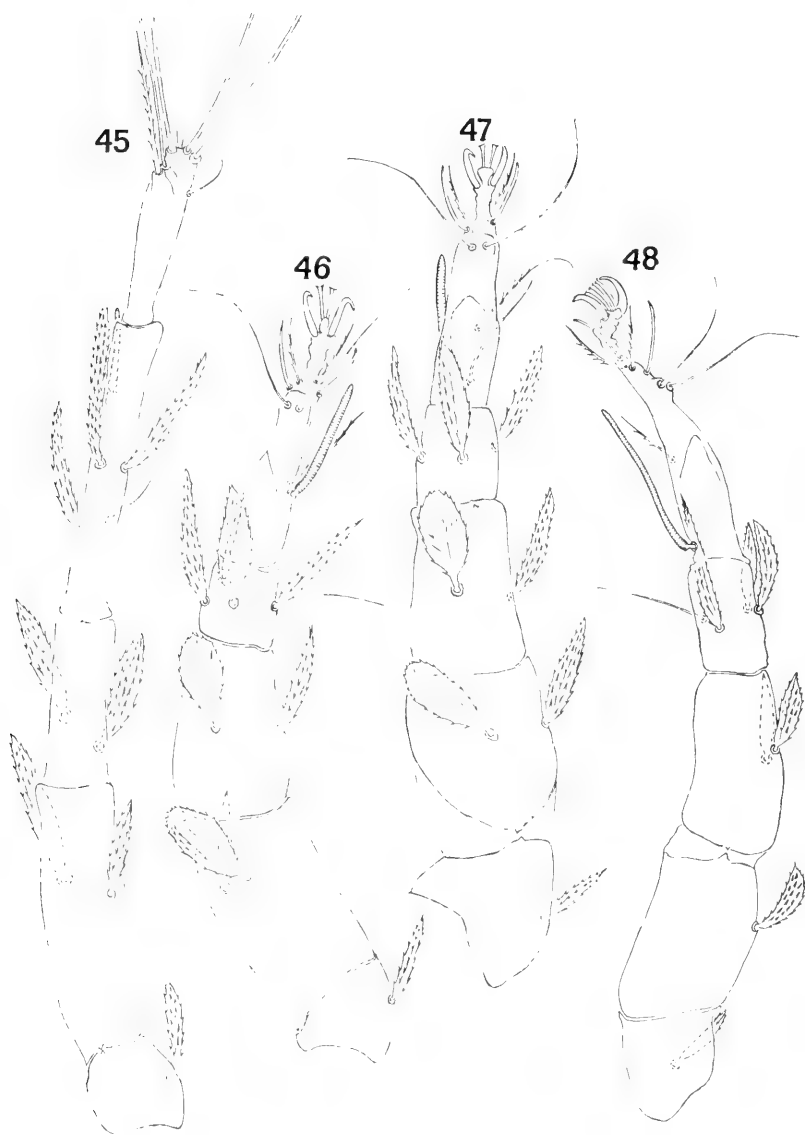
Fig. 45–48. *E. vicinus*, heteromorphic male, large form. 45, left leg I. 46, left leg II. 47, left leg III. 48, left leg IV.

Frequency Distribution of Palp Length
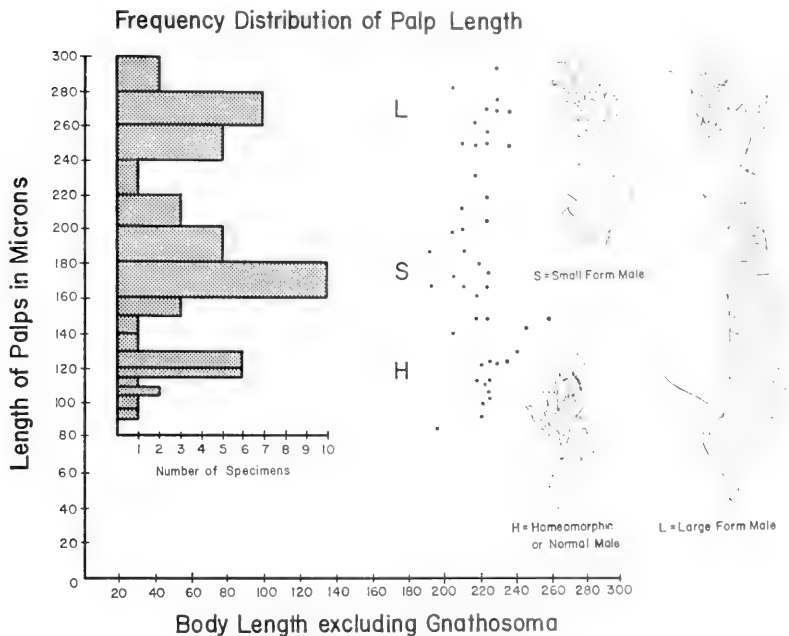
49

Fig. 49. Simple allometry and frequency in *Eutogenes vicinus*. Dorsal views of palpi of homeomorphic male (H), small form (S), and large form (L) are shown, along with placement of these specimens on allometric regression line. Several specimens of each form had the same dimensions and when calculated fell on the same point of the regression in each curve.

as found on other smaller male forms. Peritreme with 5 segments. Striae on tegmen composed of large fusiform rods as figured; gradually becoming rotund tubercles proximally. Dorsal propodosomal shield with 9 pairs of setae, whereas 9–10 pairs of setae are found on this shield of normal male and heteromorphic male small form. Hysterosomal shield with 6 pairs of setae, same number as found in all other males. Legs like other forms of species, similar in size and length; chaetotaxy for legs I–IV same as for other males, except 2 minute setae found on distal portion of tarsus I; only 1 minute seta is found on this segment for females and other males. Chaetotaxy of ventral idiosoma same as for other males. Length of body, excluding gnathosoma, 268 μ; width 204 μ.

The frequency distribution of palp length among the 3 adult male forms is illustrated in fig. 49.

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A NEW SPECIES OF ISCHNOCLOPIUS STÅL, WITH NOTES ON THE SYSTEMATIC POSITION OF THE GENUS (HEMIPTERA: REDUVIIDAE)

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ABSTRACT—A new species of harpactorine reduviid, *Ischnoclopius* **peruensis**, is described from specimens collected in the neotropics. The genus and the previously described species, *Ischnoclopius festinans* (Fabricius), are redescribed, and the generic limits and relationships with other genera are examined. The male genitalia of both species are figured.

Ischnoclopius was erected by Stål (1868) as a monotypic genus for *Zelus festinans* (Fabricius, 1803). *Ischnoclopius* was distinguished from *Zelus* chiefly by its long, narrow and flattened appearance, its posteriorly widened abdomen and the nearly equal length of the ante- and postocular lobes of the cranium. Current evaluation of *Ischnoclopius* and several closely related harpactorine genera indicates sufficient differences to warrant continued generic status.

Ischnoclopius Stål, 1868

Ischnoclopius Stål, 1868, p. 106–107, orig. descr.; Stål, 1872, p. 92, cat.; Lethierry and Severin, 1896, p. 150, cat.; Wygodzinsky, 1949, p. 41, checklist.

Long, narrow, body depressed; pale yellowish brown to dark reddish brown in color; pubescence consisting of erect, semi-erect, and decumbent setae. Compound eyes prominent, width of head through compound eyes greater than 1.5 times height of head through ocelli; ocelli only slightly raised above surrounding surface; sides of ante-ocular lobe subparallel; rostrum long, narrow, segment II more than twice length of segment I, apex of segment I not reaching anterior margin of compound eyes; antennae long, slender, with segments I and III of subequal length, each longer than 0.5 times length of protibia, segments II and IV each less than 0.25 times length of I or III. Pronotum flattened, dorsal surface of anterior and posterior lobes in same plane; integument of anterior lobe relatively smooth, faint setal tracts present, small tubercles at dorsolateral angles of collar, medial sulcus shallow; posterior lobe rugulose, humeral angles swollen; legs long, slender, profemur and protibia nearly equal in length, about 0.6 times total length; clavus and corium punctate, apex of clavus transparent, quadrate cubital cell elongate, cells of membrane oriented more transversely than longitudinally. Scutellum with small round medial depression dorsally; apex angulate. Abdominal segments increasingly wider distally, segments VI and VII flared laterally in female. Medial process of pygophore cylindrical, short, curved posteriorly toward apex, apex terminating in small hooklike process; parameres cylindrical, reduced, reaching about 0.5 or less distance from lateral margin to medial process; dorsal phallothecal sclerite semicylindrical; struts fused apically and apex recurved dorsally

toward base; basal plate arms shorter than dorsal phallothecal sclerite, separate; pedicel less than 0.25 times length of basal plate arms. Tergum VIII extending beyond IX in female.

This genus appears most closely related to *Zelus* Fabricius, *Atopozelus* Elkins (1954), and a new but as yet undescribed genus close to *Zelus*. It shares with these genera the somewhat slender body configuration, elongate profemur longer than or subequal to the metafemur, basal rostral segment noticeably shorter than segment II, subcylindrical cranial lobes, antennal segments I and III subequal, either segment longer than head and thorax combined, with segments II and IV considerably shorter. *Ischnoclopius* differs from these other genera most noticeably by having a depressed body shape and flared abdomen. It is also separated from *Zelus* by the extremely reduced condition of the parameres; from *Atopozelus* by the presence of parameres, more slender profemur and gradually constricted base of the head; and from the undescribed genus by having a single as opposed to bifurcate medial process on the pygophore.

Ischnoclopius, along with the aforementioned genera, is apparently confined to the western hemisphere.

<center>*Ischnoclopius festinans* (Fabricius)</center>

<center>Fig. 1–3</center>

Zelus festinans Fabricius, 1803, p. 281–282, orig. descr.; Zimsen, 1964, p. 338, list.
Ischnoclopius festinans, Stål, 1868, p. 107, descr.; Stål, 1872, p. 92, cat.; Lethierry
   and Severin, 1896, p. 150, cat.; Wygodzinsky, 1949, p. 41, checklist.
Identification not verified:
Zelus festinans, Walker, 1873, p. 135, cat.

Length 13–16 mm; integument yellowish brown to dark reddish brown; hemelytra shorter than abdomen in male specimen, barely achieving abdominal apex in female; legs long and slender; prominent spines on humeral angle of male.
Male: Head. Integument light reddish brown with darker areas around ocelli and with anterior area between antennal insertions lighter in color; ante-ocular lobe with erect and semi-erect setae, sparse over most of surface but more dense laterally between antennal insertion and compound eye and on tylus, erect and semi-erect setae over postocular lobe, becoming sparse ventrally; width through eyes about 1.8 times height through ocelli. Posterior surface of rostral segment I yellowish brown, remainder of rostrum reddish brown; pubescence consisting of sparse erect setae; segment II slender, elongate, over twice length of segment I. Antennal segment I yellowish brown with some reddish brown markings near base, remainder of segments reddish brown; erect setae sparse on segment I and base of segment II, becoming more dense distally on segment II.
Thorax. Anterior pronotal lobe yellowish brown to reddish brown with darker areas laterally; semi-erect and decumbent setae on setal tracts on anterior and lateral margins dorsally, over entire surface laterally; anterolaterally-directed tubercle on dorsolateral margin of collar; medial sulcus shallow at collar, deepening near posterior margin; short, wide transverse ridge behind collar on either side

Table 1.   Measurements (in mm) of *Ischnoclopius* spp.

	I. festinans			I. peruensis		
	Male	Female A	Female B	Male	Female A	Female B
Length	13.93	15.86	14.14	15.01	18.65	17.90
Width	1.85	2.04	1.70	2.00	2.45	2.30
Anteocular distance	1.40	1.47	1.25	1.40	1.70	1.70
Postocular distance	1.09	1.21	1.17	1.13	1.28	1.28
Width through eyes	1.20	1.32	1.18	1.22	1.42	1.36
Interocular distance	0.51	0.56	0.51	0.52	0.62	0.62
Interocellar distance	0.32	0.29	0.27	0.30	0.34	0.30
Ocular-ocellar distance	0.15	0.16	0.18	0.15	0.16	0.18
Rostral segment I	0.77	0.80	0.76	0.77	0.93	0.92
II	1.62	1.88	1.71	1.70	2.08	2.02
III	0.40	0.38	0.37	0.41	0.49	0.47
Antennal segment I	6.65	7.18	6.64	6.97	8.36	8.36
II	1.40	1.66	1.43	1.70	1.89	1.96
III	6.86	6.53	5.89	—	7.93	6.75
IV	—	1.21	—	—	—	—
Anterior pronotal lobe	0.91	1.02	0.87	0.94	1.17	1.13
Posterior pronotal lobe	1.55	1.70	1.59	1.89	2.19	2.08
Femoral l., pro-	8.47	—	9.11	9.86	12.22	12.00
meso-	5.36	5.68	5.04	5.68	6.75	6.64
meta-	6.54	—	5.57	6.53	7.50	7.50
Femoral w., pro-	0.19	—	0.19	0.21	0.26	0.25
meso-	0.16	0.16	0.16	0.18	0.19	0.21
meta-	0.16	—	0.15	0.19	0.21	0.21
Tibial l., pro-	8.68	—	9.22	9.65	12.65	11.79
meso-	5.79	6.22	5.57	6.32	7.50	6.97
meta-	7.07	—	6.32	7.18	8.36	8.25

of medial sulcus. Posterior lobe yellowish brown to reddish brown with darker areas laterally; decumbent setae over entire surface, some erect setae latero-ventrally; integument rugulose, more pronounced dorsally; faint longitudinal ridges defining medial one-third at anterior margin; humeral angles slightly swollen, male with small lateral spine about same length as diameter of antennal segment I. Scutellum yellowish brown; setae semi-erect; apex slightly extended into small conical process. Legs yellowish brown, apical angles of femur and apical areas of protibia reddish brown; femora with sparse erect setae, meso- and metafemora with single row of very short setae ventrally; tibial setae erect, more dense distally, protibial setae stiffer, more semi-erect or erect; small subtuberculate processes on anterior apical portion of femora. Clavus and corium yellowish brown to reddish brown, apex of clavus transparent, membrane reddish brown; decumbent and semi-erect setae on clavus and corium, with longer erect setae at base of clavus; surface of clavus and corium with punctations; wings shorter than abdomen in observed specimen.

Abdomen. Integument yellowish brown to dark reddish brown, pattern variable but with lighter colors toward lateral margins; short erect setae over entire surface, more dense dorsally and with some long setae ventrally; width gradually increasing toward posterior.

Terminalia. Pygophore reddish brown; short to moderately long setae over exposed surface; base of medial process gradually blending into raised posterior margin of pygophore; parameres cylindrical, shorter than one-half distance from lateral margin to medial process. Dorsal phallothecal sclerite semi-cylindrical; apex relatively straight; dorsolateral expansions arising on basal one-half; struts attached to base, not appreciably expanded at point of dorsal attachment to sclerite; basal plate arms about same diameter as paramere; flattened area of pedicel confined to apical portion.

Female: Slightly larger than male. Humeral angles with faint tuberculate process. Wings barely attaining apex of abdomen. Abdomen more expanded laterally, segments VI and VII more noticeably flared; abdomen darker than male.

Type-data: The female lectotype (NEW DESIGNATION) is deposited in the Universitetets Zoologiske Museum, Copenhagen, and bears the following labels: *Zelus festinans* in Am. mer. Schmidt/Type. A female paralectotype (NEW DESIGNATION) is deposited in the same collection but bears only a red label with the word "Type." This label information agrees with that of the original description by Fabricius (1803) and the generic description of Stål (1868). It is reported by Zimsen and inferred by Fabricius' work that Schmidt collected in the West Indies and the northern countries of South America.

Distribution: Trinidad and northeastern South America.

From the few specimens reported, it is apparent that some variation of the humeral spines is evident, as is the length of the hemelytra.

Material examined: Location unknown (UZM), 1 female lectotype and 1 female paralectotype. Trinidad (USNM), 1 male. Surinam: Moengo, Boven Cottica R., May 19, 1927 (AMNH), 1 female; Moengo, Tapoe, September 22, 1948, (RNH), 1 female.

Ischnoclopius peruensis Hart, new species

Fig. 4–6

Length 15–19 mm; integument yellowish brown to dark reddish brown; hemelytra exceeding abdomen in length in both sexes; legs long and slender.

Male: Head. Dorsal surface yellowish brown, lateral and ventral portion reddish brown; ante-ocular lobe with scattered erect setae over entire surface, longer and more dense on tylus, postocular lobe with moderate to long erect and semi-erect setae dorsally and laterally, becoming shorter and less dense ventrally;

→

Fig. 1–3. *Ischnoclopius festinans*. 1, pygophore, lateral view. 2, pygophore, posterior view. 3, phallus, dorsal view. Fig. 4–6. *I. peruensis*. 4, pygophore, lateral view. 5, pygophore, posterior view. 6, phallus, dorsal view.
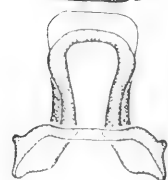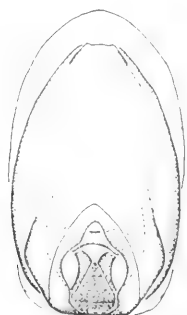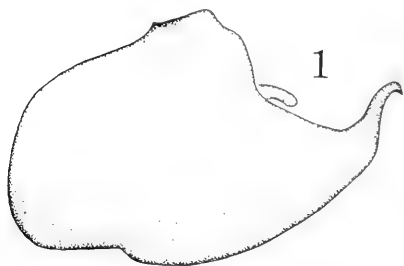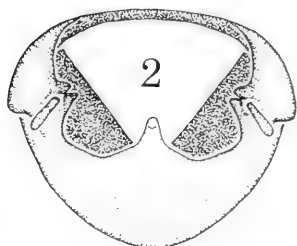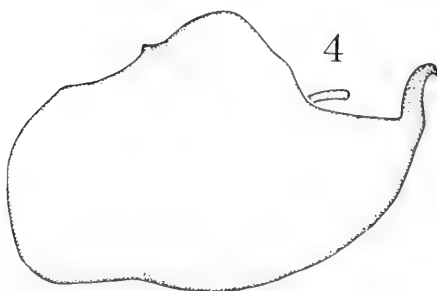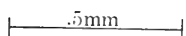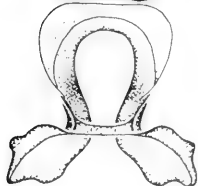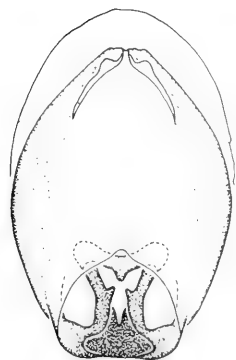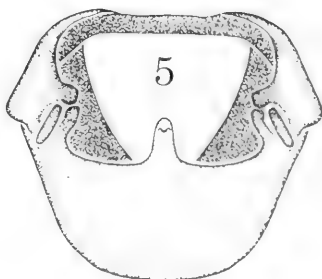
ante-ocular lobe slightly depressed, subcylindrical, width increasing slightly from immediately anterior to compound eyes to antennal insertions; ocelli only slightly elevated; width through compound eyes about 1.8 times height through ocelli. Basal portion of rostral segment I reddish brown, apical portion of I and basal portion of II yellowish brown, dark reddish brown on III and apical portion of II; short to moderately long erect setae over entire surface; segment II slender, elongate, over twice length of I. Shaft of antennal segment I yellowish brown, segments II–IV and base of apex of I reddish brown; scattered erect setae and row of short erect setae apically on segment I, pubescence on segment II consisting of sparse erect setae becoming more dense apically.

Thorax.   Anterior pronotal lobe yellowish brown dorsally and laterally, variable dark reddish brown areas laterally; some short decumbent setae confined to vestigial setal tracts dorsally, anterior margin and dorsolateral areas with longer and more dense semi-erect pubescence, short decumbent setae with scattered erect setae laterally; dorsolateral angles of collar with small tubercle; short wide transverse ridges behind collar on either side of medial sulcus; medial sulcus shallow at collar, becoming only slightly deepened posteriorly. Posterior lobe yellowish brown with some reddish brown areas laterally; inconspicuous, sparse, short, decumbent setae over entire surface, some erect setae lateroventrally; integument rugulose, more pronounced on dorsum; faint longitudinal ridges defining medial ⅓ at anterior margin; humeral angles slightly swollen, rounded; disc elevated. Scutellum yellowish brown; surface with semi-erect setae; apex angulate. Legs yellowish brown, dark reddish-brown areas on profemur, protibia and apical angles of all femora; femora with sparse erect setae, meso- and metafemora with single row of very short setae ventrally, tibial setae semi-erect or erect, increasing in density apically, some setae longer than tibial diameters, those of protibia stiffer, more erect. Clavus and corium reddish brown, veins somewhat lighter in clavus and corium, apex of clavus transparent, membrane reddish brown; short decumbent setae over clavus and corium, longer erect setae at base of clavus; surface of clavus and corium with punctations; wings surpassing apex of abdomen.

Abdomen.   Yellowish brown to reddish brown integument; short erect and semi-erect setae over entire surface, more dense dorsally, some long erect setae ventrally, more dense at apex; width gradually increasing toward posterior.

Terminalia.   Pygophore reddish brown; exposed surface covered with erect setae; lateral and posterior margins but little raised to base of medial process; parameres cylindrical, shorter than ½ distance from the lateral margin to medial process. Dorsal phallothecal sclerite semi-cylindrical, ovoid; apex notched; sharp ridgelike processes diverging dorsolaterally from apex, proceeding about one-fifth length of sclerite; struts attached to base, not appreciably expanded at points of attachment to dorsal surface of sclerite; basal plate arms about same diameter as base of medial process of pygophore; pedicel extending to lateral portion of basal plate arms.

Female: Larger than male. Abdomen more noticeably flared laterally toward posterior.

Type-data: The male holotype is deposited in the collection of the California Academy of Sciences, Los Angeles, and bears the following labels: PERU: Monzon Valley, Tingo Maria, 29-XI-1954, E. I. Schlinger and E. S. Ross, Collectors. One female allotype bearing

the same labels except for the date of XI-21-1954, is deposited in the same museum. One female paratype bearing only the label "Chanchamayo, Peru," is deposited in the Rijksmuseum van Natuurlijke Historie in Leiden, The Netherlands.

Distribution: The known specimens are from valleys of the eastern slopes of the Cordillera Central in central Peru.

This species is notably darker and larger than *I. festinans*. The base of the medial process of the pygophore is more distinct from the margin. Also, sharp apical ridges are present on the dorsal phallothecal sclerite and the pedicel has lateral extensions onto the basal plate arms. Female specimens possess less distinctively flared abdominal segments than do those of *I. festinans*. While *I. festinans* is known only from relatively low coastal altitudes, the known habitat of *I. peruensis* is in the comparatively high valleys of the eastern slopes of the Andes.

Nothing has been recorded of the biology or ecology of either species.

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THE MALE OF THE SOUTH AMERICAN KATYDID GENUS PHLUGIOLA, AND A NEW RELATED GENUS FROM THE SOLOMON ISLANDS (ORTHOPTERA: TETTIGONIIDAE, MECONEMATINAE)

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ABSTRACT—*Phlugiola* is a rarely collected genus of small katydids, apparently restricted to South America in nature, initially placed in the Listroscelinae but more recently transferred to the Meconematinae. A male from Peru of *P. redtenbacheri* Karny, here described, is the first of that sex to be reported. A second species, *P. dahlemica* Eichler, known only from females which once were established in Berlin, Germany greenhouses, has not been found since World War II. In 1969 Chopard described *P. gressitti* from the Solomon Islands; however, examination of the type reveals substantial differences which are the basis for the present description of **Lucienola**, new genus. A key to these 2 genera and the related *Phlugiolopsis* is included. Finally, a female from the Philippine Islands, evidently of a genus related to but distinct from *Phlugiola*, is discussed briefly.

In 1950 my old friend, the late Harry A. Allard, a retired botanist, collected some insects at Tingo Maria, Peru; 1 of these insects is the first male of *Phlugiola redtenbacheri* Karny to be reported. Because of its distinctive features and the rarity of the species, a description is appropriate, especially so for comparison with the unique male holotype of *Phlugiola gressitti* Chopard from the Solomon Islands. Chopard (1969), lacking a male of true *Phlugiola*, was misled into believing the 2 species are congeneric, though in fact there are several separating characters which I regard as generic in addition to those peculiar to the males. No described genus appropriate to receive *gressitti* is known to me, so I am describing *Lucienola*, new genus, in honor of Dr. Lucien Chopard (1885–1971) in recognition of his approximately 65 years of active, distinguished publishing on Orthoptera. At the same time, various generic characters of considerable interest in these and related genera are discussed.

Historical Review and Materials Examined

Phlugiola was established by Karny (1907:103) who described *P. redtenbacheri* from a single female, now preserved at the Naturhistorisches Museum, Vienna, which was part of an acquisition from Surinam, obtained in 1899 from the Staudinger firm. There is no published record of additional South American material, and Chopard (1969:48) stated that the species has never been recovered in its native country. Ley (1951) also noted the uniqueness of the original

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type. However, I have examined a single female of *redtenbacheri* from Teffe, Amazonas, Brasil, XII-10-1919 (H. S. Parish) (Acad. Nat. Sci., Phila.) (Det. Hebard, 1926). On the date label of the Teffe specimen, the third digit for the year is unclear, but accounts of Parish's Brazilian travels show that the year was 1919 (Alexander, 1921, 39–41;1959). This area is about 800 miles from Surinam. The Teffe specimen agrees well with the type as described by Karny (1907;1913) and Eichler (1938). The Peruvian male (Tingo Maria, Peru, collected 19-II-1950, in jungle, H. A. Allard) (USNM), from an area some 800 miles southwest of Teffe at an altitude of about 2,000 feet, also agrees well except for sexual features.

A second species, *Phlugiola dahlemica*, was described by Eichler (1938) from greenhouses in the Botanic Gardens at Berlin-Dahlem, Germany. It existed on various tropical plants there for 15 years or more (Harz, 1957:183) and, though its native home was uncertain, a South American origin has been conjectured (Chopard 1969:51). More than a dozen notes and papers on this species appear in the German literature. Ley (1951:292–294) stated that an air attack in 1944 partially destroyed the greenhouse holding *dahlemica* and that the little katydid apparently perished from the cold. The only confirmation available to me of this popular account is the report by Harz (1969:178) that since 1945 *dahlemica* has not been taken in the Berlin greenhouses.

Two apparent misunderstandings about *Phlugiola* occur in Chopard's 1969 paper. He referred to a third species of *Phlugiola*, said to be from the Botanical Gardens in Kew, England. This species probably is the 1 described from Kew by Zeuner (1940) as *Phlugiolopsis henryi*, which has never been assigned to the genus *Phlugiola*. Chopard also credited the entomologist F. Zacher with reporting *Phlugiola* from the gardens at Kew in 1928; actually, Zacher (1928) reported *Phlugiola* from Berlin-Dahlem under the name *redtenbacheri* prior to Eichler's detailed study of *dahlemica*, and this may be the publication Chopard mentioned.

Although the food habits of *Phlugiola redtenbacheri* are not recorded, the insect probably is predaceous, to judge from the habits of *P. dahlemica* and *Phlugiolopsis henryi*. The former was found by Eichler (1938) to feed primarily on vinegar flies (*Drosophila* sp.), whereas *Phlugiolopsis* was described by Zeuner as feeding mainly on slow-moving insects such as aphids and mealy-bugs.

The acoustic spiracles and their importance in generic definition: One difference between *Phlugiola redtenbacheri* and *P. gressitti* is the presence in the former of an acoustic spiracle (fig. 3, *as*), located in the proepimeron, just ventroposteriorly of the regular spiracle or "*truncal spiracle*," so-called because it is the normal first thoracic

spiracle connecting with a main tracheal trunk. No acoustic spiracle is evident in *gressitti*, and the opening may be concealed by the flap of the proepimeron. The occurrence, size, and location of acoustic spiracles in Ensifera, especially Tettigoniidae, are sufficiently significant to warrant a few explanatory remarks about these often overlooked structures. The acoustic spiracle, frequently much larger than the truncal spiracle, is not part of the main respiratory system, but instead provides the entrance of air to the front leg by means of a trachea leading to the tympanal organ so frequently present at the base of the front tibia in Ensifera. Presumably, the occurrence of air both outside and within the auditory area of the tibia contributes to efficiency in hearing. Extensive basic studies of the acoustic spiracle were made by Graber (1876), Zeuner (1936), Ander (1939) and Lewis (1974). However, in spite of the sometimes large size and conspicuous appearance of these organs, in Decticinae for instance, to which Rentz (1972) has applied the term "auditory structure" while calling attention to generic differences within that subfamily, general works and textbooks have paid slight attention to these interesting and distinctive organs. Sharp (1895:316–317), an exception, had a brief account. Some of the related structures, such as the *subgenual organs* and *crista acoustica*, both often mentioned in specialized accounts, have been discussed and well diagramed by Chapman (1969: 603–610). I am following Hartley (1973) in using the term *acoustic spiracle* for what has been variously called the "femoral stigma," "auditory stigma" and, together with the truncal spiracle, the "double stigmata."

Key to Phlugiola and Closely Related Genera

1. Front femur unarmed beneath; tergum 10 of male not divided by longitudinal posterior cleft; vertex of head with distinct but short cone extending in front of sides of vertex; posterior margin of male subgenital plate with stout spine, directed posteriorly, each side of midline (fig. 12, D of Zeuner, 1940); cerci of female short and stout. (Natural distribution unknown; adventive in England) .... *Phlugiolopsis* Zeuner
— Front femur armed ventrally with several small spines; tergum 10 of male conspicuously divided by longitudinal cleft; vertex of head without distinct cone (fig. 1); posterior margin of male subgenital plate specialized otherwise than above; cerci of female long and slender in *Phlugiola*, unknown in *Lucienola* 2
2. Front tibia with 5 pairs of movable spines on ventral surface; male pronotum expanded considerably in posterior half, sheltering tegmina (fig. 1); head in lateral view only moderately oblique; prothorax with conspicuous acoustic spiracle (fig. 3, *as*) in addition to truncal spiracle; male cercus with large basal arm; male subgenital plate with styli developed as long arcuate appendages (figs. 1, 2). (South America, adventive in Germany) .... *Phlugiola* Karny

— Front tibia with 4 movable unpaired spines on ventroanterior margin; male pronotum not expanded in posterior half, not covering any of tegmina (fig. 4); head in lateral view extremely oblique; prothorax without noticeable acoustic spiracle, only truncal spiracle; male cercus without basal arm; male subgenital plate with small styli borne laterally, the posterior margin specialized with sharp laterally directed "tooth" on each side, no terminal appendages. (Solomon Islands) .... *Lucienola*, new genus

Phlugiola redtenbacheri Karny, male

Head with fastigium not reaching to extremities of antennal scrobes; eyes bulging, reaching posteriorly much nearer pronotum than in *Lucienola*; no ocelli evident; face moderately oblique; exposed area of occiput short; prosternum unarmed; pronotum much swollen, expanded above tegmina, without distinct sulci or carinae.

Front femur with 3 spines mid-way on ventral surface (a more distal pair, and a single 1 on ventro-anterior margin); front tibia greatly expanded in basal 3rd, with large oval open tympanum of about equal size on each side, ventral surface with 5 pairs of movable spines, those toward apex of decreasing size and the anterior 1 of each pair somewhat longer, the most distal pair with posterior member rudimentary (right leg) or absent (left leg); apex of front and middle tibia each with pair of tiny terminal ventral spurs; middle and hind femora unarmed; middle tibia with 2 unpaired, well-spaced medium-length movable spines in mid-part of ventral margin; hind tibia with about 25 short spines along each dorsal margin, apex with 2 pairs short, sturdy spurs; all tibiae with some short but strong bristlelike setae, these regular and conspicuous along margins of hind tibia.

Abdomen small, especially reduced in size near base (probably partly due to shriveling), setal covering very sparse. Tergum 10 deeply, broadly divided, a short heavy tooth directed mesoposteriorly on each side of posterior margin; ultimate sternum (subgenital plate) broad at base, the mid-ventral surface somewhat pinched and with narrow keel along midline, apical part narrowed and divided into arms bearing the forcepslike styli; latter apically clavate, with thin partial flanges along inner margins bearing numerous setae; each cercus bearing strong, long sensory setae, with conspicuous meso-dorsally directed basal arm, the posterior apex gently incurved, somewhat toothlike in shape.

Color: Body mainly pale straw color; dorsum of head, some anterolateral portions of pronotum, and most of maxillary palpi tinged with pale green; prozona of pronotum near midline dirty pale orange, metazona and posterior margin with dark design as figured; eyes mottled with brown and pinkish; antennae pale, with dark annulae; tarsi dark brown; dorsal spot near base of abdomen and area of 10th tergal emargination blackish; apical part of styli brownish.

Specimen collected in Tingo Maria, Peru, on Feb. 19, 1950.

In the following table, measurements (in millimeters) of the male of *redtenbacheri* are shown compared with those of the Teffe, Brasil female, those given by Karny (1907) for the type-female of *redtenbacheri*, also those for a female from Leyte, Philippine Islands, of an uncertain genus resembling *Phlugiola* which is discussed later in this paper.
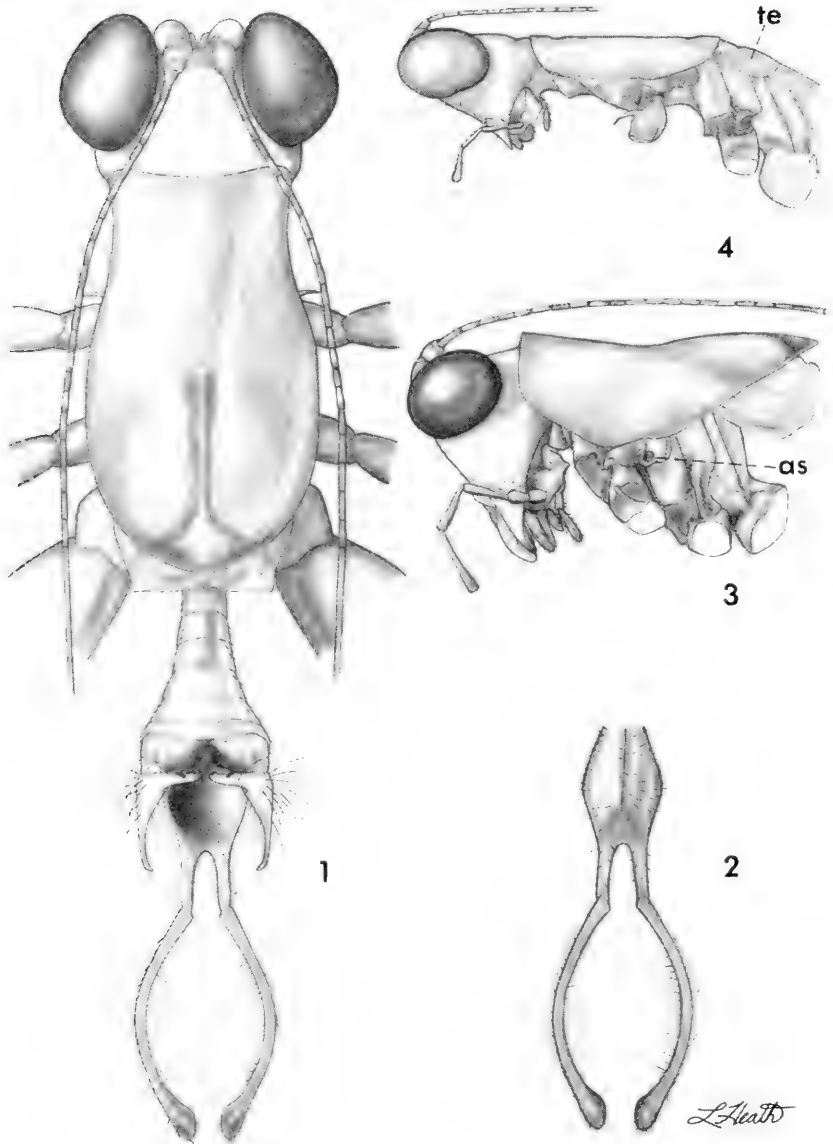
Fig. 1–3. *Phlugiola redtenbacheri* Karny, male. 1, dorsal view. 2, ventral view of subgenital plate. 3, lateral view of head and thorax (only coxae of legs shown). *as*—acoustic spiracle.

	♂ from Peru	Type ♀, after Karny	♀ from Teffe, Brasil	♀ from Leyte, P. I.
Body length, including ovipositor, in case of ♀ ♀	6.7	9.5	14.0	19.0
Pronotum	3.9	3.0	3.3	3.6
Tegmen	1.5	2.0	2.0	2.0
Hind femur	10.3	10.3	11.1	12.5
Hind tibia	10.5		11.3	13.0
Ovipositor		3.0	4.6	6.5

Lucienola Gurney, new genus

General build small, slender, brachypterous, flightless; body smooth, weakly shiny, with scant short pubescence. Eyes extending anteriorly to fastigium and dorsad of interocular area, very globose, bulging; ocelli not evident; fastigium not attaining apices of antennal scrobes; face very oblique; maxillary palpi 5-segmented; labial palpi 3-segmented; antennae long, delicate; head tapering posterior to eyes, with narrowed occipital portion shaped for reception in pronotum.

Pronotum oblong rectangular, mainly parallel sided, lateral lobes with very small bulge above front coxae, short transverse sulcus in front of bulge, median area not cut; sterna without spines; front coxa with conspicuous spine; 1st truncal spiracle on proepimeron, acoustic spiracle not clearly evident, apparently partly covered by proepimeron; tegmina not covered by pronotum, very reduced, closely appressed to body (0.7 mm long in gressitti); hind wings not evident. Front femur with 2 simple, unpaired, inconspicuous, well-separated spines in middle 3rd of ventral margin; front tibia with 4 spaced movable spines along ventro-anterior margin, a flattened oval tympanal area on each side near base, that of anterior surface well developed and apparently functional, posterior 1 narrow and rudimentary in appearance. Mid- and hind femora unarmed ventrally, latter swollen in basal half, uniformly slender in apical half; hind tibia with about 25 short serrationlike spines on each dorsal margin, 2 pairs of short, sturdy apical spurs; all tarsi with regularly spaced fine setae of moderate length, especially ventrally.

Male abdomen with posterior margin of last tergum (10) deeply divided; subgenital plate bearing distinct styli; cerci elongate.

Female unknown.

Type of genus: *Phlugiola gressitti* Chopard, 1969.

A Specimen of Uncertain Generic Placement from the Philippine Islands

A single Philippine female specimen resembling but apparently distinct generically from *Phlugiola* is of considerable interest, and its characters are noted here as a possible aid to the eventual recognition of

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Fig. 4. *Lucienola gressitti* (Chopard), male. Lateral view of head and thorax. *te*—tegmen (front wing).

an associated male: Mt. Lobi, Dagami, Leyte, P. I. VIII-4-1945, E. R. Helwig (A. N. S. P.).

Head as in *Phlugiola*; front tibia with 1 pair tiny apical spurs, a large open tympanum on each side near base; front femur with 4 ventro-anterior spines, 1 ventro-posterior spine; middle tibia with 1 pair short ventral spines a little distad of middle, 1 pair tiny apical spurs; hind tibia with 2 pairs apical spurs. Prosternum unarmed; pronotum more elongate, less oval when seen from above than in female of *Phlugiola*; tegmina simple, unveined, fully visible, reaching onto tergum 2; acoustic spiracle on epimeron, but very small and more ventral than in *Phlugiola*. Cerci very long and slender, about half length of ovipositor; latter much swollen in basal third and similar to *Phlugiola*.

Measurements: Listed following description of *Phlugiola redtenbacheri* male.

The eventual discovery of an associated male will doubtless supply characters helpful to the generic placement of the foregoing female.

NOTES ON SUBFAMILY PLACEMENT OF PHLUGIOLA

Prior to Karny (1924), *Phlugiola* was placed in the Listroscelinae, but the latter author broadened the Meconeminae (correctly Meconematinae, following Ragge, 1965:284) and included *Phlugiola* and various other genera formerly in the Listroscelinae. I have nothing to add to Karny's remarks on relationship or to those of Cohn (1957: 2–3). It may be noted, however, that the Japanese genus *Cecidophaga* Karny, 1921 is preoccupied in Lepidoptera (Gelechiidae) by *Cecidophaga* Walsingham, 1911, and Uvarov (1939) proposed the replacement name *Cecidophagula*.

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NOTES ON THE GENUS LYGISTORRHINA SKUSE WITH THE DESCRIPTION OF THE FIRST NEARCTIC SPECIES (DIPTERA: MYCETOPHILOIDEA)

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ABSTRACT—A new species of *Lygistorrhina* Skuse (Diptera: Mycetophiloidea), **sanctaecatharinae**, is described from southeastern United States. The genus is redescribed; its placement within the Mycetophiloidea is discussed; and it is considered to represent a separate family.

Fungus gnats of the genus *Lygistorrhina* Skuse are extremely rare in insect collections and are known from only a few localities (map 1). Lygistorrhine gnats differ rather strikingly from other fungus gnats because of their greatly elongate mouthparts and reduced wing venation. The apparent scarcity of these flies coupled with their peculiar structure has led to much uncertainty and controversy about their classification. Recently I was able to collect for the first time a large number of specimens of *Lygistorrhina* from southeastern Georgia and have taken this opportunity not only to describe a new species of *Lygistorrhina* but to attempt to elucidate some of the points of uncertainty about lygistorrhine fungus gnats.

Lygistorrhine fungus gnats have previously been considered to belong to a single genus, *Lygistorrhina* Skuse. *Lygistorrhina* has usually been recognized as representing a separate entity in the higher classification of fungus gnats, either a subfamily or a family.[2] Only Tuomikoski (1966) has combined lygistorrhine fungus gnats with another group and his work is discussed below. Matile (*in litt.*) is currently revising the lygistorrhine gnats of the world and is planning to divide these gnats into about 7 genera (2 based on new species). Thus, I have restricted my work to a review of the previously published literature of *Lygistorrhina* in order to place the description of my new species in proper perspective.

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[2] The use of either subfamilial or familial category for *Lygistorrhina* Skuse is dependent on whether one considers the fungus gnats as a whole to represent a family (Edwards, 1925; Tonnoir, 1929; Okada, 1937; Shaw and Shaw, 1951; Laffoon, 1965) or a superfamily (Brauns, 1954a, 1954b; Hennig, 1948, 1954, 1966, 1968, 1969; Matile, *in litt.*; Stackelberg, 1969; Rohdendorf, 1964). The question of the proper category for fungus gnats is dependent largely on one's taxonomic philosophy and, thus, is outside the scope of the present paper.

Genus *Lygistorrhina* Skuse

Lygistorrhina Skuse, 1890:598, pl. 19, figs. 1 (wing), 2 (head). Type-species, *insignis* Skuse by monotypy. Subsequent references: Edwards, 1912:203 (discussed differences between *Probolaeus* and *Lygistorrhina* and synonymized the former under the latter); Senior-White, 1922:197 (discussed generic limits of *Lygistorrhina*, broadened them to include his new species, *asiatica*); Edwards, 1925:530 (proposed a new subfamily for *Lygistorrhina*; discussed its relationships and distribution); Tonnoir, 1929:590 (key reference, general notes); Okada, 1937:46 (description, synonymy; discussion of relationships); Lane, 1946:345 (note); Shaw & Shaw, 1951:16 (as *Lygistorhina*, misspelling; note on relationships); Johannsen, 1909:62, pl. 1, fig. 23 (head), pl. 4, fig. 18 (wing) (description, distribution); Hennig, 1954:309 (discussed phylogenetic relationships of), 1966: 50, fig. 16 (distribution); Tuomikoski, 1966:254–260 (discussed relationships, placed the genus in Keroplatidae).

Subgenus *Probolaeus* Williston, 1896:261, pl. 8, figs. 15 (wing), 15a (head), 15b (mouthparts), 15c (genitalia). Type-species, *singularis* Williston by monotypy. Subsequent reference: Johannsen, 1909:93 (description, distribution); Edwards, 1912 (synonymy of the genus under *Lygistorrhina*).

Subgenus *Palaeognoriste* Meunier, 1904:87, pl. 7, figs. 9 (habitus), 10 (genitalia), 11 (wing), 12 & 13 (antenna). Type-species, *sciariforme* Meunier by monotypy. Subsequent reference: Johannsen, 1909:61 (description, distribution); Edwards 1925:530 (synonymy).

Head: Small, rounded, frequently somewhat flattened in males, narrower than thorax; front rather narrow, about ⅕ head width at antennal bases, with sides diverging above, about ⅓ head width at anterior ocellus; face narrow, about ¼ head width; vertex slightly broader than front; ocelli 3; median ocellus small; lateral ocelli distinctly separated from lateral margins of eyes, but closer to eyes than to each other; eyes very large, pubescent, separated; mouthparts greatly elongate, about half as long as body, consisting of 5 slender parts. Antenna: With scape, pedicel, and 14 flagellomeres, with all parts cylindrical and with dorsal macrotrichia.

Thorax: Small, ovate, with very short appressed hairs; long bristles on propleuron, humerus, above wing (supra-alar), postalar callus, in front of scutellum, on scutellar margin; mesonotum strongly convex; scutellum small, with marginal row of bristles; pre-procoxal bridge incomplete; prosternum laterally expanded, only narrowly separated from proepisternum; posterior pronotum without bristles, not distinctly differentiated; separation of pronotum from propleuron incomplete; mesanepisternum large, about ⅔ as high as mesokatepisternum, without a "dorsal cleft" (Shaw, 1948b: 192, #2); anepisternal suture transverse, at level of bare propleura; mesokatepisternum completely fused to pleurotergites, with posterodorsal extension; mesoanepimeron virtually absent, reduced to a narrow internal flange at base of dorsal wing process; meron absent; pleurotergite, enlarged, keellike, with a marginal row of bristles. Legs: Elongate, slender; anterior 4 coxae large, slender, elongate, about equal in length, with 1st pair very slightly longer, with bristles on anterior edges; hind coxa short, broader, about ⅔ as long as anterior coxa, with scattered bristles; anterior 4 femora, long, slender, with a row of ventral spines; anterior 4 tibiae, long, slender, with a single apical spur and an apical and simple comb on anterior pair, with 1 or 2 apical spurs on middle

pair; tarsus long, slender, with basitarsus long and about as long or longer than rest of tarsus; hind femur slightly swollen, without ventral spines; hind tibia clubbed apically, expanded on apical ⅓ or less, with 2 apical spurs and with outer spur almost twice as long as inner spur. Wing: Short, shorter than abdomen, broad; macrotrichia restricted to C, R1, and Rs; C ending before apex of wing; Sc very short, not reaching C; R1 slightly curved anteriorly on apical ½, ending in C at middle of wing; Rs apparently arising independently at base of wing, almost straight, ending in C near wing apex; M1 and M2 separate, without bases, straight, arising from middle of wing and extending to wing margin; M3 + 4 without base, slightly curved, also arising from middle of wing and extending to wing margin; Cu arising from base of wing, curved posteriorly on apical ¼, ending at wing margin; A short, straight, extending only along basal ⅔ of Cu.

Abdomen: Slender, elongate and narrow in males, shorter and broader in females, with 7 apparent segments, with narrow insertion with thorax; female cercus simple, elongate oval; female with 2 spermathecae, male genitalia with simple stylus.

Material examined: The above generic description is based on a detailed study of L. sanctaecatharinae, previously published data, and examination of pinned material of asiatica, singularis, brasiliensis, edwardsi, urichi and pictipennis (including the types of all these species).

Distribution: The present known distribution of Lygistorrhina is given in map 1. Hennig (1966) described the distribution of Lygistorrhina as a relict pattern. However, the present data suggest a pattern resulting from inadequate collecting.

The availability of an abundance of material has allowed me to do a more detailed study of Lygistorrhina than has previously been possible. During the course of this study it has been possible to correct a few erroneous observations about lygistorrhine fungus gnats.

The absence of ocelli was 1 of the principal characters on which Williston based his new genus, Probolaeus. Later Edwards (1912) noted that this condition was restricted to males and only due to their enlarged and holoptic eyes. For this reason, Edwards synonymized Probolaeus under Lygistorrhina. However, the apparent absence of ocelli in the males of lygistorrhine fungus gnats is simply an artifact. Apparently as the specimens dry the frons and sometimes the vertex collapse, and thus the ocellar triangle is concealed between the 2 large compound eyes. In my long series of sanctaecatharinae about ½ of the males have the lateral ocelli visible in the dried condition (fig. 1, 2, 5). Why the same thing does not happen when the female specimens dry is not apparent.

The previous descriptions and discussions of the mouthparts of Lygistorrhina and its synonyms are confusing and contradictory when compared to each other. Skuse (1890) and Williston (1896) described the mouthparts of Lygistorrhina as consisting of 5 elongate filaments. Both thought the palpi were absent. Meunier (1904), Senior-White
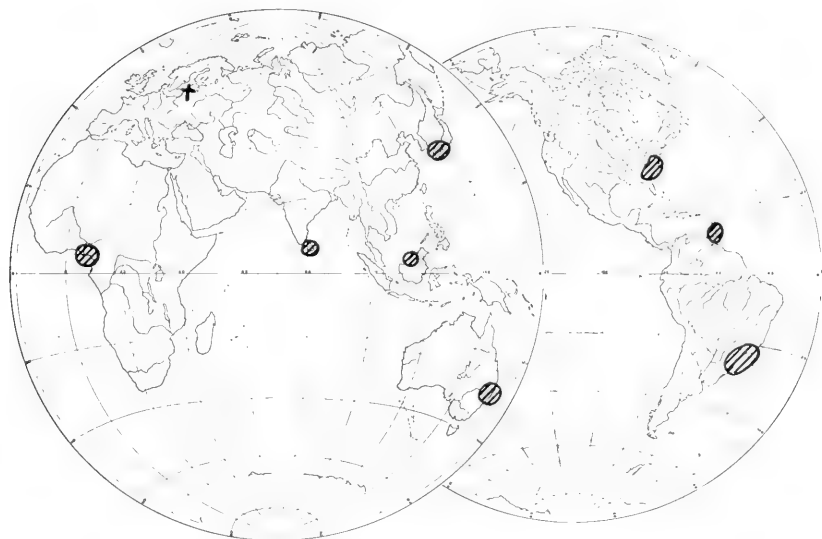
Map 1.   Distribution of *Lygistorrhina* Skuse (modified from Hennig, 1966:50, fig. 16).

(1922) and Okada (1937) all mentioned short, single-segmented palpi in addition to the elongate filaments in the descriptions of their respective new taxa.   Tuomikoski (1966) described his material of *L. brasiliensis* as having no palpi and only 4 elongate filaments, which he identified as a single, haired labrum, a pair of bare and more flexible labellae, and a single central hypopharynx.   He noted that the labrum must be bipartite in Skuse's and Williston's species.   From a detailed study of *sanctaecatharinae* and an examination of the above mentioned species (*cf.* material examined), it is apparent that the mouthparts of all known species (with the possible exception of the fossil, *sciariformis* Meunier) of *Lygistorrhina* are of the same basic structure and consist of a single small triangular labrum and 5 elongate filaments (fig. 5).   I identify these 5 filamentous parts as follows: the 2 dorsal hairy filaments as the true maxillary palpi; the 2 ventral filaments as the labella; and the single central filament as the hypopharynx

Tuomikoski (1966) made a detailed study of the phylogenetic relationships of *Lygistorrhina* and concluded that the taxon, *Lygistorrhina*, does not warrant family status (nor subfamily status in the traditional system of Edwards (1925)) but should be included in the family Keroplatidae—"In the writer's opinion, *Lygistorrhina* cannot be included in any other family than the Keroplatidae." (Tuomikoski, 1966:259).   A review of his analysis convinces me that his conclusion

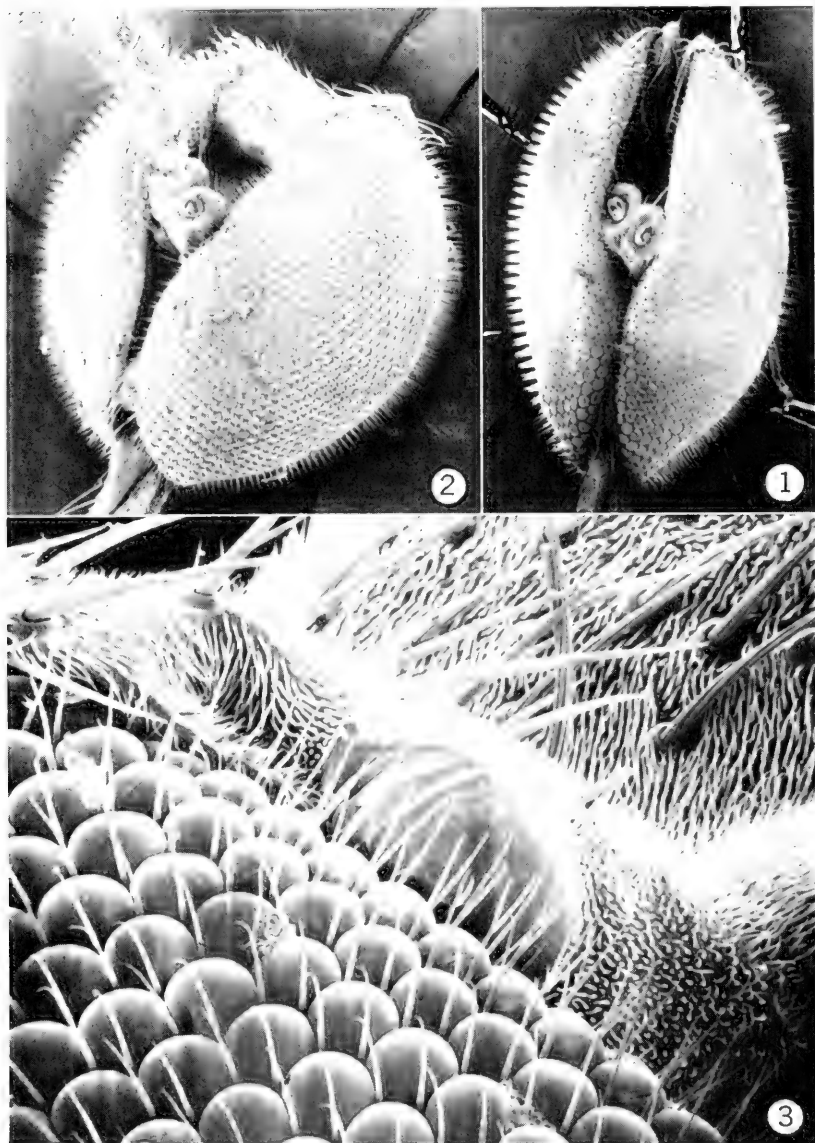Fig. 1–3.   Head of *Lygistorrhina sanctaecatharinae*, male, oblique frontal view. 1, slightly collapsed condition (90×, 5 kv). 2, completely collapsed condition (95×, 5kv). 3, enlargement of fig. 1 showing right lateral ocellus against compound eye (approximately 800×, 6 kv).

as to the relationships of *Lygistorrhina* is in error. Each of the characters discussed by Tuomikoski is reviewed in detail below and is shown to be either the result of symplesiomorphy or erroneous interpretations of the character states in *Lygistorrhina* or related taxa.

1. The presence of strong stiff macrotrichia on the flagellomeres is a plesiomorphic condition. Their absence is apomorphic. The concentration of these hairs on the dorsal surface as in *Lygistorrhina* and *Burmacrocera* (Keroplatidae) is an intermediate condition. These macrotrichia are present or absent in keroplatids as well as in mycetophilids. Therefore, their loss has probably occurred at least a few times in each family. Thus, the existence of the intermediate condition in *Lygistorrhina* and *Burmacrocera* cannot be construed as synapomorphy without other supporting evidence.

2. Some keroplatids have elongate mouthparts like *Lygistorrhina* but some genera of other families likewise have elongate mouthparts. Thus, the similarity in the length of mouthparts is irrelevant without a detailed comparison of the mouthparts of all these different genera. Unfortunately Tuomikoski did not make a detailed comparison.

3. The tibial trichiation of *Lygistorrhina* is stated to be "more like that of some 'lower' Mycetophiloidea . . ." (Tuomikoski, 1966:257) (i.e., pleisiomorphic). The fact that ". . . a similar type is also characteristic of *Macrocera* and the other 'macrocerine' genera of Keroplatidae" (Tuomikoski, 1966:257) is symplesiomorphy and not synapomorphy. After making such statements Tuomikoski then says that *L. asiatica* has the tibial setulae arranged in fairly distinct longitudinal rows, an apomorphic condition common to "many Keroplatidae and some Mycetophilidae." However, this similarity could be either synapomorphy or convergence. That *not* all keroplatids, mycetophilids nor species of *Lygistorrhina* have this specialized condition strongly suggests that its occurrence in *Lygistorrhina* and other groups is due to convergence.

4. *Lygistorrhina* has a simple fore tibial comb, consisting of a single transverse row of setulae. This is the primitive condition for all Mycetophiloidea. Thus, the fact that the macrocerine keroplatids and *Lygistorrhina* are the only groups among the "higher" fungus gnats to have retained this primitive condition is not proof of their close relationship.

5. The hind coxae of *Lygistorrhina* are "distinctly shorter than the middle coxae" (Tuomikoski, 1966:257), and this condition is also found in *Macrocera* (including *Fenderomyia*, a synonym of *Macrocera* (Coher, 1963)), a keroplatid. I consider this point only of trivial importance as a perusal of Shaw and Shaw (1951) will show that the short hind coxae are found in a few other genera in other families besides just *Macrocera*.
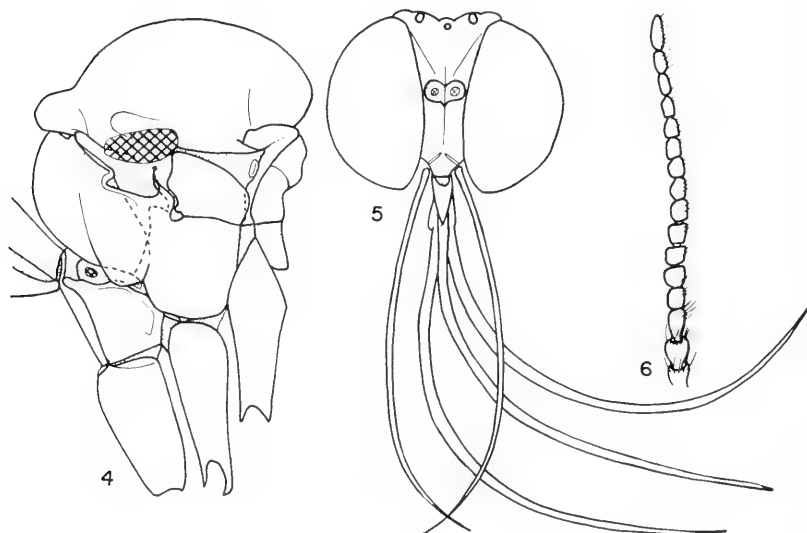
Fig. 4–6. *Lygistorrhina sanctaecatharinae.* 4, thorax, lateral view. 5, head, frontal view. 6, antenna, lateral view.

6. Lygistorrhine male genitalia are "of comparatively simple type" as found in the primitive fungus gnats and *Macrocera*. Thus, again, the similarity between *Lygistorrhina* and *Macrocera* is based only on symplesiomorphy. The fact that just 1 species of *Lygistorrhina, asiatica*, has a bifid tip to the dististyle, very similar to those of some macrocerine genera (*Macrocera* and *Paramacrocera*), indicates convergence or at most, parallelism, not recency of common ancestry.

7. Tuomikoski (1966:258) concludes his analysis with a discussion of the similarity of the thoracic pleura of *Lygistorrhina* and *Fenderomyia* Shaw (a synonym of *Macrocera*). This similarity is clearly the central point to his whole argumentation plan and had his interpretation of the structure of *Lygistorrhina* been accurate and had *Fenderomyia* actually had the peculiar pleural structure attributed to it by Shaw (1948a), then this "supposed synapomorphic" condition would have proven Tuomikoski's contentions. However, as described above, the thoracic pleura of *Lygistorrhina* is quite different from Tuomikoski's interpretation. Coher (1963:25) has shown that the peculiar structure of the thoracic pleura upon which *Fenderomyia* was based was a variable condition resulting from distortion during drying of the flies rather than that of actual structure.

The significant point in Tuomikoski's paper is that *Lygistorrhina* has the peculiar narrow insertion of the abdomen, a condition found only in the highly specialized families of fungus gnats (Keroplatidae

and Mycetophilidae). However, whether *Lygistorrhina* can be grouped with either or neither of these 2 families cannot be determined at the present due to the lack of knowledge about the phylogenetic characters and interrelationships of these groups. I feel it is best to treat *Lygistorrhina* as a separate entity (i.e., *Lygistorrhinidae*) in the higher classification of the fungus gnats as has traditionally and almost universally been done since Edwards (1925) pointed out the unique features of the genus.

Key to the Species of Lygistorrhina Skuse[3]

1. Middle tibia with 2 apical spurs; abdomen usually with basal pale colored bands (subgenus *Lygistorrhina* Skuse) 2
— Middle tibia with 1 apical spur; abdomen usually with apical pale colored bands (subgenus *Probolaeus* Williston) 5
2. Antenna yellow and black; wing with distinct brown markings 3
— Antenna black; wing without distinct brown markings, may have pale gray markings 4
3. Antenna yellow with flagellomeres 7–10 and 13–15 black (Japan) ....
.... *pictipennis* Okada (1937:45)
— Antenna yellow with flagellomeres 5–6 and 10–15 black (Borneo) ....
.... *cinciticornis* Edwards (1926:245)
4. Abdomen completely black; mouthparts short, only as long as hind femora; wing hyaline, without grayish markings (Ceylon) ....
.... *asiatica* Senior-White (1922:196)
— Abdomen with basal yellow bands on segments; mouthparts long, twice as long as hind femora; wing with grayish markings (Australia) ....
.... *insignis* Skuse (1890:600)
5. Hind femur yellow; coxa yellow; humerus and postalar callus yellow (West Indies) .... *singularis* (Williston) (1896:261)
— Hind femur dark on apical ⅗ or more; most of middle and all of hind coxae dark brown or black; mesonotum usually all dark 6
6. Abdomen completely black (females) or with only 2 or 3 complete apical yellow bands (males) (southern USA) .... *sanctaecatharinae*, new species
— Abdomen with 5 or 6 apical light colored bands 7
7. Wing with dark brown markings; abdomen with 6 apical yellow bands (Brazil) .... *cerquerai* Lane (1958:209)
— Wing hyaline, without markings; abdomen with only 5 apical yellow bands 8
8. Abdomen with narrow apical whitish bands (Brazil) ....
.... *barrettoi* Lane (1946:346)
— Abdomen with broad apical yellow bands 9
9. Middle and hind tibiae brown (Brazil) .... *edwardsi* Lane (1946:347)
— Middle tibiae yellow; hind tibia yellow on basal ⅘ 10

[3] This key is primarily based on original descriptions, although it has been checked against the types of some species as noted above under material examined. The purpose of this key is to serve as a differential diagnosis for my new species and a checklist of the described species of *Lygistorrhina*.

10. Antenna with scape and 1st 4 or 5 flagellomeres yellowish, contrasting
    with dark remainder of flagellum (Brazil)....*brasiliensis* Edwards (1932:139)
—   Antenna black (Trinidad) .... *urichi* Edwards (1912:204)

Lygistorrhina sanctaecatharinae Thompson, new species

Male: *Head* (fig. 1–2): Dark brownish black, mouthparts pale brownish
yellow except darker near tip, about as long as hind tibiae; antennae light brown,
with medial flagellomeres slightly yellowish, about twice as long as head, as
long as hind basitarsi, with verticals distinct and as long or longer than flagello-
mere.

Thorax: Dark brownish black, dull; pleuron sparsely grayish pollinose except
for large subshiny basoventral area on sternopleuron; mesonotum with 2 sub-
medial grayish pollinose vittae, with vittae broadly joined in front of scutellum,
from posterior view with these vittae appearing dark; rest of mesonotum very
sparsely grayish pollinose except densely pollinose in front of scutellum and
postalar callus and behind humerus; halter yellow; scutellum silvery pollinose,
with a single row of 6–8 marginal bristles.

Legs: Anterior 4 legs yellow except dark apical 4 tarsal segments, basal ¾
in front coxa and all of middle coxa; hind leg dark brownish black except yellow
trochanter, basal ⅔ of femur and basal ⅔ to ½ of tibia; tibial spurs single on
anterior legs, double on hind leg; inner spur of hind leg about ½ as long as outer.
Wing hyaline, microtrichose; venation as figured (fig. 10).

Abdomen: Black, with distinct apical yellow bands on only 2nd, 3rd and
usually 4th segments (both sterna and terga), with indistinct apical band on 5th
sterna and rarely with lateral apical corners of 5th tergum slightly yellowish.
Male genitalia (fig. 7–9) black; basistyle about ⅓ longer than wide; distyle
simple, about ⅔ as long as basistyle, thickened apically and ending in a short
capitate seta on upper internal angle, short pilose with 2 long setae on inner
margin; 9th tergum very large, as long as basistyle, elliptical.

Female: Quite similar to male, but differs as follows: eyes much smaller and
thus front much broader; hind femur much more extensively dark brownish, in
some specimens all brownish black; abdomen much shorter and stouter, all black
except yellow cerus, without a trace of yellow apical bands.

Measurements: [Average (range; number of specimens measured)]; overall
length, 4.86 mm (4.08–5.36; #16); 3.16 mm (2.96–3.36; #4); mouthparts, 1.70
mm (1.42–2.74; #10); wing, 2.41 mm (23.2–26.0; #11); fore femora, .75 mm
(.70–.88; #11); middle femora, .86 mm (.82–.96; #11); hind femora,
1.18 mm (1.12–1.28; #11); middle femora, .86 mm (.82–.96; #11); hind
femora, 1.18 mm (1.12–1.28; #11). Leg ratios [femora:tibiae:basitarsi:tarsi]:
front leg, 1:1.07:0.96:1.04 (#11); middle leg, 1:1.25:0.92:0.99 (#11); hind leg,
1:1.42:0.73:0.95 (#11).

Material examined: GEORGIA, Liberty County, St. Catharines Island, 24–28
April 1972, V. Picchi and F. C. Thompson, 220 ♂ ♂, 18 ♀ ♀; 18–21 September
1972, B. J. and F. C. Thompson, 9 ♂ ♂ (type-series, holotype ♂ and allotype ♀
from the April lot). In addition to the type-series I examined the following males
from U.S. National Museum: VIRGINIA, Fairfax County, Dead Run, 29 August
1915, R. C. Shannon, 1 ♂, WEST VIRGINIA, Pocahontas County, Cranberry
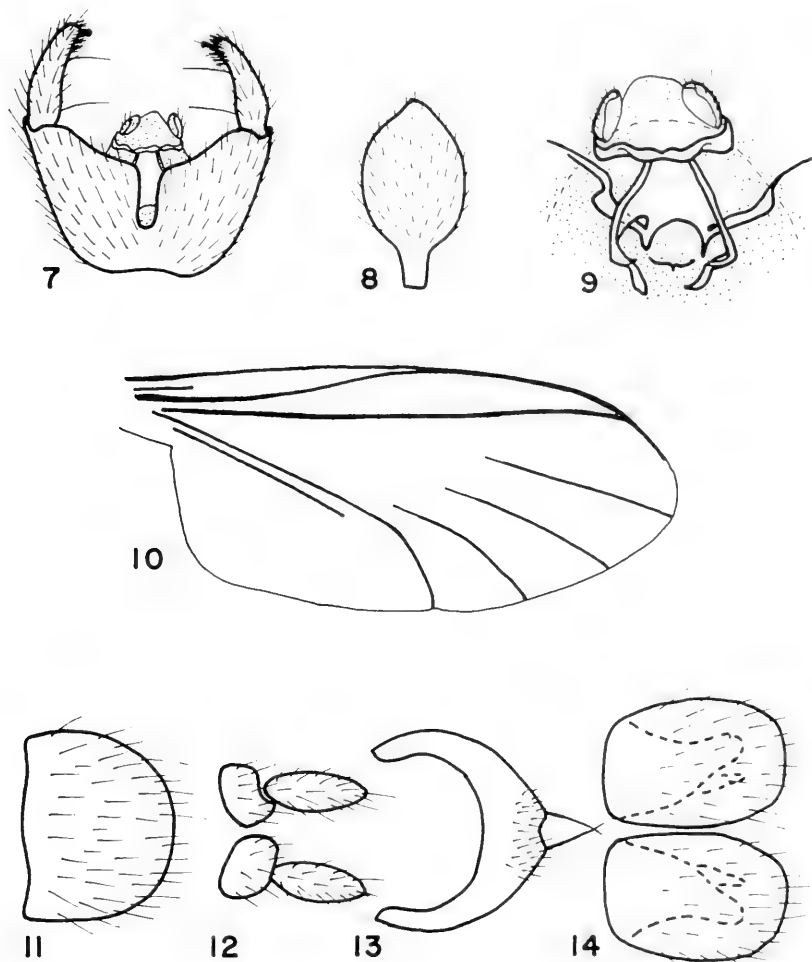
Fig. 7–10. *Lygistorrhina sanctaecatharinae*, male. 7, genitalia, ventral view. 8, 8th tergum, dorsal view. 9, enlarged view of aedeagus and cerci, ventral view. 10, wing. Fig. 11–14. *L. sanctaecatharinae*, female genitalia. 11, 8th tergum, dorsal view. 12, cerci, dorsal view. 13, 9th sternum, ventral view. 14, 8th sternum, ventral view.

Glades, 16 July 1955, W. W. Wirth, 1♂; and NORTH CAROLINA, Wake County, 16 June 1955, H. V. Weems, Jr., At *Rhus copallinum*, 1♂.

The holotype and most of the paratypes are deposited in The American Museum of Natural History. Other paratypes have been deposited in the following institutions: United States National Museum, Wash-

ington; Canadian National Collection, Ottawa; California Academy of Science, San Francisco; Museum of Comparative Zoology, Cambridge; British Museum (Natural History), London; Museu de Zoologia da Universida de São Paulo; Muséum National d'Histoire Naturelle, Paris; Natal Museum, Pietermaritzburg; Entomological Institute, Sapporo.

Discussion: The male of *Lygistorrhina sanctaecatharinae* is readily distinguished from all known *Lygistorrhina* by its reduced number of apical abdominal bands. The female of *sanctaecatharinae* with its completely black abdomen is not likely to be confused with any other known New World species. *Lygistorrhina asiatica* from Ceylon also has a completely black abdomen but can be separated by the characters given above in the key and its completely yellow coxae and hind femora. The name, *sanctaecatharinae*, is based on the type-locality of the species and is used as a noun in the genitive case. All the type-material of *sanctaecatharinae* was collected by a Malaise Fly trap.

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MALES OF THREE SPECIES OF CHEYLETUS
(ACARINA: CHEYLETIDAE)

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ABSTRACT—Clear-cut differentiating features of males of *Cheyletus* Latreille 1796 occur on the mouthparts, principally on the palpfemur, and on the stylophore of 3 species examined, viz., *C. malaccensis* Oudemans, *C. trouessarti* Oudemans and *C. cacahuamilpensis* Baker. The males were obtained from laboratory cultures of each species so that the correct matching of opposite sexes was assured.

More than 30 specific names have been applied to mites assigned to *Cheyletus* Latreille, 1796. Some of these are of dubious worth and are likely to become synonyms, or the species to which they apply are not identifiable from original descriptions. Particularly troublesome are 11 species described from males only. Our ability to recognize these is greatly hampered by the generalities presented and by the failure of the describers to pinpoint their distinguishing features.

There is perhaps no impelling reason for anyone to be obliged to identify species from males only. However, the describers of new cheyletids should be aware that the eye-catching features of the males are probably not their distinctive characters. Some samples collected in nature do provide reasonably assured associations of opposite sexes. In such cases, the taxonomically useful features of the males may give confirming information about the identity of their female counterparts.

There is an important taxonomic problem which concerns males of many genera in the family. Our ability to distinguish some 50 genera within the family Cheyletidae depends heavily upon secondary sex characters, such as the ornate or bizarre types of setae displayed only by females. Casual males therefore introduce the knotty problem of identification to genus.

In an effort to overcome some of the shortcomings of existing descriptions of males of *Cheyletus*, the writer made a comparative study of males of 3 species reared in laboratory stock cultures. Although 5 species of *Cheyletus* have been cultivated successfully in this laboratory, 2 of these, *C. eruditus* (Schrank) and *C. aversor* Rohdendorf, failed to produce males (Summers, Witt and Regev, 1972). Males of *C. eruditus* have been described from Europe (Oudemans, 1906; Hughes, 1961) but male-producing strains of this classical species have not been found in the United States (see also Beer and Bailey, 1956). Males of *C. aversor* have not been observed. The males of the 3 species dealt with here are: *C. malaccensis* Oudemans, *C. trouessarti* Oudemans and *C. cacahuamilpensis* Baker. The accounts of males of the first 2 species are redescriptions; the third is an original description.

Cheyletus malaccensis Oudemans
Fig. 1–6

Cheletes malaccensis Oudemans, 1903b, Entomol. Ber. Nederl. Ver. 1(12):84; 1906, Mem. Soc. Zool. Fr. 19:88–96.

Dorsal and ventral plating feebly sclerotized, individual plates faintly outlined, inornate. Anterior margin of prosternal plate eroded, with several crossrows of skeletal fragments; posterior margin irregularly convex; this plate bears anterior intercoxal setae. Dorsolateral body setae narrow, with flat or slightly rolled blades, margins almost parallel, fringed with numerous delicate barbs; tips bluntly rounded; few barbs on hyaline portion of blades (fig. 10, left). Humeral setae acicular, flagelliform, smooth or almost so, longer than all other setae of body proper. Dorsomedian setae resemble dorsolaterals but somewhat smaller; 2 pairs on propodosoma, 1 pair on hysterosoma. Tarsal solenidion wI fusiform, approximately ⅓ as long as body of tarsus (fig. 4). Guard seta very slender, acicular, inconspicuous, approximately ½ length of wI. Overall length of gnathosoma (heteromorph) equals or slightly exceeds length of idiosoma. Outer comb of palptarsus averages 15.2 ± 1.0 tines; inner comb averages 11.9 ± 1.2 tines. One cusplike apophysis on inner base of palptibial claw (fig. 2), this may be partly divided or, in rare specimens, a barely elevated prominence. Palpfemur of heteromorphs approximately $4\times$ longer than least diameter, slightly tapered to distal end, gently bowed inward near its anterior ⅓, mesal surface wrinkled or with numerous transverse furrows over ½ its length (fig. 3), otherwise without projecting spines or other noteworthy apophyses. Dorsal seta of palpfemur flagelliform, averages 105.4 ± 8.6 μ long, sparsely barbed. Protegmen (i.e., stylet-bearing portion of fused chelicerae) conelike, its expanded basal part armed with numerous knoblike tubercles of near uniform size, these disposed in 5–7 longitudinal rows, the outer rows diverging to invade lateral horns of rostrum; tubercles of some specimens irregularly arranged or randomly scattered. Peritremes merge near midline, somewhat below dorsal surface of tegmen; they diverge rearward, each comes to lie in sidewall of stylophore; pair of skeletal lobules project mesad to cover 1st few segments of each peritreme; tegmenal surface depressed to form trough between overhanging lobules. Uppermost surface of tegmen decorated with numerous, thin, longitudinal ridges or striae, some of which bifurcate; striae break up and disappear rearward amid scarifications of integument where fibers of stylet protractor muscles implant. Rostrum with pair of anteriorly projecting apophyses or "horns" which may be obtusely pointed, rounded or rectangular in outline (fig. 3). Conical portion of protegmen (believed to be spinae, or fixed digits of chelicerae) projects beyond tip of rostrum by approximately 20% of its length.

Average length measurements in microns (n = 20):

Gnathosoma, ventral rim to rostral apex	247.4 ± 11.4
Tarsus I, pedicel and apotele excluded	119.2 ± 6.0
Solenidion wI	35.2 ± 3.1
Dorsal seta on palpfemur	105.4 ± 8.6
Sensillum tc' (mesal seta on knob of tarsus I)	142.0 ± 9.0
Macroseta of tibia IV	139.3 ± 13.7
Vertical seta	61.4 ± 4.3

The eye-catching features of the males of *C. malaccensis* are not unique features. The gnathosoma of the common male form, the heteromorph, appears to be grotesque because the very long palp-femur carries the claw and tarsal sensilla far in front of the rostral apex. A pair of substantial apophyses project forward from the sides of the rostrum, somewhat like blunt horns. According to Oudemans (1906) this pair of hornlike projections occurs on the males of several other species in this genus. Tarsal solenidion wI is short, fusiform and accompanied by a minute guard seta. A favorable orientation of slide-mounted specimens is usually required to display this seta.

The tegmenal portion of the stylophore has what may prove to be the diagnostic characters. The peritremes originate at a low point on the inclined face of the stylophore and then each peritreme curves laterally beneath thickened folds of skeleton. Each fold bears a small mesad projection, or lobule, which overhangs the depressed median trough of the tegmen. Thin decorative ridges originate within the trough as well as behind the thickened skeletal folds which border the anterolateral angles of the tegmen. The surface ridges are plain, i.e., bear no tubercles or varicosities.

The several measurements given above were selected as those least apt to be distorted in mounted specimens.

Cheyletus trouessarti Oudemans
Fig. 7–9

Cheyletus trouessarti Oudemans, 1903a, Tijdschr. Nederl. Dierk. Ver. (Ser. 2) 8:16.   *Cheletes trouessarti* Ouds., 1903c, Tijdschr. Entomol. 46:129–132; 1906, Mem. Soc. Zool. Fr. 19:88.

Integument of idiosoma very faintly sclerotized, plates dimly outlined, with no noteworthy ornamentation other than areas of muscle attachment. Prosternal plate present, its anterior and posterior margins jagged; this plate carries anterior inter-coxal setae. Dorsolateral setae flattened, slender, gradually widening from pin-point anchorage to rounded or bluntly pointed tip; margins fringed with numerous fine barbs; midsection of largest setae may show 1–2 weakly developed, barbed ribs (fig. 10, middle). Humeral setae similar to nearby dorsal setae in form and dimensions, definitely not flagelliform. Dorsomedian setae resemble other adjacent dorsals except smaller; 1 pair on propodosoma, 1 pair on hysterosoma. Tarsal solenidion wI relatively long, spindlelike, slightly less than ½ as long as body of tarsus (fig. 8). Guard seta very slender, approximately ½ as long as wI. Gnatho-somal skeleton perceptibly tanned, its overall length approximately equal to length
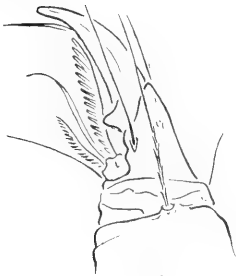
←

Fig. 1–4.   *Cheyletus malaccensis*, gnathosoma and tarsal structures of males. 1, gnathosoma, homomorph. 2, tip of right pedipalp, heteromorph. 3, gnathosoma, heteromorph. 4, tarsus I, right. Linear scales are drawn close beside figures to which they apply; scales represent 0.1 mm on this and other illustrations.
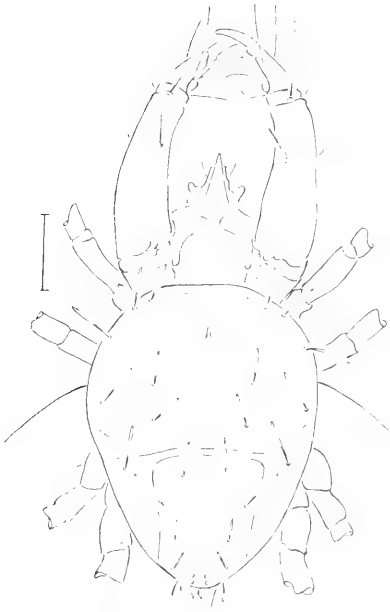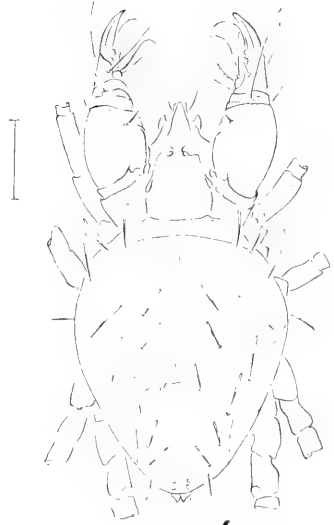
5   6   9   8   7

of idiosoma. Outer comb of palptarsus averages 14.3 ± 1.3 tines; inner comb averages 13.0 ± 1.2 tines. Number of cusps on base of palptibial claw (fig. 9) ranges from 0–3, with highest frequencies of 1 to 2 in that order. Palpfemur projects almost straight forward, without excrescences or mesal wrinkles (fig. 7); several slightly raised ridges disrupt smooth outline of its lateral face, these markings associated with areas of muscle attachment. Mesal wall of palpfemur shows pronounced thickening and a sharp bend towards center line close to mesal articulation with basis capituli (or indrawn trochanter). Dorsal seta on palp-femur acicular, sparsely barbed, 60.8 ± 6.6 μ long. Protegmen bears an inclined girdlet of rounded tubercles immediately anterior to lateral arms of peritremes; uppermost perimeter of girdlet comprises a crossrow of 6–7 tubercles; a few additional tubercles adorn protegmen near base of its smooth-surfaced, conical projection which ensheaths cheliceral styli. Surface of tegmen lies principally in 1 plane, with no central trough or elevated lappets; its general surface distinctly ornamented; a few very lightly raised, longitudinal ridges are fashioned into a netlike pattern close behind lateral arms of peritremes; most specimens have pebbly varicosities disposed at irregular intervals on net-work; surface ridges and varicosities disappear within sculptured pattern of muscle attachments on posterior ½ of tegmen. Rostrum tapers to a truncate apex, its basal area bears pair of bluntly rounded, anteriorly directed apophyses; apophyses variable in outline, with 0–4 raised tubercles like those of protegmen. Apex of protegmen projects beyond truncated tip of rostrum by not more than 10% of its length (on com-pressed, mounted specimens).

Average length measurements in microns (n = 20):

Gnathosoma	166.4 ± 12.9
Tarsus, pedicel and apotele excluded	79.6 ± 4.8
Solenidion ωI	30.0 ± 4.6
Dorsal seta on palpfemur	65.3 ± 6.4
Sensillum tc'	94.0 ± 8.9
Macroseta of tibia IV	66.5 ± 6.6
Vertical seta	36.1 ± 3.5

The features of *C. trouessarti* which are believed to be most useful for recognizing the species are (1) the occurrence of pebblelike vari-cosities on the meshwork of ridges on the tegmen close behind the peritremes and (2) the thickened mesal wall of the palpfemur in cleared specimens.

Other helpful but not unique characters are as follows: (1) 1 pair of dorsomedian seta on propodosoma; (2) lateral apophyseal processes on the rostrum; (3) small number and near equality in numbers of tines on both comblike seta; (4) the relatively small size of the species as reflected in lengths of the several parts measured; (5) com-

←

Fig. 5–6. *Cheyletus malaccensis*, general appearance of males. 5, heteromorph. 6, homomorph. Fig. 7–9. *C. trouessarti*. 7, gnathosoma. 8, tarsus I. 9, tip of pedipalp.

paratively narrow, spatulate dorsal seta which are not classifiable as acicular in structure.

The character of 3 basal cusps on the base of the palptibial claw which occurs in more than 80% of the females of this species does not appear often in the male line ($f = 2$ in 20).

<center>Cheyletus cacahuamilpensis Baker</center>
<center>Fig. 11–13</center>

Cheyletus cacahuamilpensis Baker, 1949, Proc. U.S. Nat. Mus. 90(3238):282 (female).

Platings of idiosoma faintly roughened, with pebbly textured surface; dorsal plates clearly delineated; intercoxal plating absent in sternal area, individual setae of 2 pairs of sternal intercoxals borne on discrete, tiny platelets. Anterior margin of propodosomal plate slightly excavate or concave rearward, and eroded so that several cross stripes of skeletal fragments partly filled this excavation. First pair of dorsolateral hysterosomal setae originate on discrete platelets clearly separated from principal median plate on hysterosoma. Dorsal setae of idiosoma (fig. 10, right), humeral setae and some on leg segments spatulate, with rounded ends, upper surface with 2–4 barbed ribs; relatively straight sides diverge from basal granule to describe angle of approximately 30°. Dorsomedian setae similar to nearest dorsolaterals but appreciably smaller; 1 pair on propodosoma, 1 pair on hysterosoma. Tarsal solenidion wI relatively long, slender, gently tapered from base to blunt tip (fig. 13). Guard seta flagelliform, sparsely barbed, slightly longer than wI, average length 60.0 ± 4.7. Inner comb of palptarsus averages 22.3 ± 1.9 tines; outer comb averages 17.3 ± 1.2 tines. Palptibial claw normally bears 1 basal tooth (fig. 11). Palpfemur robust, approximate length to width ratio $= 1.6:1$; lateral face evenly convex and marked with several slightly raised ridges which border roughened areas of muscle origin; mesal face almost straight, its somewhat thickened wall armed with a localized cluster of 16–26 denticles, the latter having apices tilted forward (fig. 12). Dorsal seta of palpfemur spatulate, approximately equal to 1st dorsolateral propodosomal seta (i.e., vertical) in form and size. Protegmen without tubercles, its anteriorly projecting cone (fixed digits or spinae) not overreaching rostral tip. Tegmenal surface faintly etched on its anterior ½ with broken striae which may or may not show a reticulate pattern; anterolateral corners of tegmenal skeleton extend forward to form pair of prominent, pointed processes which cover part of peritremes just over their acute rearward flexures. A fairly symmetrical pattern of muscle attachments restricted to posterior ½ of tegmen, this general area not invaded by striae or surface ridging. Rostrum shaped as illustrated (fig. 12), smooth in profile, without lateral apophyses or surface tubercles.

→

Fig. 10.   First dorsolateral hysterosomal setae of males of 3 species, to same magnification, C. malaccensis, C. trouessarti and C. cacahuamilpensis, left to right respectively. Fig. 11–13. C. cacahuamilpensis. 11, tip of pedipalp. 12, gnathosoma. 13, tarsus I.
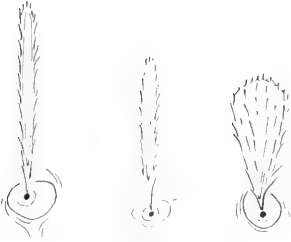
10

11

13

12

Average length measurements in microns (n = 17):

Gnathosoma	199.8 ± 7.0
Tarsus, pedicel and apotele excluded	100.9 ± 3.6
Solenidion wI	48.3 ± 3.6
Dorsal seta on palpfemur	42.9 ± 3.7
Sensillum tc′	90.8 ± 4.9
Macroseta of tibia IV	a spatulate seta
Vertical seta	42.2 ± 2.8

Two conspicuous features are probably distinctive. One is the anterior projections of the tegmen which cover portions of the peritremes. The other is the patch of thornlike denticles on the mesal aspect of the femur.

Other features helpful for recognizing this species are as follows: (1) absence of apophyses on the sides of the rostrum; (2) absence of small, rounded tubercles on any part of the stylophore; (3) the almost scooplike dorsal and humeral setae; (4) no flagelliform macroseta on tibia IV.

This is an original description of the male. Allotype and paratypes deposited in the Entomology Museum, University of California, Davis.

DISCUSSION

Whereas differences between these 3 species show principally in gnathosomal organization, the idiosomal and leg structures appear to be similar in most respects. The writer has been unable to distinguish these males in respect to body shape, dorsal plates or genitalia. Considerable importance attaches to the structure of dorsal body setae. Also the number of dorsomedians on the propodosomal plate is useful for separating species: *C. malaccensis* has 2 pairs of dorsomedians on the propodosomal plate; *C. trouessarti* and *C. cacahuamilpensis* have only 1 pair on this plate. It is noteworthy that females of *C. malaccensis* normally have no dorsomedian setae. Also of taxonomic interest is the fact that the first dorsolateral hysterosomal setae of the 3 species are set on separate platelets independent of the large median hysterosomal plate; among females of these 3 species, only *C. cacahuamilpensis* has the first dorsolateral hysterosomal setae set on the principal median plate.

Tarsus I displays significant quantitative differences between species, especially as to relative length of solenidion wI and its associated guard seta. The numbers of setae on the podomeres of legs I–IV are the same for all of the species described here: femora 2-2-2-1, genua 3-2-2-2, tibia 6-4-4-4, tarsi 9-8-7-7 (guard seta not included).

Each of the 3 species dealt with here produce both heteromorphic and homomorphic males. The latter represent a small fraction of the total males in the populations sampled. Homomorphs differ from

heteromorphs principally in the length and girth of the femora of the pedipalps (cf., fig. 1, 3 and 5, 6). Possibly also the dimensions of some of their other parts may be slightly smaller. The differences between the 2 kinds of males are not noticeable when extreme types are compared but heteromorphism of this sort appears to be quantitative and the intergrades are troublesome to classify. The few homomorphs of C. trouessarti which have been picked out of cultures show incipient lateral projections on the rostrum, no tubercles on the stylophore and 3 basal teeth on the palptibial claw. In other words, they so much resemble females that probably some escape notice when samples are scanned.

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TWO NEW NEOTROPICAL STENOLEMUS (REDUVIIDAE: EMESINAE)

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ABSTRACT—*Stenolemus* **pilosus** and *Stenolemus* **haitianus** are described from Bolivia and Haiti respectively. The latter record extends the range of the genus into the Antilles.

Thanks to the courtesy of Dr. Pedro Wygodzinsky, of the American Museum of Natural History (AMNH) at New York City, N. Y., I received for study several specimens of *Stenolemus* among which there was the first new species described below. Dr. Thomas H. Farr of the Institute of Jamaica, sent me the new species from Haiti also described below.

The type-specimens are deposited in AMNH and at the Institute of Jamaica, Kingston, Jamaica, as detailed below. In the measurements that follow 26 micrometer units are equivalent to 1.0 mm.

Stenolemus pilosus Maldonado Capriles, new species

Male: Overall color brownish, conspicuously ornamented with ivory-white or pale straw-color. Head with anterior lobe ventrally, posterior lobe laterally, interocular and dorsal depression, median suture of anterior lobe brownish, remaining parts ivory-white. Eyes reddish-brown. Antennae: First segment with 2 median and 1 subapical long brown annuli; 2nd segment with 4 annuli, the subapical the longest, other 3 of same length; 3rd and 4th segment brownish, yellowish apically. Beak pale straw-colored, base of 2nd segment brownish; 3rd pale brownish, darkening towards apex. Anterior lobe of pronotum broadly ivory-white along median line; with main lateral sulcus ivory-white, remaining lateral portions brownish; ventrally pale straw-colored; peduncle ivory-white dorsally, brownish laterally, and straw-colored ventrally; posterior lobe dorsally with median and lateral carina ivory-white, remaining portions brownish, laterally brown, straw-colored below; spines straw-colored. Mesopleura shiny brown. Forelegs: Coxa with a post-basal and anteapical broad brownish bands; femur and tibia with 4 brown bands, more or less equidistant; tarsi darkening toward apex; longer spines of armature with black tip, shorter spines brown and with light bases; spines of tibia brown. Meso- and metacoxa irregularly spotted with brown. Meso- and metafemur each with 5 brownish annuli; intervening light portions slightly longer than annuli. Basal ½ of meso- and metatibia with 2 short brown annuli. Meso- and metascutellum brown, spine, and apical margin pale straw-colored. Abdomen ventrally light-brown, irregularly variegated with brown; lateral and posterior margin near median line of each sternum and spinelike projections on posterior margin near median line straw-colored. Long fine pilose on legs and body, hairs concolorous with area of emergence. Forewing with claval and subclaval areas whitish, remaining parts brownish with veins and false veins whitish, as in fig. 1; large discal cell with a median orange-brown calloused area; extensive whitish area on apical cell.

Head as long as wide (28:28), with 2 short dorsal spines on posterior lobe, sulcus deep; interocular space 1½× as wide as width of eye (12:8). Antennal segments 60:44:12:12; 1st segment very long pilose dorsally and laterally, other segments short pilose. Pronotum with well-defined peduncle; peduncle slightly shorter than length of anterior lobe (12:14); width of anterior lobe 15; posterior lobe gradually widening from base to apex, length 22, posterior width 30, posterior margin deeply concave; all 4 spines relatively short (fig. 2 and 3). Spine of mesoscutellum long, slightly inclined backward, sharp; spine of metascutellum vertical, apex rounded. Posteroventral series of forefemur; 1st spine with large base, curved toward apex of segment, with small apical black spine; 12 more spines, large, medium, and small in no particular order, all with large base and with nearly straight apical spine; the 3rd or 4th as large as the 1st, the others smaller. Abdominal sterna 3–5 with 1 + 1 short, sharp spines on posterior margin. Margin of connexivum straight, unspined; spiracles on midlength of margin of each segment. Last abdominal tergum with hind margin oval. Genital segments as in fig. 4; hind margin of hypopygium with a wide flat projection shallowly angularly notched at tip. Length 8.00 mm.

Holotype male, in the AMNH, from Santa Cruz de la Sierra, Bolivia, 26 April 1958, Pinkerton collector. Paratypes: 5 males, 1 in the author's collection, 4 in the AMNH. This species runs to S. *decarloi* in Wygodzinsky's (1966) key. Their forewings are differently colored.

They can be separated as follows:

Margin of connexivum straight; forefemur with spiniferous spines diminishing in size .... *pilosus* Maldonado Capriles

Margin of connexivum produced on segments 4 and 5; spiniferous spines of about the same length .... *decarloi* Wygodzinsky

Stenolemus haitianus Maldonado Capriles, new species

Head pale straw-colored; apex of post-ocular process yellow-white; 1st antennal segment yellow-white, with short pilosity arising from small pale-brown spots, 2nd yellow-white basally darkening to blackish-brown apically, 3rd brownish, 4th straw-colored; beak straw-colored. Pronotum: Yellow-white; anterior lobe straw-colored above on each side of median line, posterior lobe with apex of humeral spine yellow. Forelegs yellow-white; tibia with a preapical brown annulus. Long spines of femur black-tipped. Midleg: Coxa yellow; femur very light brown, with 5 inconspicuous whitish annuli; tibia and tarsi brownish. Hind coxa yellow-white ventrally, remaining areas grayish; femur as in midleg, the annuli more conspicuous basally; tibia blackish-brown basally fading to brown toward apex; tarsi brown. Forewings with cells of basal ½ mostly black, other cells brownish, veins white, a broad transverse white fascia at apex of 2nd discal cell, fig. 5. Hind wing dark-gray with ivory veins. Abdomen: First segment yellowish, 2–5 segments shiny blackish; last 2 brown basally, yellowish apically; genital capsule brownish; connexival margin ivory-white; lateroventrally on sterna 2–5 with an ivory-colored line that includes the 4 small ventral projections. Densely pilose; body and femora covered with short pilosity, pilosity not much longer than diameter of segment; pilosity on tibia shorter.
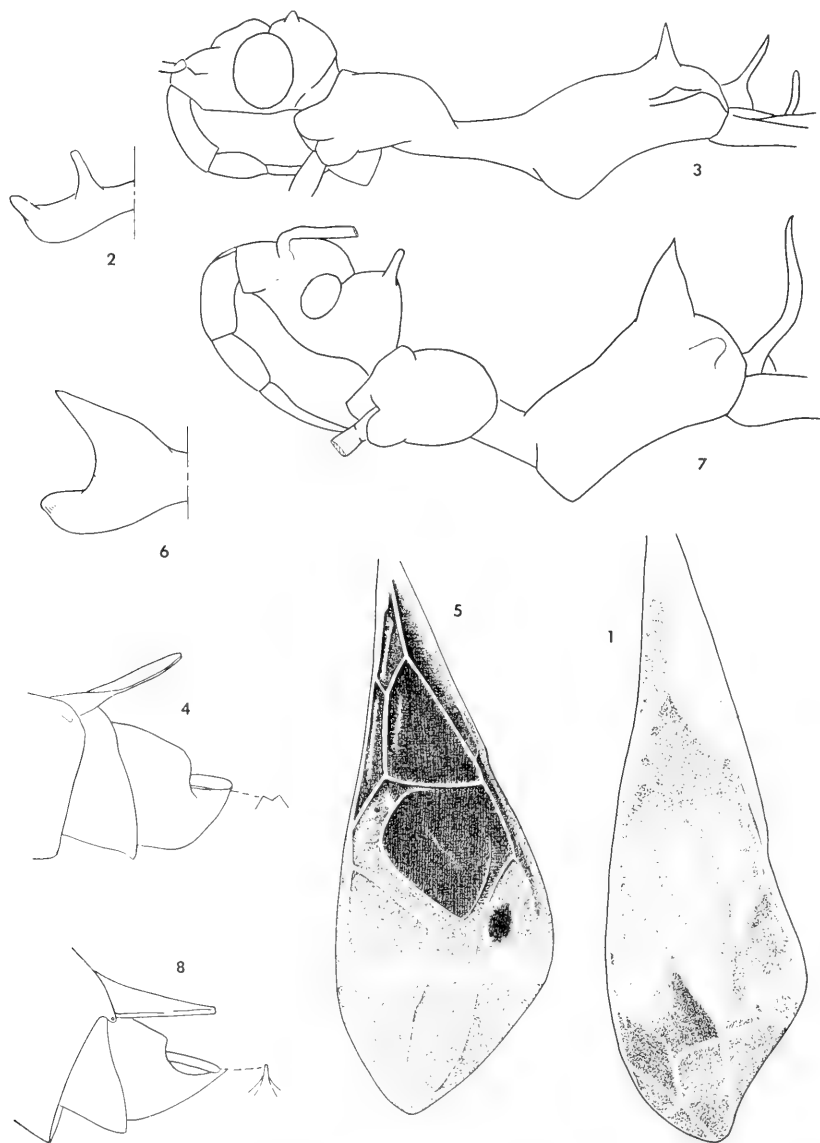
Fig. 1–4. *Stenolemus pilosus*, n. sp. 1, forewing. 2, spines of posterior lobe, caudal. 3, head and pronotum, lateral. 4, hypopygium, lateral. Fig. 5–8. *Stenolemus haitianus* n. sp. 5, forewing. 6, spines of posterior lobe, caudal. 7, head and pronotum, lateral. 8, hypopygium, lateral.

Head 1.5× as long as wide (31:23), with 1 + 1 horns behind eyes, as in fig. 6; interocular space nearly 2× as wide as eyes (11:6); eyes not attaining level of dorsal and ventral surface of head. Antennal segments: 82:76:12:22; very short pilose. Pronotum with peduncle much shorter than anterior lobe (4:15); anterior lobe wider than long (21.5:15); posterior lobe: median length 25, posterior width 40, with 1 + 1 heavy discal projections, humeral angle with blunt short projection, as in fig. 6 and 7. Scutellar spines long, curved and slender. Forelegs with coxa as long as peduncle and anterior lobe of pronotum together; femur slightly shorter than 1st antennal segment; armature of posteroventral series consisting of vertical spines slightly shorter than cross-section of segment, alternating with shorter spines to midlength, thence spines shorter and inclined toward apex; the inner series consisting of short spines, again alternating with still shorter spines, and getting gradually shorter toward apex; individual spines consisting of a vertical base and a black spine inserted apically. The foretibia with 2 rows of uniform short black spines. Abdomen ventrally with 4 pairs of short spines; apical angle of each connexival segment not produced. Hypopygium as in fig. 8; apical margin of hypopygium produced into a sharp point. Length 9.5 mm.

Holotype male, Haiti, Farcy, 16 May 1959, M. W. Sanderson, and T. H. Farr collectors; in the collection of the Institute of Jamaica.

Because the submedian projections of the posterior lobe of the pronotum are quite large, very much larger than the humeral processes, *haitianus* is close to *mirabilis*. However, the different coloration of the forewing, the peduncle shorter than the anterior lobe, and the 2 short horns behind the eyes separate *haitianus* from *mirabilis*. Another species with large submedian spines on the pronotum is S. *anduzei* but it lacks processes on abdominal sterna and the forewing is differently colored.

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MEGASENNIUS, A NEW GENUS FOR ACANTHOSCELIDES MURICATUS (SHARP) (COLEOPTERA: BRUCHIDAE), A SEED PREDATOR OF CASSIA GRANDIS L. (CAESALPINIACEAE) IN CENTRAL AMERICA

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ABSTRACT—**Megasennius** is described as a new genus for *Acanthoscelides muricatus* (Sharp), a Central American species probably related to *Sennius*. Both *Sennius* and *Megasennius* develop as larvae in seeds of *Cassia*, but *Megasennius* is restricted to *Cassia s. str.*, whereas *Sennius* larvae develop exclusively in other subgenera. Other bruchids restricted to *Cassia s. str.* are 2 species of *Pygiopachymerus* and 1 of *Zabrotes*. *Megasennius muricatus* is probably similar to these species in having a wide geographic range in tropical America, and its larvae probably attack seeds of all species of *Cassia s. str.* *Megasennius* and *Pygiopachymerus* are similar in 2 peculiar morphological features that distinguish them from their respective closest relatives. These features are probably related to special adaptations either for predation of seeds of *Cassia s. str.* or for emergence through the thick pod walls.

Johnson and Kingsolver (1973) stated that *Sennius* can be separated reliably from *Acanthoscelides* only by the hinge sclerites characteristic of the male genitalia. We recently discovered that a species heretofore placed in *Acanthoscelides* also has hinge sclerites, though of different form than in *Sennius*. *Acanthoscelides muricatus* (Sharp) is here placed in a monobasic new genus, *Megasennius*, distinguished from *Sennius* by the following characteristics: postocular lobe expanded and sharply delimited rather than short and inconspicuous; elytron strongly declivous basally and with striae 3–6 terminated by strong mucronations rather than nondeclivous and without strong mucronations; hind tibia with mucro much longer than coronal denticles rather than about as long as coronal denticles; and hinge sclerites of male genitalia oblique and crossed rather than arcuate and discrete. The larvae of *Sennius* and *Megasennius* develop in seeds of *Cassia*, but larvae of *Megasennius* are restricted to *Cassia s. str.* whereas those of *Sennius* are restricted to other subgenera. The terminology and general format for descriptions in this paper follow those of Johnson and Kingsolver.

Genus *Megasennius* Whitehead and Kingsolver, new genus

Type-species: *Bruchus muricatus* Sharp.

Description: Moderately large acanthoscelidine bruchids with the following characteristics (italicized when different from *Sennius*).

Head: With frontal carina blunt, alutaceous at base; antennae not sexually dimorphic, distal segments slightly eccentric, not serrate, *much shorter than hind femur*; in lateral view, venter of eye on same plane as ventral surface of labium; *postocular lobe elongated*.

Prothorax: With lateral carina present only as blunt posterolateral ridge; apex with short band of fine punctations; disc almost regularly convex, without asperities but with short median channel basally. Procoxae slightly separated at apices by vertical lamina of prosternum.

Elytra: With striae regular, not distorted laterally, well marked, *with prominent teeth at bases of striae 3–6; base strongly declivous*. Scutellum short, broad, bifid apically.

Hind femur: With ventral face flattened, mesoventral margin of face with single flattened subapical spine, lateroventral margin of face not carinate. Hind tibia with transverse apicolateral row of spinules (tibial corona), *mucro much longer than coronal denticles*; lateroventral carina reduced to basal remnant.

Abdomen: With basal sternum unmodified; pygidium evenly convex, without asperities; apical margin of last sternum of male broadly emarginate to receive apex of pygidium, apical margin of last sternum of female without emargination. Male genitalia with lateral lobes *strongly bowed*, expanded mesally at apices, *divided to near base*; internal sac with hinge sclerites *oblique and crossed*, apical closure valve of ejaculatory duct circular, lateral diverticula present near closure valve.

Comparisons and relationships: Johnson and Kingsolver (1973) listed characteristics to separate *Sennius* from other New World genera of Bruchinae, and our comments regarding *Megasennius* are similar. The following genera differ from *Megasennius* by having more than 1 spine on the hind femur, by having the hind tibia strongly arcuate, or both: *Algarobius* Bridwell, *Caryedes* Hummel, *Ctenocolum* Kingsolver and Whitehead, *Gibbobruchus* Pic, *Meibomeus* Bridwell, *Merobruchus* Bridwell, *Mimosestes* Bridwell, *Pectinibruchus* Kingsolver, *Penthobruchus* Kingsolver, *Pseudopachymerina* Zacher, *Pygiopachymerus* Pic, *Rhipibruchus* Bridwell, and *Stylantheus* Bridwell.

The following New World genera have 1 spine on the hind femur but are distinguished from *Megasennius* by lack of hinge sclerites and these additional characteristics: *Cosmobruchus* Bridwell, *Dahlibruchus* Bridwell, and *Lithraeus* Bridwell by the lack of carinae on the hind tibia; *Bonaerius* Bridwell, *Cercidiestes* Bridwell, and *Stator* Bridwell by the definite lateral carina on the pronotum; and *Neltumius* Bridwell by the gibbous pronotum. *Abutiloneus* Bridwell and *Megacerus* Fahraeus have the spine of the hind femur either greatly reduced or absent. The cosmopolitan genera *Bruchus* Linnaeus and *Calloso-*

bruchus Pic are distinguished from *Megasennius* by having an external spine on the hind femur.

Megasennius is distinguished from *Sennius* Bridwell, *Acanthoscelides* Schilsky, and the Old World genus *Bruchidius* Schilsky by having the following characteristics in combination: hind femur with single large spine (from some *Sennius* and *Bruchidius*, and from most Central and South American species of *Acanthoscelides*); elytron with strong teeth at bases of striae 3–6 (from all *Acanthoscelides* and *Sennius*, and from most *Bruchidius*); mucro of hind tibia long (from *Sennius* and most *Acanthoscelides*); and median lobe of male genitalia with hinge sclerites (from *Acanthoscelides* and *Bruchidius*; present but of different form in *Sennius*).

Certain large South American species have less elongate hinge sclerites than do the North American species treated by Johnson and Kingsolver (1973), but they probably belong to *Sennius*. None have the elytral, tibial, and genital characteristics of *Megasennius*.

<center>

Megasennius muricatus (Sharp), NEW COMBINATION

fig. 1–6

</center>

Bruchus muricatus Sharp 1885: 464; Pic 1913: 36.   Type-locality: Bugaba, Panama.   Type deposited in British Museum (Natural History), London.
Acanthoscelides muricatus: Blackwelder 1946: 760.

Description: Length (pronotum-elytra) 4.6–5.0 mm.   Width 3.0–3.2 mm. Maximum thoracic depth slightly greater than length.

Integument: Basically rufous.   Head and labrum dark, no postocular spot; antennal articles 1–5 testaceous, outer articles darker; prothorax dark rufous, coxa rufous, rest of leg rufotestaceous; pterothorax dark rufous; elytron rufous, humerus dark; middle leg rufous; hind leg dark rufous; abdominal sterna and pygidium dark rufous.

Vestiture: Uniformly yellowish, nearly uniformly distributed, moderately dense, recumbent; sparse on postocular lobe; small dense postocular patch; median line and small patch on each side of pronotal disc dense; nearly uniform on pygidium but most dense basally and narrowly along midline.

Head (fig. 4):   Short and broad, densely punctulate; frons with median carina extended from frontoclypeal suture to vertex, flat, alutaceous, broadened basally; frons width about equal to width of eye; ocular sinus about ⅔ as long as width of eye; postocular lobe elongated, swollen, strongly delimited by sulci; distance from base of antenna to apex of labrum about ½ as long as distance from upper limit of eye to apex of labrum; antenna (fig. 1) with articles 1 and 3 filiform, 2 moniliform, 4 about as long as 3, 5–10 eccentric, 5 and 6 about as long as broad, 7–10 slightly transverse, 11 elongate and subacute; antenna not reaching base of pronotum.

Pronotum (fig. 3):   With disc subcampanulate, slight depressions each side of middle, coarsely punctate; faint lateral carina from base ½ way to coxal cavity; shallow median impression from basal lobe to basal ⅓. Prosternum separating coxae except at apices.
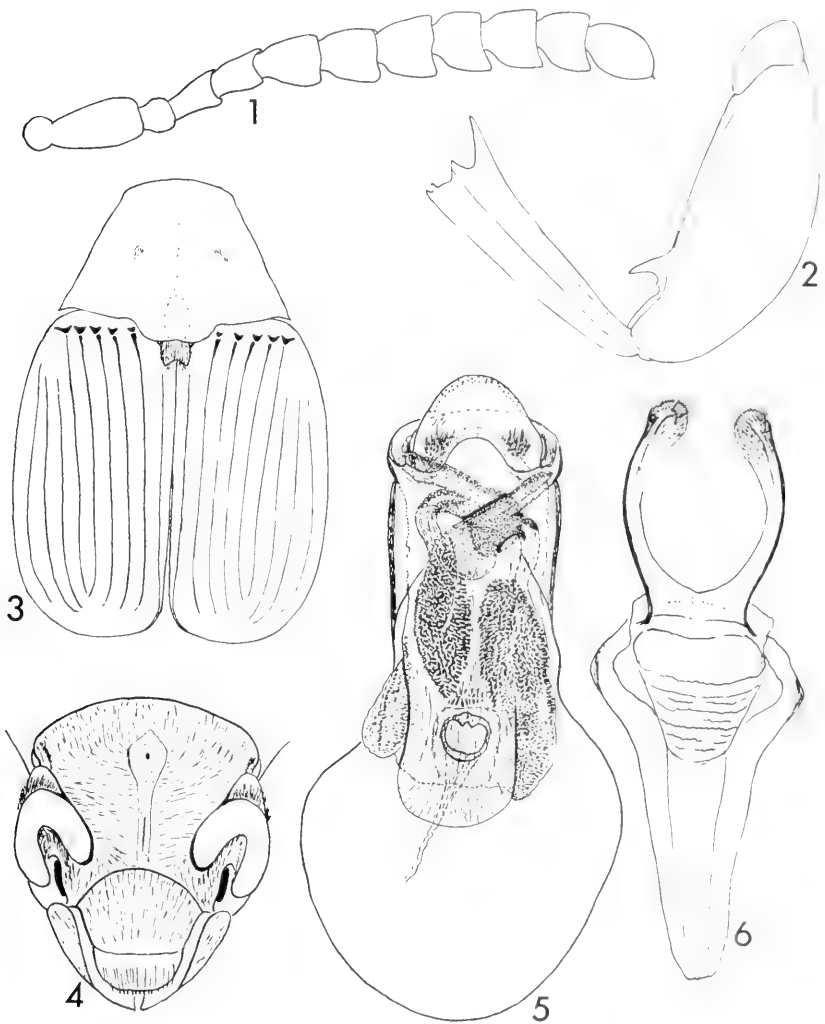
Fig. 1–6. *Megasennius muricatus* (Sharp). 1, antenna. 2, hind femur and tibia. 3, pronotum and elytra. 4, head. 5, male genitalia, median lobe. 6, male genitalia, lateral lobes.

Pterothorax: With scutellum transverse, bidentate, with dense vestiture. Elytron (fig. 3) about 2× as long as broad, dorsal surface evenly convex between humerus and medial margin; striae deep, finely punctate, striae 2–6 abruptly terminated before base by prominent mucronations, strial intervals finely punctulate; base strongly declivous in front of strial mucronations; distance between striae at base subequal; humerus punctulate, pubescent, intervals 8 and 9 finely

scabrous at humerus. Venter punctulate. Hind coxa punctate. Hind femur (fig. 2) clavate; ventral surface flat, with conspicuous inner carina, subapical acuminate spine about as long as width of tibial base. Hind tibia (fig. 2) with ventral, lateral, and dorsomesal glabrous longitudinal carinae, lateroventral carina faintly evident in basal ½; tibial corona with 2 or 3 dorsal spinules, large lateral tooth, mucro about 2× as long as lateral tooth and about ¼ as long as 1st tarsomere, sinus at base of mucro conspicuous; 1st tarsomere with ventral, lateral, and mesal glabrous longitudinal carinae.

Abdomen: With 1st sternum not flattened medially, about as long as remaining sterna, posterior margin straight; sterna 2–4 unmodified; sternum 5 emarginate in male, entire in female; pygidium punctate, convex in lateral view.

Male genitalia (fig. 5–6): Median lobe broad; in ventral view, ventral valve rounded apically, lateral margins convex, base not as broad as apex of median lobe, arcuate in lateral view; hinge sclerites large, complex, oblique, crossed; internal sac with dense microspicules in apical ⅔ and extending into diverticula. Lateral lobes slender, bowed, cleft nearly to base, setose and mesally expanded at apices.

Material examined: Six specimens from El Salvador and Costa Rica, plus type and cotype from Panama. Origin unknown: intercepted 6-II-1971 in *Cassia* sp. at Laredo, Texas (4102:71-2032). EL SALVADOR. La Libertad: Quezaltepeque, 19-VI-1968, D. Q. Cavagnaro and M. E. Irwin. San Salvador: San Salvador, 5-VI-1958, O. L. Cartwright, and 9-VI-1958, L. J. Bottimer. COSTA RICA. Puntarenas: Puntarenas, 3-II-1970, reared from *Cassia grandis* L. by D. H. Janzen.

Discussion: *Megasennius muricatus* is known at present only from seeds of *Cassia grandis*, but it may be expected in seeds of related species. Kingsolver (1970a, b) and Janzen (1971) have published records of 2 other bruchid genera from various species of *Cassia s. str. Pygiopachymerus lineola* (Chevrolat) was reported from *C. fistula* L., *C. grandis* L., *C. javanica* L., and *C. moschata* H.B.K., El Salvador to Brazil; *P. theresae* Pic from *C. fistula* and *C. grandis*, Panama to Colombia; and *Zabrotes interstitialis* (Chevrolat) from *C. grandis* and *C. moschata*, Mexico to Brazil. *Megasennius muricatus* is probably similar to these species in host plant selection and in geographic distribution.

In the *North American Flora*, Britton and Rose (1930) recognized nearly 30 segregate genera within what is customarily treated as *Cassia*; for convenience, these segregates are here termed "subgenera," though they are not now formally recognized by most botanists. The bruchid fauna of *Cassia s. str.* is wholly different from those of the other "subgenera," most of which lack the woody seed pods characteristic of *C. grandis* and related species. One species of *Acanthoscelides*, several of *Amblycerus*, and all of *Sennius* are apparently obligate seed predators of 1 or more of these other subgenera, the bruchid faunas of which so far as known are only slightly distinct from one another. This basic dichotomy in host plant selection is stressed

for 2 reasons: it constitutes biological justification for distinguishing *Megasennius* from *Sennius*, and it indicates that systematic relationships of *Cassia s. str.* to other *Cassia* groups should be reexamined.

Megasennius and *Pygiopachymerus* are similar in 2 characteristics that set each of them apart from their respective closest relatives. In both, the postocular lobe is expanded and sharply delimited, whereas in *Sennius* and *Penthobruchus* the postocular lobe is short and inconspicuous. Also, both are characterized by having strongly developed teeth near the base of the elytron. The functional significance of these structures is unknown but probably has some connection either with development in seeds of *Cassia s. str.* or with the boring of the exit hole through the extraordinarily thick pod wall by the adult (Janzen, 1971).

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A NEW NEARCTIC SPECIES OF FORCIPOMYIA (FORCIPOMYIA) DESCRIBED IN ALL STAGES (DIPTERA: CERATOPOGONIDAE)

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ABSTRACT—*Forcipomyia* (*Forcipomyia*) **bystraki**, new species from North America, is described and illustrated in all stages. The species was reared from wet moss and from under bark of decaying trees.

We are taking this opportunity to describe a new, apparently common biting midge of the genus *Forcipomyia* from eastern North America because we have recently received specimens of the immature stages, which are of considerable taxonomic importance in this genus. For an explanation of terms dealing with immature stages see Saunders (1924) and Chan and LeRoux (1965). Terminology dealing with adults is discussed in Chan and LeRoux (1965) and Dow and Wirth (1972). Types are in the U.S. National Museum in Washington, D.C. Paratypes will be deposited in the Canadian National Collection, Ottawa; the California Academy of Sciences, San Francisco; and the British Museum (Natural History), London. We are indebted to Mrs. Ethel Grogan for preparing the illustrations.

It is a pleasure to name this new species in honor of our good friend and coworker Paul G. Bystrak, who has successfully reared it, and in recognition of his contributions to the study of the genus *Forcipomyia*.

Forcipomyia (*Forcipomyia*) *bystraki* Grogan and Wirth, new species

Fig. 1–2

Diagnosis: Large species with pale yellow legs, distal ½ of hind femur and narrow band on distal portion of hind tibia brown; females with well-developed mandibular teeth and small, ovoid spermathecae; males with pale 9th segment, telomere pale with darkened tip, basimere contrasting dark brown; claspettes fused on proximal ¼. Larvae can be distinguished from all other described *Forcipomyia* (*Forcipomyia*) by their setose, broadly hastate *a* hairs with serrated edges; pupae with small respiratory organ bearing 6 spiracular papillae and a small spine on apex of anterior side.

Holotype: Adult female. Wing length 1.16 mm; breadth 0.48 mm.

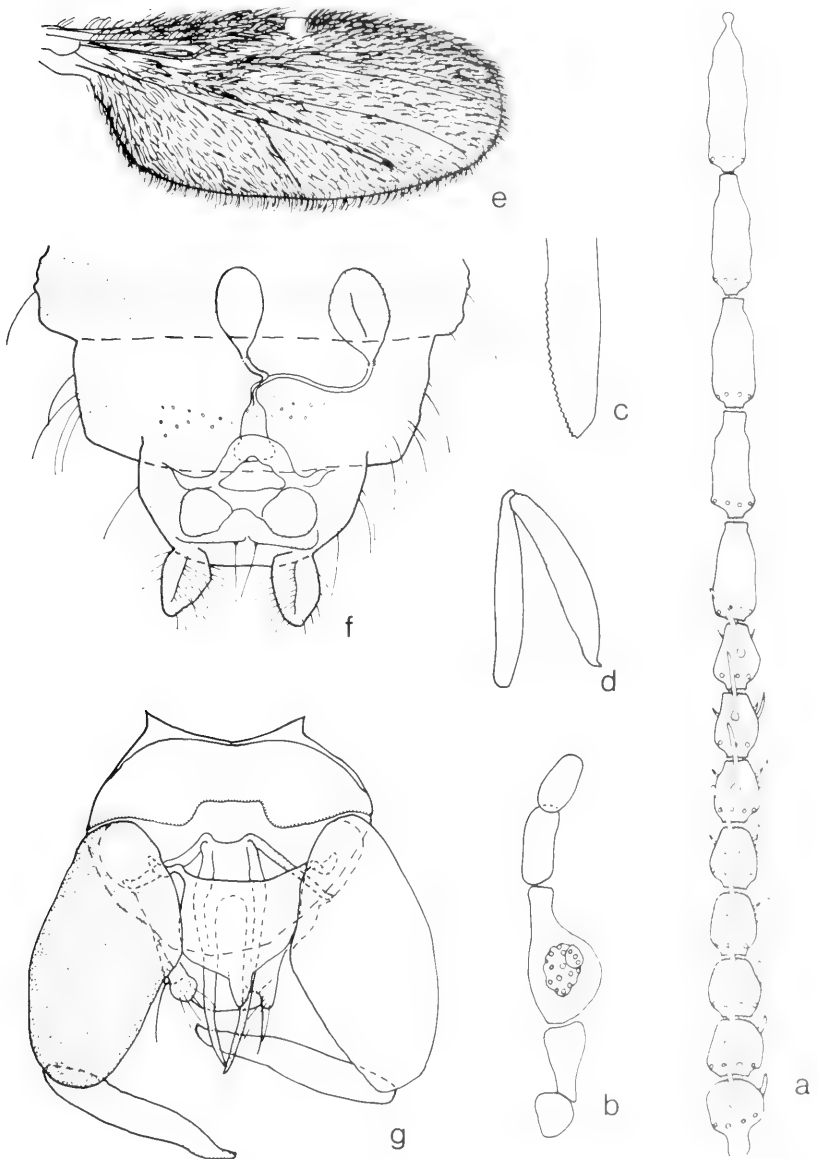[1] Mail address: c/o U.S. National Museum, Washington, D.C. 20560.

Fig. 1. *Forcipomyia bystraki.* a–f, female. a, antenna. b, palpus. c, mandible. d, hind femur and tibia. e, wing. f, genitalia. g, male genitalia.
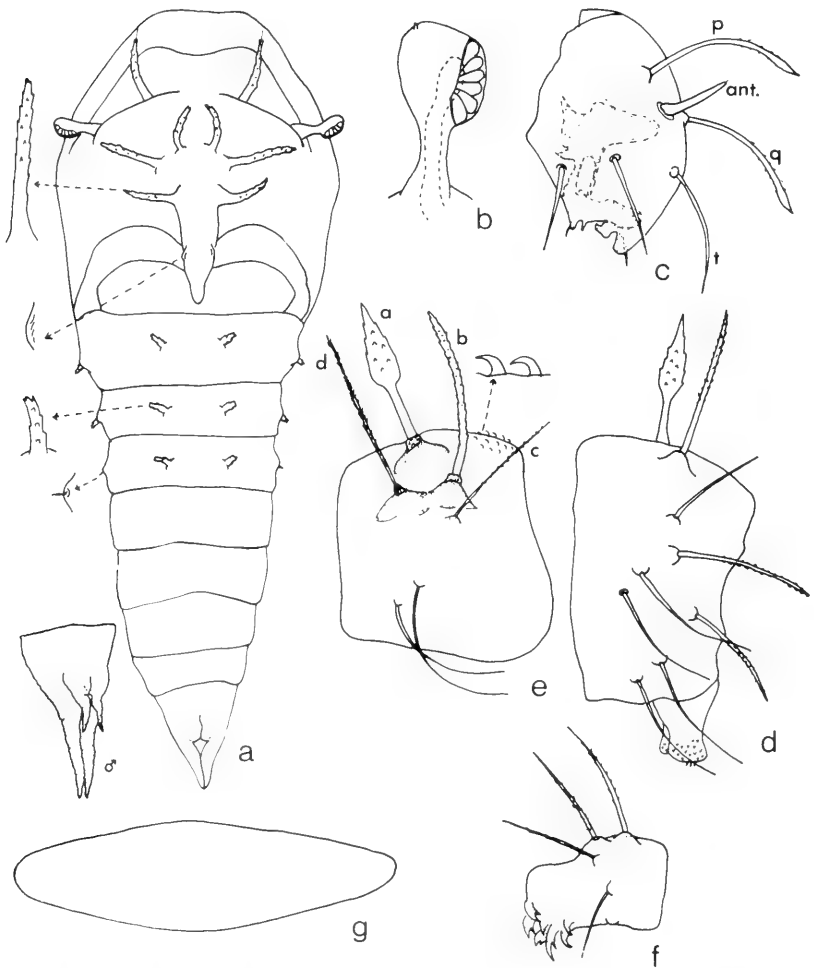
Fig. 2. *Forcipomyia bystraki.* a, pupa. b, pupal respiratory organ. c, larval head. d, larval prothoracic segment. e, larval mid-abdominal segment. f, larval caudal segment. g, egg.

Head: Brown; antenna and palpus lighter brown. Eyes bare; in broad contact. Antenna (fig. 1a) with proximal 8 flagellar segments globose, possessing multiple sensoria; distal 5 segments elongate, lacking sensoria; apical segment with distinct apical papilla; flagellar segments with lengths in proportion of 10-8-8-8-8-9-9-9-15-16-17-18-24; antennal ratio 1.30. Palpus (fig. 1b) with segments in proportion of 12-21-37-21-17; 3rd segment greatly expanded proximally with distinct deep pit bearing numerous minute, hyaline sensilla; palpal ratio 2.25. Mandible (fig. 1c) heavily sclerotized with about 30 sclerotized teeth.

Thorax: Brown; mesonotum brown with long brown setae. Legs pale yellow; distal half of hind femur and narrow band on distal portion of hind tibia brown (fig. 1d); femora and tibiae with long setae; hind tarsal ratio 0.90; 5th tarsomeres with well-developed fringed empodia and greatly curved claws. Wing (fig. 1e) about 2.5 × longer than broad; unicolorous brown with a small yellowish anterior spot at tip of costa; covered with macrotrichia, most dense on and proximal to radial sector; costal ratio 0.44. Halter pale.

Abdomen: Brown; covered with long setae; segmental membranes pale giving abdomen a banded appearance. Genitalia as in fig. 1f: spermathecae ovoid, subequal with short necks, ducts hyaline and joining posteriorly where they enter the hyaline bell-shaped bursa copulatrix; genital sclerotization U-shaped with recurved tips.

Allotype: Adult male. Similar to female holotype with the usual sexual differences and the following other differences: mandible more slender, apex only with small slender teeth; thorax darker brown; hind leg pattern nearly identical; claws with slightly bifid tips; wing more slender.

Genitalia: As in fig. 1g. Ninth segment pale, color contrasting with brown basimere; sternum about 1.7× broader than long with a truncate caudomedian notch, base concave; 9th tergum tapered distally, distal portion brownish. Basimere dark brown, nearly straight, about 2× as long as broad; telomere pale with darkened tip, nearly straight, about 0.83× the length of basimere, tapered slightly distally. Aedeagus lightly sclerotized, shield-shaped; distal portion with elongate, pointed, median process; basal arm short, recurved and anteriorly directed. Claspettes fused on proximal ¼, lightly sclerotized; distal portion broadly forked, each distal process a slender rod slightly tapering distally with pointed tip; basal apodeme slender, tip slightly recurved.

Variation: *Females*: Wing length 1.21 (1.10–1.35, n = 10) mm; breadth 0.50 (0.45–0.55, n = 10) mm. Costal ratio 0.46 (0.44–0.49, n = 10). Antennal ratio 1.35 (1.10–1.51, n = 10). Palpal ratio 2.34 (1.89–2.66, n = 10). Hind tarsal ratio 0.86 (0.78–0.92, n = 10). Some females in the type-series lack the narrow brown band on the hind tibia. *Males*: Some males in the type-series have a broader brown band on the hind tibia than does the allotype.

Pupa (fig. 2a):   Retains larval exuviae. Thorax with 4 pairs of setose, cuticular, dorsal spines, the anterior pair each with a terminal seta; and a pair of small, rounded, posterior tubercles. Respiratory organ (fig. 2b) small, with 6 lateral spiracular papillae, and a small spine on apex of anterior side. Abdominal segments 2–4 each with a pair of blunt, setose, dorsal spines; segments 2–3 each with a pair of blunt, setose lateral spines; segment 4 with a pair of short, slender, lateral spines; remainder of abdomen bare. Terminal processes appressed in male and female.

Larva (4th instar):   Body light brown, lightly sclerotized. Head (fig. 2c) with very heavily sclerotized internal structures; antenna apparently with 3 segments; p hair long, distal portion setose, tip slightly hastate; q hair identical to p hair; t hair long, slender. Prothoracic segment (fig. 2d) with pseudopod split for nearly entire length and with 3 medioventral sclerotized hooks on each side; a hair long, setose, broadly hastate with serrated edges; b hair longer than a hair, long, broad, setose; c hair shorter than b hair, slender; d hair similar to b hair. Surface of midabdominal segments (fig. 2e) with short, recurved setae; a and b hairs like those on prothoracic segment; c hair shorter than b hair, slender, setose;

d hair longer, broader than *c* hair, setose, basal papilla fused to basal papilla of *b* hair. Caudal segment (fig. 2f) small; anal blood gills short, rounded; anal pseudopod with double row of sclerotized hooks, 8 on each side.

Egg (fig. 2g): Ellipsoid, measuring 0.26 by 0.08 mm.

Biology: This species has been reared from under bark of tulip poplar and black oak, and from moss, by P. G. Bystrak and from under bark of a stump by W. W. Wirth.

Distribution: Common in the eastern United States from Michigan and Maryland south to Arizona and Florida.

Types: Holotype, ♀; allotype, ♂; on slides with their associated larval and pupal exuviae, reared from wet moss by P. G. Bystrak, Headwaters, Highland County, Virginia, June 1969 (Type no. 72211, USNM). Topotypes, 4 ♂ ♂, collected with holotype; other paratypes, 370 ♀ ♀, 136 ♂ ♂, 7 larvae, as follows:

FLORIDA: Alachua Co., Gainesville, Chantilly Acres, 18 April–21 September 1967, F. S. Blanton, light trap, 144 ♀ ♀, 46 ♂ ♂. Baker Co., Olustee, July 1971, F. S. Blanton, 1 ♀. Charlotte Co., Englewood Beach, 16 June 1960, W. Jernigan, 1 ♂. Franklin Co., Sumatra, Right's Lake, April 1973, G. B. Fairchild, 2 ♂ ♂. Gilchrist Co., 15 June 1960, G. K. Hicks, 1 ♀. Hardee Co., Ona, July 1970, E. Irons, 1 ♀. Highlands Co., Sebring, Highlands Hammock St. Pk., 15 April 1970, W. W. Wirth, 1 ♀. Hillsborough Co., Tampa, March 1967, Taylor, 4 ♀ ♀, 1 ♂; Harris Swamp, March–April 1967, 10 ♀ ♀, 5 ♂ ♂. Indian River Co., Vero Beach, Ent. Res. Cntr., April 1956–May 1960, 31 ♀ ♀, 12 ♂ ♂. Jackson Co., Florida Caverns St. Pk., 26 May 1973, W. W. Wirth, 6 ♂ ♂. Jefferson Co., Monticello, September–October 1969, W. H. Whitcomb, 8 ♀ ♀, 2 ♂ ♂. Lee Co., Sanibel Island, 11 May 1973, W. W. Wirth, 1 ♀. Leon Co., 3 mi N Tallahassee, May 1970, F. S. Blanton, 3 ♀ ♀, 4 ♂ ♂. Levy Co., Camp Williams, July 1960, G. K. Hicks, 1 ♀. Liberty Co., Torreya St. Pk., 20 May 1966, H. V. Weems, 8 ♀ ♀, 5 ♂ ♂; 15 April–30 June 1967, F. S. Blanton, 6 ♀ ♀, 6 ♂ ♂; 22 April 1967, W. W. Wirth, 1 ♀. Marion Co., Juniper Springs, 28 April 1970, W. W. Wirth, 1 ♂. Orange Co., Lake Magnolia Pk., 6 August 1970, E. Irons, 1 ♂; Orlando, 19 July 1969, G. M. Stokes, 2 ♀ ♀; Rock Springs, 21 April 1970, W. W. Wirth, 9 ♀ ♀. Putnam Co., Lon's Lake, May–September 1971, F. S. Blanton, 19 ♀ ♀, 5 ♂ ♂; Red Water Lake, 27 May 1967, F. S. Blanton, 2 ♀ ♀; Welaka, 9 April 1964, H. A. Denmark, 3 ♀ ♀. Sarasota Co., Myakka River St. Pk., 21 May 1973, W. W. Wirth, 2 ♀ ♀, 2 ♂ ♂. ILLINOIS: Jersey Co., Grafton, 6 May 1973, reared from tree hole, W. E. Snow, 1 ♂. KANSAS: Douglas Co., Lawrence, May–August 1956, A. R. Barr, 15 ♀ ♀, 3 ♂ ♂. Riley Co., August–September 1964, N. Marston, 11 ♀ ♀; Manhattan, 15 June 1958, W. W. Young, 2 ♀ ♀. MARYLAND: Anne Arundel Co., Galesville, Java Farms, Muddy Creek, reared from black oak, 4 January— emerged 6 March 1970, P. G. Bystrak, 1 ♀; Odenton, Towser's Branch, reared from tulip poplar, 22 February—emerged 6 March 1970, P. G. Bystrak, 2 ♀ ♀, 2 ♂ ♂. Cecil Co., Calvert, under bark of log, 29 March 1969, J. G. Connell, 7 larvae. Montgomery Co., Forest Glen, 13 July–29 August 1956, 15 April–5 June 1967, W. W. Wirth, 15 ♀ ♀, 1 ♂. Prince Georges Co., College Park, reared from tulip poplar, 26 March—emerged 2 April 1970, P. G. Bystrak, 1 ♀. Worcester

Co., Shad Landing St. Pk., 6 October 1973, W. L. Grogan, Jr., 1 ♀, 3 ♂ ♂; Snow
Hill, 25 June 1966, W. H. Anderson, 1 ♀. MICHIGAN: Cheboygan Co.,
Douglas Lake, 15–29 July 1954, 16 July–8 August 1959, R. W. Williams, 8 ♀ ♀,
2 ♂ ♂. MISSISSIPPI: Washington Co., October 1962, R. H. Roberts, 1 ♀.
MISSOURI: Jackson Co., Independence, April–August 1957, K. Shain, 1 ♀, 4 ♂ ♂.
NORTH CAROLINA: Macon Co., Highlands, July 1965, P. M. Marsh, 1 ♀.
VIRGINIA: Fairfax Co., Falls Church, Holmes Run, 19 May 1958–21 September
1961, W. W. Wirth, 49 ♀ ♀, 21 ♂ ♂; 10 April 1960, reared from under bark of
stump, W. W. Wirth, 1 ♀. Smyth Co., Saltville, salt marsh, 4 May 1962, W. W.
Wirth, 1 ♀. WEST VIRGINIA: Hardy Co., Lost River St. Pk., 8–14 July 1963,
K. V. Krombein, 2 ♀ ♀.

The following specimens were examined but are not designated as paratypes:
ARIZONA: Cochise Co., Chiricahua Nat. Mon., 1 June 1967, C. W. Sabrosky,
6 ♀ ♀, 9 ♂ ♂; Cochise Stronghold, Dragoon Mts., 16 July 1958, C. W. O'Brien,
6 ♂ ♂. Pima Co., Sabino Canyon, Santa Catalina Mts., 7 July 1960, Johnson and
Werner, 1 ♀; Sycamore Canyon, Ruby, 22 May 1954, G. D. Butler, 1 ♀, 4 ♂ ♂.
NEBRASKA: Otoe Co., Dunbar, 6 July 1962, W. W. Wirth, 9 ♀ ♀. TEXAS:
Aransas Co., Aransas Wildlife Refuge, 22 April 1956, W. W. Wirth and R. H.
Jones, 3 ♀ ♀, 2 ♂ ♂. Kerr Co., Kerrville, 21 March 1955, W. W. Wirth, 9 ♀ ♀, 1 ♂.

Discussion: *Forcipomyia bystraki* belongs to a small group of
species in the subgenus *Forcipomyia* characterized by well-developed
mandibular teeth. *Forcipomyia townesi* Wirth (1952) from the western
and northern states is apparently closely allied to *bystraki*, differing
by having much larger, oval, female spermathecae, the legs extensively
brownish with the hind femur brown on more than the distal ½ grad-
ually shading to a pale proximal portion, and the male 9th segment
dark in color. The male allotype of *F. townesi* figured by Wirth (1952)
was misidentified and belongs to another, as yet undetermined spe-
cies; the genitalia of *F. townesi* are almost identical with those of *F.*
bystraki, with the difference noted above. We have identified *F.*
townesi from USNM specimens from California, Oregon, Utah, On-
tario, New York, and Florida.

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ADDITIONS TO THE NEARCTIC ANTHICUS (COLEOPTERA: ANTHICIDAE)[1]

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ABSTRACT—Two new species are described, *Anthicus* **antiochensis** from Antioch, Contra Costa County, California, and *A.* **musculus** from southern Arizona. *Anthicus crinitus* LaFerté is recorded from the Western Hemisphere for the first time, from Puerto Rico and Florida; it is widely distributed in Africa and southern Asia.

Since my revision of the genus *Anthicus* in North America (Werner, 1964), I have had opportunity to examine additional collections, and have re-examined some previously available series. As a result, I am now able to add 2 new species to the anthicid fauna of North America, both from north of Mexico, and to mark an apparently recent introduction of an Old World species into Florida. Many new state records have accumulated; these will be summarized in the forthcoming catalog of Nearctic Coleoptera.

Anthicus crinitus LaFerté
Fig. 2, 5

Anthicus crinitus LaFerté, 1848: 204–5 (type-loc.: Egypt or Senegal). Bonadona, 1956: 117 (adds Algerian Sahara, lists Canary Islands, N. Africa, Asia Minor, Arabia); 1959: 124 (adds Mauritania); 1960: 53 (adds Afghanistan, lists Cape Verde Islands, central Africa, India, and probably Japan); 1963: 590 (adds Ennedi and Tchad).

2.5–3.2 mm, body rufescent to brown with all but bases of femora and often head darker, tibiae paler; elytra bright rufescent with extensive dark markings that leave rufescent basal 2/5 except for small humeral darkenings and a postmedian cordiform marking across both elytra in most specimens. The cordiform marking disappears 1st in dark specimens. Shiny, elytra with fairly conspicuous long, subdecumbent setae and less conspicuous decumbent setae about ½ as long, pointed in same direction.

Redescribed from ♀, Vero Beach, Florida, 3.24 mm long. Head subtruncate at base, with shallow median excavation, feebly convex, 0.54 mm long, 0.67 wide across eyes, 0.58 behind, smooth, shiny, with sparse, distinct but shallow punctures, ca. 0.06 mm center to center, bearing shaggy decumbent setae and erect tactile setae, both ca. 0.10 mm. Middle of frons bulging slightly, puncture-free, flanked by small longitudinal groups of denser punctures, convergent behind and extending across clypeofrontal suture onto sides of clypeus. Eyes large, prominent, 0.32 × 0.23 mm, separated by 0.40 and 0.23 mm from base. Junctions of facets with very short, erect setae, ca. 0.01 mm. Antennae luteous, gradually

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thicker apically; measurements in 0.01 mm, base to apex: 15/7, 10/6, 13/6, 10/6, 9/7, 10/7, 10/8, 9/8, 10/9, 10/9, 16/9; segment 1 simple. Palpi luteous, last segment of maxillary palpi securiform, 0.14 × 0.10 mm. Pronotum widest and sides rounded at apical 2/5, gently convex, 0.70 mm long, 0.48 wide across base, 0.47 at constriction, 0.57 maximum, 0.25 at distinct collar; surface shiny, with punctures and setae slightly denser than on head. Elytra 2.0 mm long, 0.80 wide at distinct humeri, 1.12 maximum; surface shiny, punctures moderately dense, 0.06 mm center to center, slightly denser and deeper near base; omoplates just discernible. Setae double; long, 0.16 mm, slightly curved and subdecumbent; and much shorter, ca. 0.07 mm, decumbent; tactile setae nearly erect, 0.10 mm, not very conspicuous. Underside of thorax with punctures and pubescence similar to elytra, of abdomen similar but punctures much smaller. Legs moderately slender, especially middle and hind tarsi; front femur 0.58 × 0.20 mm, front tibia 1.0 × 0.10, hind femur 0.83 × 0.18). ♂ (Ponce P.R.) with apex of sternum 7 slightly excavated, not otherwise modified; tergum 8 with apical zone ca. 0.25 mm wide, demarcated anteriorly, nearly flat, finely punctulate and pubescent.

Specimens examined: FLORIDA: Indian River Co.: Vero Beach (10 June 1964, W. L. Bidlingmaier, suction trap, ♀, Fla. State Coll. Arthrop.). Gadsden Co.: Quincy (1971, in pitfall trap in soybean field on Agr. Exp. Sta., 1, U. Fla.). GREATER ANTILLES. PUERTO RICO: Ponce (28 Apr. 1936, Dozier, 5, MCZ); Isla Mayaguey, Parguera (18 Dec. 1962, Paul & Phyllis Spangler, 1, USNM); La Parguera (29 July 1969, H. & A. Howden, 1, CNC); Fortuna A. E. S. (March 1968, F. Fisk, 2, Coll. D. S. Chandler). There are 10 additional specimens in the USNM without data, 8 of them on distinctive H. S. Barber multiple hair mounts.

The peculiar postmedian pale mark of the elytra is produced by a slightly antemedian dark band that narrows toward, and may be interrupted at the middle, this connecting laterally with dark sides behind middle and apex. This mark and the double elytral pubescence would serve to distinguish this species from all others in our fauna. It would run to couplet 32 in Werner (1964); this couplet can be expanded to a triplet to include reference to the markings, which are different from those of either alternative listed.

This is the first time that the species has been reported from the New World. It probably has become established only recently. The first records are from Puerto Rico, 1936. It has been taken there several times since, and more recently from Florida. Laferté's 2 specimens indicated a wide range across northern Africa; since 1848 the known range in the Old World has been extended east to Afghanistan and India, possibly to Japan, and west to include the main islands off the coast of North Africa. There are some additional localities, as well as synonymy of several Marseul species, listed in the Junk catalog (Pic, 1911); I believe that the records cited by Bonadona have been more critically examined. My identifications have been based on comparison with specimens from Afghanistan identified by Bonadona.
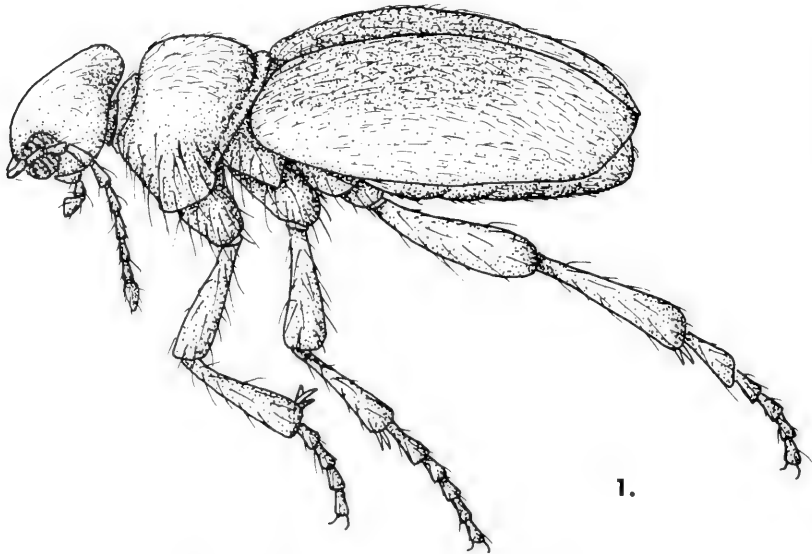
Fig. 1. *Anthicus antiochensis*, male. Drawing by Wynne Brown.

Anthicus antiochensis Werner, new species
Fig. 1, 4

Very large, 4.7–5.4 mm, moderately robust, with subtruncate elytra and shaggy pubescence on underside and legs; head subtriangular; stramineous, elytra with a slightly postmedian dark cloud of variable extent and intensity, and a narrow subapical sutural mark that is slightly darker. Outer edge of front tibia very sharp, modified for digging. ♂ 4.70–5.40 mm, mean 4.97, SD 0.162, n = 19; ♀ 4.55–5.15 mm, mean 4.84, SD 0.21, n = 5.

Holotype ♂, 4.90 mm. Head subtriangular, 0.80 mm long to clypeofrontal suture, 1.05 wide across eyes, 0.95 behind; disc only slightly and very evenly convex, curve of front and eyes almost continuous, only a narrow groove setting off the eyes. Eyes moderately prominent, 0.37 × 0.28 mm, 0.70 mm apart and 0.60 from base; facets fine and even, separate, with erect setae at junctions, ca. 0.01 mm. Head surface smooth, but not obviously so because of moderately dense, 0.05 mm center to center, shallow but sharply defined punctures and appressed pale pubescence, 0.09 mm, grading to shaggy setae ca. 0.35 mm long beneath. Clypeofrontal suture well defined, transverse. Palpi small, last segment of maxillary palpi securiform, 0.21 × 0.14 mm; labial palpi very small. Galea and mentum apparently modified for digging by being slightly platelike. Some of setae of underside of head long and shaggy, others about as on top, intermixed. Antennae moderately slender, gradually thickened apically, with subdecumbent setae and suberect tactile setae that are somewhat shaggy under magnification; measurements: 27/14, 16/9, 25/8, 25/8, 26/9, 25/10, 26/10, 23/10, 21/11, 21/11, 27/11.
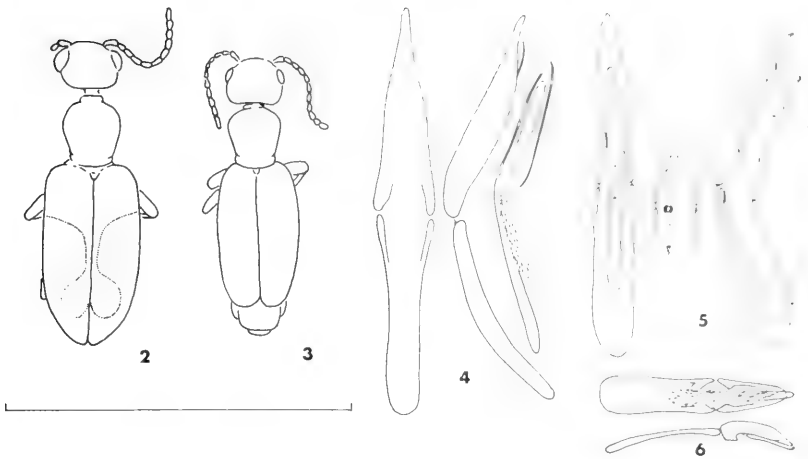
Fig. 2. *Anthicus cribratus*, Ponce, Puerto Rico.   Fig. 3. *A. musculus*, paratype from type-locality.   Fig. 4. *A. cribratus*, Ponce, Puerto Rico, aedeagus in ventral and left lateral views, at horizontal line = 1 mm.   Fig. 5. *A. antiochensis*, paratype, same, at vertical line = 1 mm.   Fig. 6. *A. musculus*, paratype from type locality, same, at horizontal line = 1 mm.

Pronotum slightly flattened, 1.10 mm long, 0.70 wide across base and constriction, 1.08 maximum, 0.45 at the short collar. Punctures and pubescence slightly denser than on head, setae grading to long and shaggy on underside. Elytra 3.0 mm long, 1.3 wide at the distinct humeri, 1.7 maximum, slightly swollen and with suture distinctly but not sharply elevated; omoplates not evident; apex truncate, slightly produced at suture; smooth, punctures moderately dense, ca. 0.04 mm center to center at base, slightly sparser behind; setae decumbent, almost appressed, ca. 0.11 mm long dorsally, grading to ca. 0.21 low on sides; tactile setae ca. 0.16. Hind wings apparently fully developed and functional. Underside of thorax with punctures similar to elytra, of abdomen feebly microreticulate with finer and denser punctures. Sternum 7 less produced than in ♀ but not otherwise modified; tergum 8 ca. 0.53 mm wide, with a slight excavation at apex producing blunt points ca. 0.14 mm apart.

Legs with some long setae, the front tibiae, especially, modified for digging. Front femur 0.95 × 0.30 mm, front tibia 0.95 × 0.13, hind femur 1.36 × 0.32. Front tibia flat behind, with dense pubescence on flexor surface, the outer edge sharp and augmented by a densely-packed edging of overlapping scales. Internal angle of apex with a recurved hook, 1 spur behind hook normally long and nearly straight, and another, ½ as long, slender and inconspicuous, just beside it. Outer apex bluntly produced, with 2 spatulate setae plus 1 more normal seta mesal to them. Front tarsi slightly produced laterally, with strong but not highly modified, slightly curved setae. Middle and hind tibiae not fossorial, middle with a small curved spine and 2 normal spurs. ♀ tibiae as in ♂ but without recurved spine on front and middle tibiae; smaller spur of front tibiae very tiny. Hind tibial spurs long and slender, barely tapered.

Holotype ♂ : Antioch, Contra Costa County, CALIFORNIA, June 29, 1953, R. O. Schuster, in California Academy of Sciences. Paratypes: all topotypical; 18 eutopotypical; 3—June 10, 15, 1952, J. G. Rozen; 1—May 19, 1952, P. D. Hurd; 1—Oct. 5. 1953, P. D. Hurd & Wasbauer.

Very distinct because of its large size, long ventral setae and fossorial front tibiae. It would run to couplet 44 in Werner (1964) and can there be treated by inserting a couplet, for presence vs. lack of long ventral setae and fossorial front tibiae, between couplets 43 and 44. It might also be placed in couplet 13, but differs from both species in this couplet by having the long elytral setae confined to lateral areas, and in having fossorial front tibiae. Many of the specimens have adhering grains of fine sand, indicating a dune association.

Anthicus musculus Werner, new species

Fig. 3, 6

1.66–2.00 mm, subparallel, slightly flattened; rufescent, appendages slightly paler; shiny, with moderately dense, sharply-defined punctures and decumbent pubescence; tactile setae suberect, short and slender. Of aspect of a small, pale *Vacusus*, but with mesosternum not expanded. ♂ 1.66–1.93 mm, mean 1.76, SD 0.07, n = 11; ♀ 1.80–2.00, mean 1.89, SD 0.07, n = 6. Wingless specimens have the sides of the elytra slightly incurved anteriorly and the humeri weak.

Holotype ♂, 1.66 mm. Head 0.35 mm long, 0.38 wide across eyes, 0.35 behind, subquadrate, truncate at base, with narrowly rounded temporal angles. Surface smooth, shiny, with moderately dense, well-defined but small punctures, 0.02–0.03 mm center to center; intervals nearly flat; punctures absent from a narrow midzone. Setae appressed, fine, 0.04 mm, tactile setae erect, fine, 0.03. Eyes moderately prominent, 0.13 × 0.10 mm, with erect simple setae, ca. 0.01 mm, at junctions of facets; widely separated, by 0.27 mm; 0.17 mm from base. Measurements: 8/6, 6/5, 7/5, 7/5, 7/5, 7/5, 7/5, 7/6, 7/6, 7/6, 10/6. Segment 1 pedunculate but not strikingly so, segments 7–10 grading to nearly quadrate. Last segment of maxillary palpi securiform, 0.09 × 0.06 mm. Pronotum with surface and pubescence similar to head, 0.41 mm long, 0.26 wide at base, 0.25 at constriction, sides just perceptibly concave from there to widest, 0.34 mm, at apical ¼, 0.15 at distinct collar. Elytra somewhat flattened, without omoplates, 0.90 mm long, 0.36 wide at the weak humeri, 0.50 maximum, the sides very gently and almost evenly convex from humeri to separately rounded apices; surface similar to forebody, punctures deeper and less sharply defined, ca. 0.03 mm center to center, setae decumbent, 0.04 mm, tactile setae suberect, 0.03, inconspicuous. Hind wings absent or highly vestigial. Underside of thorax with punctures similar to pronotum, of mesothorax with some fine microreticulation of intervals; abdomen very finely punctulate and with appressed setae. Sternum 7 not modified; tergum 8 0.22 mm wide, apical area darkened but not delimited anteriorly. Front femur 0.30 × 0.10 mm, front tibia 0.22 × 0.05, hind femur 0.38 × 0.10. Front and and middle tarsi noticeably expanded.

Holotype ♂ : 5 mi. W. Marana, Pima Co., ARIZONA, 28 April 1972, D. S. Chandler, under cow dung, deposited in USNM. Paratypes:

ARIZONA: Gila Co.: Cutter (13 July 1949, F. Werner & W. Nutting, 2♀♀). Maricopa Co.: Wickenburg (H. K. Gloyd, lt. trap, 22–23 Aug. 1950, 2♂♂, 2♀♀). Pima Co.: Marana (eutopotypical, 7♂♂); Sta. Catalina Mts. (Sabino Cn., 2500 ft., 26 July 1948, F. Werner & W. Nutting, ♀). Sta. Cruz Co.: Patagonia (4 mi. SW, on Sonoita Cr., 3 Aug. 1952, H. B. Leech, ♀, Cal. Acad. Sci.).

Because of its small size and uniform rufescent color, *musculus* would be most easily confused with *sonoranus* Werner. It reaches the last couplet, 55, occupied by *sonoranus* and *obscurellus*, in my 1964 key to species. The differences from *sonoranus* are not great, but appear to be consistent. Wingless specimens with the lateral margins of the elytra convex are quite identifiable; winged specimens are much more similar. The main points of difference seem to be that the first antennal segment is much less sharply pedunculate and that the head punctures are not as deep. *Sonoranus* has the first antennal segment almost as sharply pedunculate as *ancilla* Casey, a much larger species from farther north. In case of doubt, the blunt tip of the tegmen of the male aedeagus of *musculus* contrasts greatly with the slender apex of this structure in *sonoranus*. Wingless *sonoranus* with the side margins of the elytra convex can be distinguished from *obscurellus* LeConte by their smaller size, paler color, and more coarsely punctured head. The tegmen of the male of *obscurellus* is sharply notched before the apex. It is unlikely that the ranges of the two overlap, since *obscurellus* is found only on the Pacific Coast from central California northward.

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A NEW SPECIES OF ENLINIA FROM OKLAHOMA
(DIPTERA: DOLICHOPODIDAE)

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ABSTRACT—*Enlinia* **robinsoni**, n. sp., is described from specimens taken from mating swarms of a simuliid fly in Murray County, Oklahoma.

Among material submitted for determination by William K. Reisen, University of Oklahoma, was a new species of the genus *Enlinia* collected from mating swarms of a simuliid. This is the first record of the genus from the central part of the United States and makes it appear likely that species of the genus may eventually be found almost anywhere in the country. I am grateful to Dr. Reisen for the opportunity of describing this most interesting fly.

Enlinia robinsoni Steyskal, new species
fig. 1–7

Male: Length of body and wing 1.25 mm each. Color brown, with middle of mesoscutum blackish with blue-green metallic reflections; front black with trace of greenish reflection; antenna blackish, arista brown; wing hyaline, except for 3 spots of brown pigment, 1 on node of radial vein and 2 on veins in the petiole of the wing (fig. 1); bristles brown to black, those of mesoscutum yellowish.

Head large; eyes approximated on face, separated by approximately 15 μ and attaining oral margin laterally, anterior ommatidia noticeably enlarged; antenna as in fig. 2, 3rd segment discoid, arista inserted centrally on slight elevation.

Thorax strongly convex above, but almost posterior half between dorsocentral bristles gently concave; dorsocentral bristles 7, hindmost pair much the largest.

Legs unicolorous brown; foreleg as in fig. 3, coxa with strong mesal bristle close to apex, femur with 9 or 10 small ventral spinules increasing in size toward tip of femur, tibia ordinary, tarsus greatly modified as shown; midleg as in fig. 4, femur with long ventral spinules near base and several much smaller bristles apicad thereof, tibia somewhat thickened and in apical ⅓ below with patch of numerous erect setae; hindleg lacking distinctive hairs, bristles, or conformation.

Wing as in fig. 1, posterior margin sinuate, 3rd vein bent backwards beyond crossvein, entire surface covered with uniform microsetation.

Abdomen with tip as in fig. 5; 4th sternum narrowed medially and with small posterior projection; 5th sternum with depressed, triangular median portion and pair of lateral pieces turned ventrad apically; surstylus cuneate, with erect dorsal seta close to apex; cerci small, depressed, with tips turned outward and bearing tufts of fine hairs.

Female: Similar to male, except for sexual characters; wing plain (fig. 6), but with 3 brown subbasal spots similar to those of male; eye with uniform ommatidia,
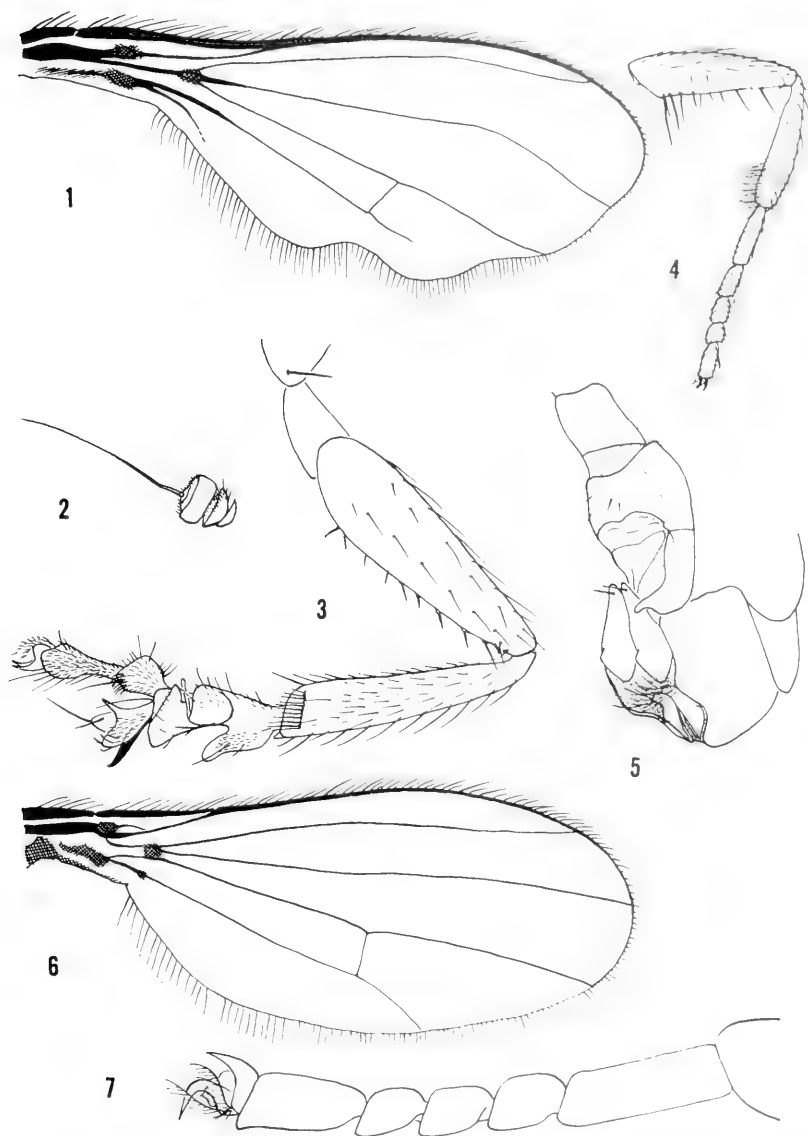
Fig. 1–7. *Enlinia robinsoni*, n. sp. 1, wing of male. 2, antenna of male. 3, foreleg of male, left, anterior view. 4, midleg of male, left, anterior view. 5, male abdomen, oblique lateroventral view of tip. 6, wing of female. 7, fore-tarsus of female.

separated on face about twice as far as in male; foretarsus (fig. 7) plain, length of segments from base to tip 0.35, 0.15, 0.14, 0.125, and 0.235 of total length of tarsus.

Holotype (male) and allotype, Turners Falls, Murray County, Oklahoma, 8 July 1972, from mating swarm of Simuliidae (Wm. K. Reisen); no. 73006 in U.S. National Museum, including wings and legs of both sexes mounted in euparal on 2 microscope slides. There are also 2 female specimens lacking heads.

The name of the species is a noun in the genitive case given in recognition of Harold E. Robinson's excellent work in bringing to light these tiny, inconspicuous insects.

Enlinia robinsoni is apparently most closely related to *E. plumicauda* Robinson, a Mexican species to which it will run in the key by Robinson (1969). It agrees with that species in its very similarly conformed wing and legs, but differs therefrom in details of those parts. The postabdomen lacks the plumose appendages from which the name of *E. plumicauda* is derived, there is no pigmented streak in the anal area of the wing, and the penultimate segment of the foretarsus is much shorter than in *E. plumicauda*. Of the North American species treated in Robinson and Arnaud (1970), none is very much like *E. robinsoni*, although the presence of the apicomesal bristle of the forecoxa and the structure of the last preabdominal sternum indicate its relationship with *E. magistri* (Aldrich). It is likely that many more species of *Enlinia* in the United States await discovery and description; it is therefore premature to make a revised key to the species.

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THE GENUS MYZODIUM WITH THE DESCRIPTION OF M. KNOWLTONI, NEW SPECIES (HOMOPTERA: APHIDIDAE)[1]

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ABSTRACT—The genus *Myzodium* presently includes only 2 species, *M. modestum* (Hottes) and *M. knowltoni* Smith and Robinson, new species. There is a key for the apterous viviparae and descriptions are given for the apterous and alate viviparae of both species.

Myzodium Börner

Börner (1950a:11) described *Myzodes* (*Myzodium*) *rabeleri* n. sp. and designated it as the type of the new subgenus. Later (1952a:121), he raised *Myzodium* to generic rank and indicated that *M. modestum* (Hottes) (*Carolinaia modesta* Hottes, 1926b:117) was closely related to *M. rabeleri*. He also placed *Myzodes* (*Myzodium*) *brevirostre* Börner (1950a:11) in *Myzodium*. Hille Ris Lambers (1952b:15) stated that *Myzodes rabeleri* Börner "can hardly be anything but this species (*Carolinaia modestus* Hottes), also, *M.* (*Myzodium*) *brevirostris* Börner 1950 might be the same species." Heinze (1960a:818) retained *Myzodium brevirostris* Börner as a distinct species. Stroyan (1966a:112) placed *brevirostris* Börner in *Dysaphis*. Remaudière (1952a:242) described *Myzodium lagarriguei* but this species is now placed in *Ericaphis* (Hille Ris Lambers, 1955a:9; Stroyan, 1957b:323; and Prior and Stroyan, 1960a:283).

We have not seen all of the above species but we are accepting the opinions of the various authors. Thus, *Myzodium* presently includes only *M. modestum* and *M. knowltoni*, n. sp.

Myzodium is characterized as follows. Apterae without secondary rhinaria. Alates with secondary rhinaria scattered irregularly on antennal segments III, IV and V. Vertex of aptera widely W-shaped, with a distinct small central protuberance. Head, antennal segments I and II rugose. Antennal segments III–VI, coxae, femora and siphunculi strongly imbricated. Tarsal chaetotaxy, 3-3-2. Cauda shield-shaped.

Fig. 1. *Myzodium knowltoni*, n. sp., apterous vivipara.

Key to Apterous Viviparae

1. Dorsum of abdomen sclerotic, rugose .... *M. modestum* (Hottes)
— Dorsum of abdomen not sclerotic, sometimes appearing rugose on sides
    because of reticulations .... *M. knowltoni* Smith and Robinson

Myzodium knowltoni Smith and Robinson, new species
fig. 1

Apterous Viviparae: Color of cleared specimens not distinctive, thorax and abdomen pale, with head, siphunculi, cauda and appendages slightly darker.

Much variation among specimens in body size. Body length (not including cauda), 1.16² (0.88–1.74). Frontal tubercles moderately produced, divergent,

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² All measurements in millimeters. The measurement before the parentheses is that of the holotype or lectotype.

covered by small blunt scales or nodules. Antennal segment I almost as rough as head, II less rough, remainder of antennal segments imbricated throughout. Setae on head and antennal segments sparse, blunt and minute, those on III not more than 0.005 long. Antennae 6-segmented, shorter than body, 0.72–1.26 long. Length of antennal segments: III, 0.21 (0.16–0.31); IV, 0.15 (0.10–0.21); V, 0.12 (0.09–0.17); VI, 0.09 (0.07–0.12) + 0.24 (0.17–0.31). Secondary rhinaria absent. Rostrum reaching beyond metacoxae; rostral IV + V, 0.12 (0.11–0.14) long with usually 2, occasionally 4 setae in addition to those at the apex.

Thorax and abdomen strongly and coarsely reticulate dorsally under high magnification. Length of metatibiae, 0.55 (0.41–0.76). Metatarsomere II, 0.075 (0.06–0.09).

Siphunculi, 0.25 (0.20–0.37) long, tapering from base to just before apex, then widening to a strong flange; diameter at base 1.5–2.0 times narrowest diameter of siphunculi. Siphunculi with strong, coarse imbrications. Cauda, 0.09 (0.07–0.10) long, shield-shaped, with usually 1 dorsal preapical and 2 pairs of lateral setae.

Alate Viviparae (11 specimens): Color of cleared specimen: head, thorax, antennal segments beyond base of III, brown; antennal segments I, II and base of III, pale. Abdomen pale with faint, brown, dorsal transverse bands on segments III–VII. Bands on abdominal segments may be coalesced. Siphunculi and tip of cauda darker.

Body length (not including cauda), 1.40–2.09. Frontal tubercles moderately produced and divergent, covered with small scales or nodules, but noticeably less rough than head. Antennal segments I and II scaly, remainder of antennal segments imbricated throughout. Setae on head and antennal segments sparse, blunt, minute; those on III not more than 0.005 long. Antennae 6-segmented, shorter than body (1.25 long). Length of antennal segments: III, 0.35–0.44; IV, 0.19–0.32; V, 0.16–0.25; VI, 0.11–0.14 + 0.29–0.39. Secondary rhinaria on III, 20–35; IV, 6–14; V, 0–6. Rostral segments IV + V, 0.12–0.15 long, with 2–4 setae in addition to those at the apex. Length of metatibiae, 0.75–1.01, of metatarsomere II, 0.08–0.10. Wings hyaline, media twice-branched. Siphunculi, 0.25–0.30 long, slightly tapering, but more cylindrical than in apterous viviparae, with strong flange, and coarsely imbricated. Cauda, 0.09–0.12 long, shield-shaped, with 1 dorsal preapical and 2–3 pairs of lateral setae. Abdomen smooth dorsally, lateral sclerites slightly scaly.

Collections: All of the specimens of *M. knowltoni* were collected by placing samples of "moss" in a modified Berlese funnel and capturing the specimens in alcohol when they left the "moss." *Myzodium knowltoni* has not been observed feeding on moss. All samples were collected in Logan Canyon, Utah. Tony Grove Canyon used to be known as part of Logan Canyon.

Types: Holotype: apterous viviparous female, Logan Canyon, Utah, 12 August 1962 (Coll. K62-70, 1 slide G. F. Knowlton Coll.) deposited in the United States National Museum. Paratypes: All from areas in Logan Canyon. Tony Grove Creek, 5 August 1972 (2 slides, G. F. Knowlton and R. K. Casier Coll.), 6 August 1973 (2 slides, G. F. Knowlton Coll.), Tony Grove Canyon, 21 August 1974 (1 slide, Coll.

Fig. 2. *Myzodium modestum* (Hottes), apterous vivipara.

No. 74-52, and 5 slides, Coll. 74-53, G. F. Knowlton and C. F. Smith Coll.).

Logan Cave, 9 September 1974 (4 slides, Coll. K74-3; 9 slides, Coll. No. K74-4; 10 slides, Coll. No. K74-5, G. F. Knowlton Coll.); 10 September 1974 (2 slides, Coll. No. K74-23, G. F. Knowlton Coll.). Spring Hollow, 20 September, 1974 (Coll. No. K74-27, 3 slides, Coll. No. K74-29, 1 slide G. F. Knowlton Coll.).

Paratype slides deposited in the collections of the United States National Museum, the Canadian National Collection, A. Grant Robinson, George F. Knowlton, North Carolina State University at Raleigh and Clyde F. Smith.

Comments: *Myzodium knowltoni* is similar to *M. modestum*

(Hottes), but in *modestum* the thorax and abdomen of the apterous viviparae are sclerotized dorsally, and the siphunculi are very black (fig. 2). In *knowltoni* the abdomen is reticulated dorsally and the siphunculi are paler. Also, there are differences in the shape of the siphunculi and cauda (see fig. 1 and 2). This species is named in honor of G. F. Knowlton, Professor Emeritus of Entomology, Utah State University and an indefatigable collector of aphids.

Myzodium modestum (Hottes)

Carolinaia modesta Hottes 1926b:117.
Myzodes (*Myzodium*) *rabeleri* Börner 1950a:11.

Apterous Viviparae: Color of cleared specimen: Head, thorax, dorsum of abdomen and all appendages dusky to dark. Older specimens very dark on dorsum of the abdomen.

Much variation among specimens in body size. Body length (not including cauda), 1.2–1.65. Frontal tubercules moderately produced and divergent, covered by small blunt scales or nodules. Antennal segments I and II almost as rough as head. Remainder of antennal segments imbricated throughout. Setae on head and antennal segments sparse, acute to slightly blunt and minute. Those on III not more than 0.008 long. Antennae 6-segmented. Length of antennal segments III, 0.27 (0.18–0.27); IV, 0.14 (0.12–0.16); V, 0.16 (0.13–0.16); VI, 0.10 (0.09–0.11) + 0.29 (0.24–0.32). Secondary rhinaria absent. Rostrum reaching beyond metacoxae. Rostral segments IV + V (0.12–0.16); usually with 4 setae in addition to those at the apex. Length of metatibiae, 0.82 (0.66–0.85). Metatarsomere II, 0.09 (0.08–0.10). Siphunculi, 0.34 (0.27–0.38). Siphunculi with strong, coarse imbrications. Cauda, 0.07–0.09, shield-shaped, with usually 1 dorsal preapical and 2 pairs of lateral setae. Dorsum of abdomen sclerotic and rugose.

Alate Vivipara: One specimen. Antennae, siphunculi, cauda, distal ⅔ of femora, tip of tibiae and of tarsi dusky.

Antennal segment III, 0.42; IV, 0.25; V, 0.23; VI, 0.11 + 0.34. Secondary rhinaria on III, ca. 30; IV, ca. 10; V, 0. Rostral segments IV + V, 0.14. Metatibia, 0.97. Metatarsomere II, 0.10. Siphunculi, 0.26, with imbrications, shaped similarly to those of apterous viviparae. Cauda, 0.07, shield-shaped with apparently 2 pair of lateral setae.

Types: There are 4 slides marked paratype in the United States National Museum. One slide has 3 apterous viviparae. The 1 at the top of the slide, which has 1 complete antenna is here designated lectotype. Data on slide, "*Carolinaia modestus, Polytrichum commune*, June 23, 1925, St. Paul, Minnesota, F. C. Hottes." Paratype, F. C. Hottes.

Comments: *Polytrichum commune* Hedw. appears to be the most common host for this aphid. We have seen specimens from California (R. C. Dickson), Minnesota and North Carolina in the United States and Caddy Lake, Manitoba, Canada. It has been recorded from Aus-

tria, England, Germany, Greenland, Iceland, the Netherlands and Scotland.

References

Literature references are in "Bibliography of the Aphididae of the World" by Clyde F. Smith. North Carolina Agricultural Experiment Station Tech. Bull. No. 216, 1972.

NOTES ON THE GENUS POMERANTZIA BAKER WITH A DESCRIPTION OF A NEW SPECIES FROM INDIANA (ACARINA: POMERANTZIIDAE)

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ABSTRACT—*Pomerantzia kethleyi* Price, a new species of pomerantziid mite from prairie soil in Indiana is described. Morphological features which appear to have particular taxonomic value are indicated, and a key to the 4 known species in the family Pomerantziidae is given.

To date, only 3 species of mites have been described in the family Pomerantziidae, i.e., *Pomerantzia charlesi* Baker (1949), *P. prolata* Price (1971), and *P. benhami* Price (1974). The first species was described from Georgia, the latter 2 from California. An additional species from a prairie habitat in Indiana is described below. Knowledge of 4 species permits comments on taxonomically useful structures in this rare group of mites.

Pomerantzia kethleyi Price, new species

Female: Elongate, weakly sclerotized, soil-dwelling mite measuring about 0.5 mm in body length. Closely resembling *P. prolata* Price except in the chaetotaxy of the legs and genital region. Peritremes with 6–7 chambers. Propodosomal plate with 3 pairs of marginal setae and a faint median reticulated area. Hysterosoma with 5 dorsal plates. Dorsolateral hysterosomal setae situated in a line slightly anterior to setae of hysterosomal plate I. With 4 pairs of genital and 4 pairs of paragenital setae. Anus terminal, with 3 pairs of setae. Without discrete ventral plates anterior to coxal plates of legs III and IV. Numbers of tactile setae (first figure) and chemosensory setae, including both solenidia and sensory pegs (figure in parentheses, only if present), on the podomeres of legs I through IV respectively are: tarsi, 19(8)-13(6)-11-12; tibiae, 12(3)-5(1)-5(1)-9(1); genua, 10(1)-5-5-6; telofemora, 5-5-4-5; basifemora, 5-4-3-3; trochanters, 1-1-2-1; coxae, 4(2)-4-4-3. Coxa I bears both a supracoxal and an infracoxal sensory peg, as in *P. prolata*. Average and range of measurements in microns of 5 adult specimens are: anus to tips of chelicerae 528, 508–549; leg I (from coxo-trochanteral joint to claw tips) 314, 306–326; leg II 196, 191–204; leg III 216, 210–225; leg IV 278, 271–291; and tarsus I (to claw tips) 60, 56–62.

Tritonymph: Resembling adult female, but with only 3 pairs of genital and 3 pairs paragenital setae and lacking an ovipositor. With 3 pairs of genital discs. Leg chaetotaxy as in the adult except for 1 less solenidion on tarsus I and II, and 1 less tactile seta on tibia IV. Peritremes with 4–5 chambers. Two specimens examined averaged 451 microns from anus to tips of chelicerae.

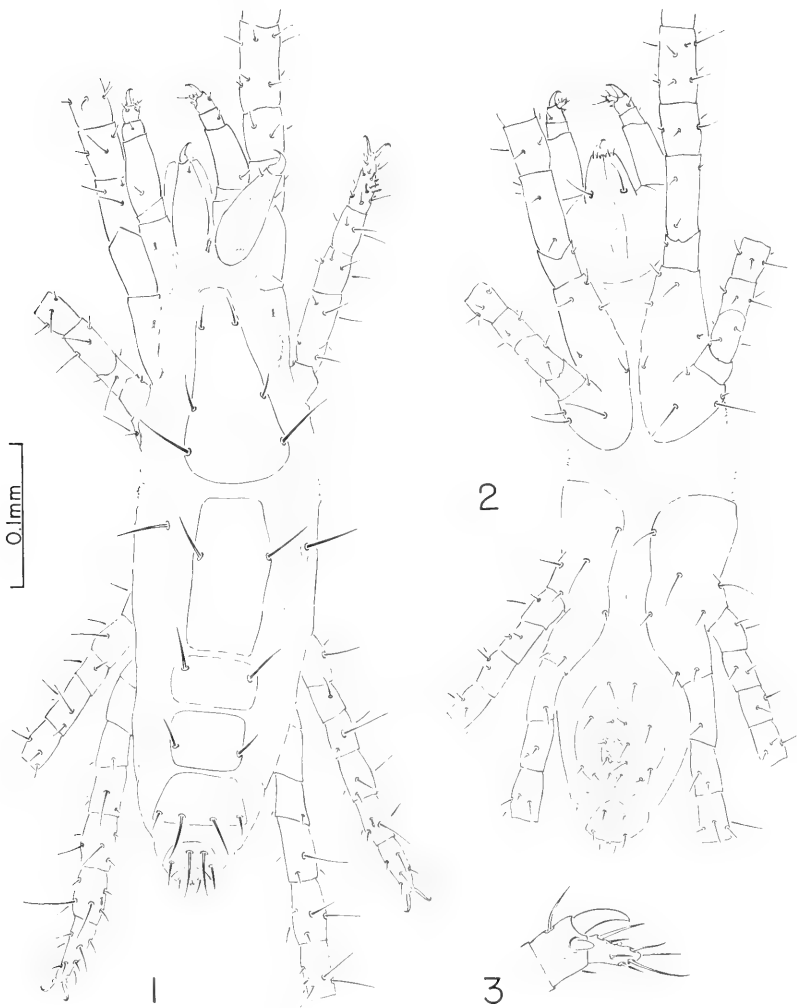The male and the other nymphal stages are unknown.

Fig. 1–3. *Pomerantzia kethleyi*, new species. 1, adult female, dorsal view. 2, same, ventral view. 3, same, tibia and tarsus of palpus, inner side.

The type locality of *P. kethleyi* is 2 miles S. of St. John on U.S. 41, Lake County, Indiana. These mites were collected at several depths between 35 and 65 cm in prairie grassland soil on December 15, 1973. The species is named after the collector, Dr. John Kethley of the Field Museum of Natural History, Chicago. The holotype female, 3 paratype females, and 2 tritonymphs are deposited in the Field Museum of
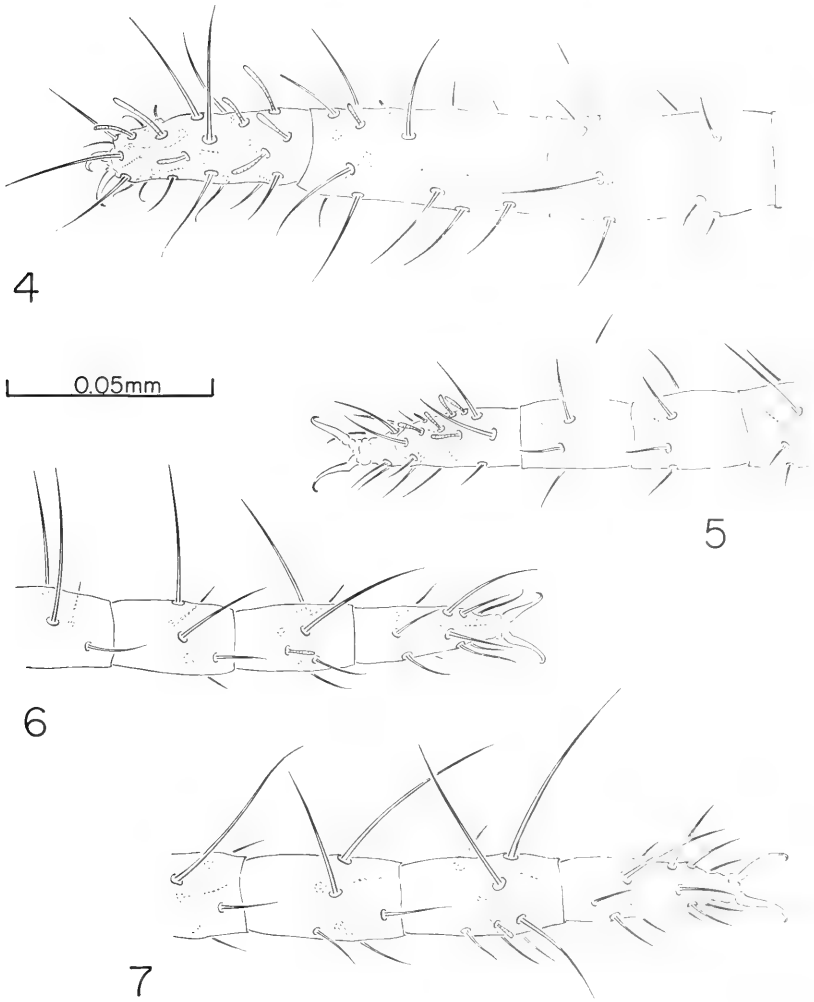
Fig. 4–7. *Pomerantzia kethleyi*, new species. 4, adult female, terminal segments of leg I. 5, same, leg II. 6, same, leg III. 7, same, leg IV.

Natural History, Chicago. One paratype female is in the author's collection.

As noted by Price (1974), *P. charlesi* and *P. benhami* are similar to each other and distinct from *P. prolata* in 1) having a pair of ventral plates anterior to the coxal shields of legs III and IV, 2) lacking a ventral sensory peg on coxae I, 3) lacking a sensory peg on tarsi II, and

4) having the dorsolateral hysterosomal setae situated in a line posterior, rather than anterior, to the setae of the first hysterosomal plate. *Pomerantzia kethleyi* n. sp. resembles *P. prolata* with respect to the above characters, and therefore the 4 known species appear to fall into 2 groups of 2 species each. As additional species become known, the differences noted above may justify placement of *prolata* and *kethleyi* in a distinct genus.

In addition to the above, the most important characters for species identification appear to be the numbers of genital and paragenital setae, numbers of solenidia on tarsi I and II, numbers of tactile setae on genua I and on the tarsi, tibiae, genua, and coxae of legs IV. The number of chambers in the peritremes, nature of the reticular pattern on the propodosomal plate, and size of the ovipositor also may be useful. An amplified key to species based on these characteristics is presented below.

Key to the Adult Females of the 4 Known Species of Pomerantzia Baker

1. With discrete ventral plates anterior to coxae III, dorsolateral setae in line posterior to setae of hysterosomal plate I, coxa I without a ventral sensory peg, tarsus II without sensory peg, with 5 pairs of genital setae, 12 tactile setae on genua I, 5 on genua IV, and 4 on coxae IV 2

— Without ventral plates anterior to coxae III, dorsolateral setae in line anterior to setae of hysterosomal plate I, coxa I with ventral sensory peg, tarsus II with sensory peg, with 3 or 4 pairs of genital setae, 10 tactile setae on genua I, 6 on genua IV, and 3 on coxae IV 3

2. Length from anus to cheliceral tips about 350 microns, with posterolateral pores on hysterosomal plate III, without reticular pattern on propodosomal plate, with 16 tactile setae on tarsi I, 11 on genu I, 13 on tarsus II, and 8 on tibia IV .... *charlesi* Baker

— Length about 450 μ, without pores on hysterosomal plate III, with reticulations on propodosomal plate, with 19 tactile setae on tarsus I, 12 on genu I, 14 on tarsus II, and 9 on tibia IV .... *benhami* Price

3. With 5 solenidia and 1 sensory peg on tarsus I, 2 solenidia and 1 sensory peg on tarsus II, 11 tactile setae on tarsus IV, and 3 pairs genital and 3 pairs paragenital setae .... *prolata* Price

— With 7 solenidia and 1 sensory peg on tarsus I, 5 solenidia and 1 sensory peg on tarsus II, 12 tactile setae on tarsus IV, 4 pairs genital and 4 pairs paragenital setae .... *kethleyi* Price, n. sp.

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ORUS FEMINEUS, A NEW SPECIES OF STAPHYLINIDAE (COLEOPTERA) FROM FLORIDA

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ABSTRACT—*Orus* **femineus** is described from Florida. This is the first species in the genus in which the female has diagnostic sexual characteristics.

The genus *Orus* was revised by Herman (1964, 1965) who presented excellent illustrations including invaluable drawings of the secondary male characteristics, thus making positive specific identifications possible for the first time. Moore and Legner (1972) described and illustrated 2 new species of *Orus* (*s. str.*) from California.

In this paper we describe a new species of *Orus* (*s. str.*) from Florida, the first of this genus from the southeastern United States except for a single doubtful record of *Orus* (*Pycnorus*) *dentiger* (Le Conte) from Georgia.

Females of *Orus* usually have very weak external distinguishing characters. The female of the new species described below has a strong character to distinguish it from all others.

Key to Males of Orus (s. str.)

1. Last visible abdominal sternite shallowly emarginate, emargination not deeper than wide 2
— Last visible abdominal sternite deeply emarginate, emargination deeper than wide 4
2. Fifth visible abdominal sternite emarginate; neck ⅕ the width of head 3
— Fifth visible abdominal sternite sinuato-truncate; neck ¼ the width of head .... *shastanus* Casey
3. Fourth visible abdominal sternite with central emargination bounded each side at border by denticle; surface centrally impressed with tubercle within impression .... *femineus* n. sp.
— Fourth visible abdominal sternite unmodified .... *montanus* Fall
4. Fifth visible abdominal sternite sinuate along posterior margin .... *sinuatus* Herman
— Fifth visible abdominal sternite with posterior margin lobed or emarginate 5
5. Fifth visible abdominal sternite emarginate 6
— Fifth visible abdominal sternite lobed 8
6. Emargination of 5th visible abdominal sternite more than ½ as deep as wide .... *giulianii* Moore and Legner
— Emargination of 5th visible abdominal sternite less than ½ as deep as wide 7

7. Fifth visible abdominal sternite deeply impressed ....
.... *frommeri* Moore and Legner

— Fifth visible abdominal sternite very shallowly impressed .... *fraternus* Fall

8. Fifth visible abdominal tergite with tubercle 10

— Fifth visible abdominal tergite without tubercle 9

9. Paramere short, not extending beyond apex of median lobe, broad, with
lateral margins straight in dorsal aspect .... *hemilobatus* Herman

— Paramere long, extending beyond apex of median lobe, slender, with
lateral margins sinuate in dorsal aspect .... *punctatus* Casey

10. Abdominal tubercle well developed, margined laterally by a carina; meta-
femora carinate .... *femoratus* Fall

— Abdominal tubercle feeble, not margined by carina; metafemora not
carinate .... *distinctus* Casey

Orus (*s. str.*) *femineus* Moore and Legner, new species

Holotype (male): Head and pronotum dark castaneous with anterior margin
of pronotum paler; elytra piceous with narrow testaceous border; abdomen piceous;
antennae, trophi and legs testaceous. *Head*: As wide as long; above finely densely
punctured and finely densely microreticulate; beneath sculptured much as above
except gula which is smooth and not impressed; supraorbital fovea vague; labrum
strongly quadridentate, 2 central teeth slightly longer than lateral teeth, central
teeth obliquely truncate at apices. *Pronotum*: $\frac{1}{10}$ longer than head, $\frac{1}{5}$ longer
than wide; sculptured much like head; with vague longitudinal raised central
line. *Elytra*: $\frac{1}{10}$ longer than pronotum, conjointly $\frac{1}{10}$ wider than long; surface
sculpture a little coarser than that of head and pronotum. Anterior tarsus mod-
erately dilated. *Abdomen*: With surface of 3rd visible sternite vaguely im-
pressed centrally near apex; apical margin of 4th visible sternite emarginate in
central $\frac{3}{5}$, emargination with distinct tooth each side, surface impressed adjacent
to emargination, center of impression raised in distinct, conical tubercle; apical
margin of 5th visible sternite shallowly emarginate in central third, the adjacent
surface strongly impressed; apical margin of 6th visible sternite abruptly emar-
ginate in central third, the emargination almost as deep as wide, surface strongly
impressed adjacent to the emargination. Lenth 4.5 mm.

Tall Timbers Research Station, about 25 miles north of Tallahassee, Florida,
July 11, 1972, ultraviolet light, C. W. O'Brien collector.

Allotype (female): Similar to holotype except head and pronotum a little
darker; anterior tarsus not dilated; sternites not modified; 6th tergite with surface
in apical half deeply impressed each side of midline so as to create distinct ridge
which is produced beyond apex in pointed tooth. Same data as holotype.

Paratypes: One ♀, same data as holotype; 1 ♂, 2 ♀ ♀ same data except
July 4, 1972; 1 ♀ same data except July 7, 1972; 1 ♂ Gainesville, Florida March
4–6, 1967, ultraviolet light, D. L. Hays collector.

Variation: The testaceous apical margin of the elytra is reduced or absent
on some specimens.

Distribution of types: The holotype and allotype are deposited in the En-
tomology Department of the California Academy of Sciences, 1 paratype each
with University of Florida; Florida State Collection of Arthropods; J. F. Cornell;
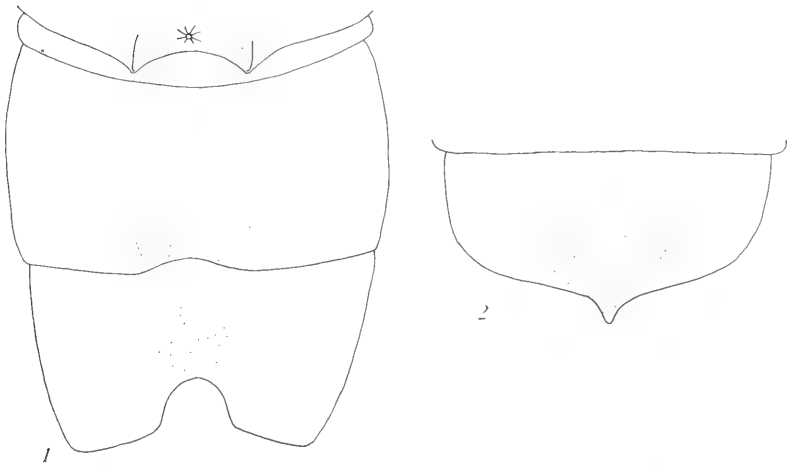
Fig. 1–2. *Orus femineus* n. sp. 1, Apex of fourth, and fifth and sixth visible abdominal sternites of male. 2, Sixth visible abdominal tergite of female.

and the remaining 2 specimens in the collection of the University of California at Riverside.

The most remarkable characteristic of this species is the strongly modified 6th visible tergite of the female. Females of the other known species of *Orus* are very difficult to differentiate among themselves.

Males of this species can be distinguished from all other species by the strongly modified 4th visible tergite with a pronounced tubercle in the middle of the central impression.

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LARVAL HABITATS OF TABANUS SUBSIMILIS SUBSIMILIS BELLARDI IN SOUTHEAST TEXAS (DIPTERA: TABANIDAE)

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ABSTRACT—*Tabanus subsimilis subsimilis* Bellardi is an abundant, widespread, and aseasonal horse fly throughout some southern states. Heretofore knowledge of its larval habitat was based upon 4 collections. Three pupae and 180 larvae have now been taken from diverse habitats in south Texas: established lawn turf (St. Augustine and Bermuda grasses); grassy seepage areas from domestic septic tanks and sink drains; flower beds containing bugleweed, *Ajuga reptans* L., and *Chrysanthemum* spp. (1 locality) and *Canna lilies* (2 localities); compost beneath a fallen, rotted tree in a forest; and levees of flooded rice fields. The most heavily populated breeding sites described here were characterized by upland locations, mineral soils, absence of standing water, and soil moisture provided by seepage. This information suggests *T. s. subsimilis* is a highly adaptive and generalized soil insect, not depending upon the niches usually associated with tabanid breeding in lowlands. Its occurrence in both uplands and lowlands suggests the larva of this species has wide adaptive limits regarding habitat requirements. This attribute complements other characteristics also showing high biotic potential—high frequency of occurrence in different localities where it is abundant (the most frequent species in southeast Texas); dominance in 5 physiographic regions; wide distribution in the southern U.S.; and extensive seasonal range.

Collectors of immature Tabanidae have commented on the sparsity of larvae of species often predominating as adults—some, the most widespread and most abundant pest species of southeastern North America. Some are unknown as larvae and others are uncommon or rare in larval collections near standing water. The immatures of some are undescribed. The species known as larvae have been described from few specimens. These are the so-called "terrestrial" species, known largely, if at all, from the drier, more well-drained, and predominantly mineral soils of uplands.

Heretofore, knowledge of the larval habitat of *Tabanus s. subsimilis* Bellardi was based upon 4 collections—each made in 1 locality of Tennessee, Texas, Alabama, and South Carolina. Goodwin (1967) collected a single larva of *T. subsimilis* from mud beneath the surface of a small pasture pond in Tennessee. His description is based upon that specimen (Goodwin, 1973). Gingrich and Hoffman (1967) collected 452 larvae of *T. subsimilis* (and *T. atratus* F.) in effluent that had drained into a dry creek bed behind a barn producing a loose, spongy mat of fecal debris. A sample of 50 specimens contained 8 *T. subsimilis* larvae. The identity of adults reared from these larvae was confirmed by Dr. Alan Stone (R. A. Hoffman, personal commu-

nication). Watson (1968) reared 1 male and 1 female from larvae collected in a pond bank in Baldwin Co., Alabama. Two larvae were taken from seepage areas on a South Carolina golf course by L. L. Pechuman and T. R. Adkins, Jr. in 1970 (Pechuman, personal communication).

<div align="center">Larval Collections of T. subsimilis in South Texas</div>

The first larva of *T. subsimilis* was discovered by my daughter, Virginia, in a flower garden of our home (March 11, 1973). The flower beds skirted the side of the house and contained bugleweed (*Ajuga reptans* L.) and *Chrysanthemum* spp. Several weeks later, I found 1 pupa in the same beds. Thirty feet from the *Ajuga* beds, a second larva was found beneath the roots of dense, established lawn turf. The predominating grass in this area was St. Augustine (*Stenotaphrum secondatum* (Walt.) Kuntze), with some Bermuda grass (*Cynodon dactylon* (L.) Pers.). The larva was about 8 in. beneath the soil surface. I subsequently found 2 larvae in *Canna* lily beds in my lawn nearby, and an additional larva in compost beneath a fallen, rotted tree some 20 yds away in an adjoining woodlot. (*Leucotabanus annulatus* (Say) was also found in this compost.) Two larvae were discovered in a second *Canna* bed near the laboratory. This bed is enclosed by a concrete wall and was flooded at the time. The larvae were found floating on the water surface by students sampling mosquito larvae there.

Nine larvae were taken from sod surrounding flooded rice fields. The larvae were found in soil samples which were taken here above the water line of levee slopes and subsequently examined for mosquito eggs. This location is near Danbury, Texas and some 11 mi NW and inland from the West Bay of Galveston. *Tabanus subsimilis* was commonly collected as an adult in a West Bay coastal marsh near this larval collection site (Thompson, 1973a).

The collections of these 16 larvae and 1 pupa were mostly fortuitous. Those made in my lawn and garden suggested *T. subsimilis* could breed there and in adjacent upland situations in large numbers. Therefore, an intensive examination of the premises near my home was made to determine the extent of such breeding. My lawn and garden were examined, as were natural and undisturbed habitats in the adjoining woodlot—an upland oak forest.

Post oaks (*Quercus stellata* Wang.) are the predominating trees with some blackjack oaks (*Q. marilandica* Muenchh.) and willow oaks (*Q. phellos* L.) on the ridges, and water oaks (*Q. nigra* L.) in the gullies and washes. The dominant shrub is yaupon (*Ilex vomitoria* Ait.) which gives these woods their sometimes brushy character when it supports dense growths of lianas here—greenbriar (*Smilax* spp.).

poison ivy (*Rhus radicans* L.), Virginia creeper (*Parthenocissus quinquefolia* (L.) Planch.), wild grape (*Vitis* sp.), and ivy treebine (*Cissus incisa* (Nutt.) Des Moulins). Although most of this forest is on a ridge with sharp slope, large areas are marked by alternating narrow ridges and dry wash gullies, the latter carrying runoff to an intermittent stream feeding a nearby impoundment.

In mid-February of 1975, 40 sq ft of soil were examined in the sandy banks of the intermittent stream; in the *Canna* beds where several larvae were previously found; in a dry, well-drained and open lot between my lawn and the oak forest behind it; and in well-drained and leaf-littered depressions of the forest. The top 3 ins. of these soils were turned with a rotary tiller and then critically examined using hand cultivators. No tabanid larvae were found.

Ground treatments with aqueous emulsions of pyrethrins, similar to those used for the same purpose by Bailey (1948) were made in July and August in my lawn and garden and in the adjoining woodlot. These collections produced 164 more larvae and 2 pupae of this species. The great majority of these (91%) came from 2 grassy, algae-laden seepage areas produced by effluent from domestic septic tanks. The first area was the *Canna* lily bed previously described which had become saturated with seepage from my now improperly operating septic tank (28 larvae). The second was an unshaded open area adjoining my lot and produced by my neighbor's septic tank; this area was bare but for algae and invading sparse Bermuda grass (125 larvae and 2 pupae). One larva was also taken from a leaf-covered forest gully behind the house, kept moist by an open sink drain.

Pyrethrin treatments were also made in the oak forest in well-drained and leaf-littered depressions; in damp, leaf-littered depressions in dry-wash gullies; and in the sandy beds and pool margins of the intermittent stream below the forest. Only the damp and leaf-littered depressions of dry-wash gullies produced larvae (9 larvae in 4 treatments of approximately 81 sq ft of gully surface). One of these larvae was *T. subsimilis.*

Larvae were maintained in 2-oz clear glass vials containing washed builder's sand and exposed to a 14½-hr photoperiod and were fed lab-reared house fly or stable fly larvae once weekly. Adults were reared from 1 or more larvae taken at each site; approximately ⅓ of the 155 larvae taken from plumbing seepage areas in the yard near my home were reared to adults.

Discussion and Conclusions

Habitat descriptions from the literature and my descriptions here enable several general conclusions regarding the larval habitat of this apparently highly adaptive species.

Proximity to Water: Extensive larval collections in the southern U.S. in recent years by many workers—most of these concentrated in lowlands in, under, and near water—have produced only 4 samples conclusively shown to represent this species. At least some of the collections by Schwardt in Arkansas under *T. lineola* L. (1931; 1936) probably represented *T. subsimilis*; Schwardt's studies included examination of drier situations under stones and leaves. Extensive collections were made in littoral sites of several other study areas of the state where adult faunal studies were being conducted (Thompson, 1973b, 1974a). This work produced larvae of some horse flies abundant or common there as adults (*Tabanus atratus, T. cymatophorus* Osten Sacken, *T. molestus* Say, *T. nigripes* Wiedemann, *T. petiolatus* Hine, *T. proximus* Walker, *T. stygius* Say, *T. trimaculatus* Palisot de Beauvois, and *T. venustus* Osten Sacken); but larvae of the very abundant *T. subsimilis* (and of *T. fuscicostatus* Hine, *T. sulcifrons* Macquart, and *Hybomitra lasiophthalma* (Macquart)) were absent in such collections.

Other habitat descriptions in the literature, as those of Schwardt for *T. lineola* F., could have been based upon collections of *T. subsimilis*. Philip (1942) noted that the form most commonly reared by Schwardt (1931) as *T. lineola* F. was *T. subsimilis* Bellardi (= *T. vittiger schwardti* Philip; Philip, 1965). Although no habitat information was available for the 16 specimens of each sex that Philip selected as paratypes, Schwardt (1936) did note that larvae were invariably taken near stagnant water. He elaborated this description with additional collections and observations:

"While usually taken in mud near ponds or watercourses, larvae occasionally are found under stones or leaves in fairly dry places. In the summer of 1933, hundreds were found in masses of floating algae in a small swamp."

The diversity of larval habitats critically documented for *T. subsimilis* suggest any and all of the habitats described by Schwardt could have applied to this species. Although *T. subsimilis* was found beneath standing water in a pond by Goodwin (1973), in a pond bank by Watson (1968), and in the rice field levees I report here, my collection data suggests this species breeds predominantly in upland situations.

Physical Substratum: Teskey (1969) noted in his study of immature forms representing eastern North American species that his *Tabanus* collections were more frequent in soils having mineral constituents, in contrast to those of *Hybomitra* and *Atylotus* which were made in organic soils. He added that such habitat associations might reflect geographic distribution more than specific habitat preference. The common occurrence of some abundant and widespread species such

as *Tabanus quinquevittatus* Wiedemann, *T. sulcifrons*, and *Hybomitra lasiophthalma* in both mineral soils unassociated with standing water and in a variety of lowland habitat niches, suggests habitat selection is adaptive for such successful species. These same conclusions apply to *Tabanus subsimilis*. Although an unnatural situation, the spongy matted vegetative substratum from barn effluent described by Gingrich and Hoffman (1967) was entirely organic. The soils near my home containing this species included decomposed organic matter containing little mineral soil (oak compost); top soil mixed with coarse sand from a stream bed and with rotted manure (*Ajuga* beds); top soil mixed with some coarse sand (*Canna* beds); and sandy clay soils beneath dense grass root mats (lawn turf); or algae-laden mineral soil covered by sparse grass growth (septic tank seepage areas). Physical substratum is apparently a nonlimiting factor in larval habitat selection.

Larval Habitat Diversity and Adaptation: The collections by Goodwin (1967), Gingrich and Hoffman (1967), Watson (1968), and Pechuman (personal communication) and Adkins were made from diverse habitats: mud beneath a small pasture pond; spongy, matted fecal debris from barn effluent accumulating in a dry creek bed; a pond bank; and a golf course seepage area, respectively. The rice field and lawn and garden habitats I have described in this paper also show *Tabanus subsimilis* breeds in a great variety of situations.

My lawn and garden collections, 2 of which produced large numbers (155) concentrated in well-defined localized habitats, probably represent the more typical habitats of this species—habitats characterized by upland locations, mineral soils, absence of standing water, and soil moisture often provided by seepage. The occurrence of *T. subsimilis* in my lawn and garden—an ecologically disturbed rural habitat, like that of *T. cheliopterus* var. *fronto* Osten Sacken in the garden of Brimley (1911)—is probably secondary and has no specific causal relationship in habitat selection. The diversity of habitats described here, especially those in wild situations, supports this contention.

This habitat diversity suggests *T. subsimilis* is a highly adaptive and generalized soil insect, not necessarily dependent upon the habitat niches associated with tabanid breeding in lowlands. Its occasional occurrence in both lowlands (pond banks, rice field levees) and uplands suggests this horse fly is more generalized ecologically than other species breeding in or near water. This adaptability to larval habitat complements several other characteristics showing high biotic potential.

Abundance, Frequency, and Geographical Distribution: *Tabanus subsimilis* is widespread, common, and often abundant in some

southern states, its distribution extending into Mexico. It is the most common species of wide distribution in east Texas. It is 1 of the major species in 5 physiographic regions of SE Texas (coastal marshes, Pine Belt, Post Oak Belt; Thompson 1973a & b, 1974a & b); less extensive collections from the Edwards Plateau and the Blackland Prairies also suggest it is 1 of the most important species there. *Tabanus subsimilis* was the most frequent species collected in the Navasota River Watershed, being taken in 14 of 16 sites surveyed in that study of Post Oak Belt fauna (Thompson, 1974a). This species is the most frequent *Tabanus* taken (either sex) in miscellaneous collections from varied sources in southeast Texas (vehicles, buildings, light traps, net collections from livestock).

Seasonal Distribution: *Tabanus subsimilis* appears in early March, peaks from late March to late May, and nearly disappears in late September. Because it occurs continuously throughout 9 months of the year and reaches maximum numbers over a 3-month period, the seasonal distribution should be considered aseasonal. Both sexes have been taken from building walls in late November. In Texas areas where both species were numerous, *T. subsimilis* commonly preceded appearance of *T. lineola* by 2–4 weeks (Thompson, 1973b, 1974a & b; unpublished data); and of *T. lineola* var. *hinellus* Philip by 2 weeks (Thompson, 1973a).

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A NEW SUBSPECIES OF GLAUCOPSYCHE (PHAEDROTES) PIASUS FROM NEVADA (LEPIDOPTERA: LYCAENIDAE)

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ABSTRACT—*Glaucopsyche* (*Phaedrotes*) *piasus* **nevada**, new subspecies, is described.

Recently Dr. J. F. Gates Clarke of the National Museum of Natural History, Washington, D.C., brought to my attention an interesting series of *Glaucopsyche piasus* Boisduval that he had collected in central Nevada. These specimens are unusually dark on the upper side with very broad blackish margins. Study of material at the U.S. National Museum, the Allyn Museum of Entomology in Sarasota, Florida, and the University Museum, Boulder, Colorado, confirmed Dr. Clarke's surmise that an unnamed subspecies existed. Inquiry was made of Dr. Rindge at the American Museum of Natural History, Mr. Clench at the Carnegie Museum and Mr. Herlan at the Nevada State Museum. None have material from the mountains of central and eastern Nevada. Material seen from the Toiyabe Range, the Toquima Range, the Snake Range and the Ruby Mountains is consistently different from surrounding subspecies. The full extent of the range of this novelty to the east and the southwest has not yet been determined. Burdick material from the White Mountains of California adjacent to the south central Nevada border is closer to the new subspecies than to Californian *sagittigera* (F. and F.). Material from Pocatello, Idaho, is intermediate to the new subspecies and *toxeuma* Brown. This somewhat established the north-south range.

Glaucopsyche (*Phaedrotes*) *piasus nevada* Brown, new subspecies

fig. 1

MALE: maximum radius of the left forewing of the holotype, 15.7 mm.

UPPERSIDE: dark reflecting blue with broad, dark marginal zones. On the forewing the dark marginal zone ranges basad along M_3 from about ¼ to 1½ the distance inward from the margin to the base of the wing. The dark marginal zone is narrower on the hind wing. The fringes are checkered white and black, boldly on the forewing and less so on the hind wing.

UNDERSIDE: warm, dark grey with well developed markings of the usual pattern. Forewing has greyish-black crescentic submarginal marks, indistinctly margined outwardly with a few light scales; the postdiscal series bold and narrowly ringed with whitish scales; cell-end and mid-cell spots well developed and ringed with whitish scales. Hind wing is with the whitish postdiscal band about as wide as the darker submarginal zone of ground color. The nervules are marked with light grey scales. The submarginal row of crescentic black marks is complete.

Fig. 1.   Holotype of *Glaucopsyche* (*Phaedrotes*) *piasus nevada* Brown.

A marginal spot in Cu_1-Cu_2 is crowned with an arc of pale rusty scales. Similar, smaller and less pronounced spots in the flanking interspaces are with smaller clusters of rusty scales between the spots and the whitish band. The "arrowheads" of the whitish band are not strongly sagittate. The postdiscal series of black spots is complete but varying in size. Each of these spots is ringed with whitish scales. A subcostal spot near the base, a mid-cell spot and two very small cell-end spots complete the black decoration. The characteristic elongated whitish patch on the cell often is smaller than usual in *piasus*.

FEMALE: maximum radius of the left forewing of the allotype, 13.2 mm.

UPPERSIDE: the blue is a little lighter than on the male and the dark margins wider, especially on the forewing. On the forewing the dark margin covers $\frac{1}{2}$ to $\frac{2}{3}$ the distance from the edge of the wing to the base. On the hind wing the dark margin is from $\frac{1}{5}$ to $\frac{1}{4}$ the width of the wing along Cu_2. Sometimes there are touches of rusty scales near the inner margin of the dark zone in the vicinity of the anal angle. These are never so prominent as on *piasus sagittigera*.

UNDERSIDE: marked as on the male. On the forewing the submarginal area is lighter than the rest of the ground color. On the hind wing the whitish area on the cell appears to be larger than on the male type.

DISTINGUISHING FEATURES: the subspecies *nevada* is noticeably darker on the upper side and has much wider dark marginal areas than are found on

typical specimens of the other subspecies. This is especially true of the females of *nevada*. The subspecies *piasus piasus*, from coastal regions of California, has very subdued contrast on the underside of the hind wings and in that differs from the other subspecies including *nevada*. The other west coast subspecies, *piasus sagittigera*, with strong contrast on the under hind wing, has narrower marginal dark zones, is much paler on the upperside and usually has bold rusty patches in the submargin on that surface of the female. Such patches are occasionally found on *nevada* but always are much smaller and usually obsolescent. The Rocky Mountain subspecies, *piasus daunia*, has lighter coloring on the upper side and much narrower dark margins, especially on the females. Beneath, *daunia* and *nevada* are quite close. On the upperside *nevada* and *toxeuma* approach each other in tone of the blue, but *toxeuma* has much narrower dark margins than are found on *nevada*. Beneath this pair of subspecies approach each other closely. On *nevada* the postdiscal series of black spots (at the inner edge of the whitish zone) is complete though varying in size. On *toxeuma* this series is incomplete. A tension zone between the two may exist across southern Idaho.

HOLOTYPE: a male in the collections of the United States National Museum of Natural History, Washington, D.C. It was collected by Dr. J. F. G. Clarke at Bob Scott Campground in the Toiyabe National Forest, Lander County, Nevada, 7300–7500 feet above sea level, 3 June 1974.

ALLOTYPE: a female in the collection of the United States National Museum of Natural History bearing the same data as the holotype.

PARATYPES: thirteen additional specimens, 10 ♂ ♂, 3 ♀ ♀, collected by Dr. Clarke at the same place as the holotype on dates ranging from 31 May through 3 June 1974.

In the Allyn Museum of Entomology, Sarasota, Florida, there are seven specimens from the Toiyabe Range that bear the following data: 2 ♂ ♂ Summit Canyon, 7000–7200 ft. a.s.l., Nye Co., 30-vi–1.vii.1968, collected by J. Emmel and O. Shields; 1 ♂ Kingston Canyon, Lander Co., 7.vii.1969, collected by C. Callaghan; 1 ♂ Kingston Canyon, Lander Co., 6000–7200 ft. a.s.l., 30.vi.1968, collected by J. Emmel and O. Shields; 2 ♂ ♂ south and west facing slopes, Victorine Canyon, south side of Bunker Hill, Lander Co., 8000–10,000 ft. a.s.l., 11.vii.1969, collected by J. Emmel and O. Shields; 1 ♀ Italian Creek, Lander Co., 20.vii.1969, collected by C. Callaghan.

The following paratypes in the University Museum, Boulder, Colorado, are from the William N. Burdick Collection. All of the material was taken in Nye County, Nevada, in either the Toiyabe Range or across the valley in the Toquima Range. It was papered for almost 40 years and is somewhat faded. 6 ♂ ♂, 2 ♀ ♀, Toiyabe Range, 7400', W. side Cloverdale Ck., T10N, R39E, Sec. 25, 5.vi.1935; 1 ♂, 6 ♀ ♀, Toiyabe Range, 7000', Reese River Camp, T12N, R40E, Sec. 34, 11.vi.1935; 2 ♀ ♀, Toquima Range, 8000', Mt. Jefferson Creek, T10N, R44E, Sec. 24, 16.vi.1935; 6 ♂ ♂, 1 ♀ N. Fork Twin River, 7–9000', T12N, R42E, Sec. 23, 22.vi.1935; and, 1 ♀, S. Fork Twin River, T12N, R42E, Sec. 28, 25.vi.1935.

In addition to the type series in the National Museum of Natural History there is a short series of *nevada* from the Angel Lake area, Humbolt Range (Ruby Mountains) in Elko County, Nevada, taken 29.vii.1949. In the Allyn Museum

there are 30 specimens from the Angel Lake area and three from other points in the Ruby Mountains, Elko Co., Nevada. The Allyn Museum also holds a short series from Snake Creek, Snake Range, White Pine Co., Nevada. All of these are good examples of *piasus nevada* but I have excluded them from the paratype series. My reason is trivial, I prefer the type series to be geographically as homogeneous as possible.

Specimens from the vicinity of Pocatello, Idaho, appear to be intermediate between *nevada* and *toxeuma*. The single specimen that I have seen from Humbolt County, Nevada, is best placed with *piasus sagittigera*. I suspect this may be true for all specimens from western Nevada. The series of *piasus* in the Burdick Collection from the White Mountains, Inyo County, California, resembles *nevada* very closely. It differs in that the blue of the upper side is somewhat lighter, just about the same as *sagittigera* while the dark marginal areas are as on *nevada*. I suspect that these may be somewhat faded through age.

While at the National Museum of Natural History I had the opportunity of studying Boisduval's types of *piasus* and of *rhea*. They are placed correctly in Brown (1971). On the other hand more careful study of the type of Reakirt's *catalina* in the Field Museum of Natural History, Chicago, places it and *lorquini* Behr in the synonymy of *piasus piasus* Boisduval (compare figs. 1–4 with figs. 16–18, Brown *op. cit.*).

REFERENCE

Brown, F. Martin. 1971. The "Arrowhead Blue," *Glaucopsyche piasus* Boisduval (Lycaenidae: Plebelinae). Jour. Lepidopterists' Soc. 25:240–246.

A STRANGE APHID FORM

In a collection of aphids from leaves of mockernut hickory, *Carya tomentosa*, taken June 10, 1975 at the National Arboretum, Washington, D.C., was 1 individual of *Monelliopsis nigropunctata* (Granovsky) that combines characters of ovipara and vivipara. It is largely like the ovipara—apterous with 6 rows of capitate setae (2 marginal and 4 dorsal) but it has knobbed cauda and bilobed anal plate of the adult vivipara, which is always alate. The body contains 5 smooth eggs and 4 or more setate embryos. The one hind tibia present has sensoria as found in the ovipara.

From the same collection were reared 25 normal viviparae of *nigropunctata* besides specimens of 2 species of *Monellia*.

An aphid form such as this has not been seen before in over 20 years of collecting from hickories and walnuts. Oviparae have never been taken in the Washington area before September.

THEODORE L. BISSELL, *3909 Beechwood Rd., Hyattsville, Maryland 20782.*

OBITUARY

MORTIMER D. LEONARD
1890–1975

Mortimer Demarest Leonard, Honorary member of the Entomological Society of Washington, and an active member of the Society since 1921, died peacefully on August 26, 1975. He had been in failing health for several months and on August 4 he and Mrs. Leonard moved from their residence in Washington, D.C., the scene of his "Aphids on a rooftop," to a nursing home in Cherry Hill, New Jersey. He was buried in the family plot in Ridgewood, New Jersey.

Dr. Leonard was born in Brooklyn, New York, June 23, 1890, the son of Mortimer Haight and Elizabeth Demarest Leonard. He attended local grammar schools, but his last year of elementary school education was taken at Cheshire Academy in Connecticut. In this comparatively rural area, he was fascinated with the out-of-doors. He became especially interested in birds and in learning to identify them. The following year Mortimer enrolled in DeWitt Clinton High School in New York City. There he came under the tutelage of H. G. Barber, the hemipterist, who noted Mortimer's enthusiasm for natural science and introduced him to the wonderful world of insects.

The teacher fostered the student's growing interest in entomology and when Mortimer decided to become a professional entomologist, Mr. Barber advised him to go to Cornell University where the great teacher, John Henry Comstock, headed the Department of Entomology. Mortimer matriculated in Cornell's College of Agriculture in the fall of 1909, and began an association which he treasured for his entire life. He was awarded a B.S. degree in 1913, a Ph.D. degree in entomology and plant pathology in 1921.

Dr. Leonard's entomological career was varied and unconventional. He summarized his entomological work by saying that about 40 percent of his time had been spent as an "official entomologist," about 60 percent in "commercial

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positions." In the former category he included his work as part time assistant to the Extension Entomologist, Assistant Professor in Extension Entomology and editor-in-chief of "A list of the insects of New York," all at Cornell; acting State Entomologist at Albany, New York, chief of the Division of Entomology, Insular Experiment Station, Department of Agriculture, Puerto Rico; and business analyst for pesticides in the federal office of Price Administration during World War II. Dr. Leonard's "commercial positions" started in 1921 when he left the academic life to become field director for the Bowker Chemical Company. At that time, well before the common use of pesticides for various environmental ills, such a step was unorthodox and radical and was commented on unfavorably by some members of the entomological profession. For Dr. Leonard, however, it was the first of several successful associations with commercial companies. In one capacity or another he was later employed by the Florida Agricultural Supply Company, John Powell and Company, Julius Hyman and Company, and the Shell Chemical Company. He enjoyed both "official" and "commercial" entomology, and felt that his life's work had been rewarding to him and helpful to peoples throughout the world.

Dr. Leonard's name appeared as author or joint author of about 170 articles from 1912 to 1975. Many early papers were published with the late Professor C. R. Crosby, and most dealt with injurious insects and their control. Their volume, "Manual of Vegetable Garden Insects and their Control," presented concise, compiled information on this group of insects. Other articles were published with C. P. Alexander and other Cornell associates. Several of these dealt with classification, life histories and faunal studies of dipterous, hemipterous and hymenopterous insects. His thesis for the doctorate was "A revision of the dipterous family Rhagionidae (Leptidae) in the United States and Canada," a study that remains authoritative. Other articles were concerned with the application of pesticides or the development of uses for them. Most of his later writings related to aphids.

Well before his retirement in 1961 as consultant in entomology to the Shell Chemical Company, Dr. Leonard had become interested in the collection of aphids in New York State. Thereafter he continued this project and expanded his interests to include aphids occurring elsewhere in the United States. Through his efforts thousands of aphids were collected and identified. In New York State his endeavor resulted in an increase of known species from 128 in 1928 to about 462 in 1975. He devoted much time to the preparation of regional lists which gave all available collection data for the insects. Collectors and determiners were given full credit for their cooperation and help. He gave his collection of over 500 aphid species and his aphid library to Cornell University. This material and reprints of his articles on aphids are in the Department of Entomology, Comstock Hall, Cornell University, Ithaca, New York 14850.

During his career, Dr. Leonard belonged to several scientific organizations, attended their meetings whenever possible and participated in their activities. In addition to the Entomological Society of Washington, his affiliations were, at one time or another, fellow of the American Association for the Advancement of Science; member of the American Association of Economic Entomologists, Entomological Society of America, Brooklyn Entomological Society, Florida Entomological Society, New York Entomological Society, Texas Entomological Society,

Entomological Society of Japan, Washington Academy of Sciences and Sigma Xi (honorary). He also was a member of Lamda Chi Alpha and the Cosmos Club.

Dr. Leonard attended the 4th International Congress of Sugar Cane Technologists in Puerto Rico, 3rd International Congress of Microbiology in New York, 3rd International Congress of Malaria in Washington, and the 10th International Congress of Entomology in Montreal, Canada. He also attended the 11th World Health Assembly, and the 10th Anniversary Commemorative Session of the World Health Assembly in Minneapolis, Minnesota.

Dr. Leonard was an exceptionally well known entomologist. In his work he met hosts of people of diverse disciplines from America and foreign countries, and he travelled widely in the United States. He was kind, cordial, sociable, communicative, and intensely interested in people and their activities. He was a friend to all men.

Dr. Leonard is survived by his wife of 57 years, Doris Pratt Leonard, by a brother, Donald D. Leonard, and by one nephew.

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BOOK NOTICES

The Stink Bugs of Ohio (Hemiptera: Pentatomidae). By David G. Furth. Bull. Ohio Biol. Survey (new series), vol. 5, no. 1. 1974. 60 pages. $2.50.

A Pictorial Key to the Hawkmoths (Lepidoptera: Sphingidae) of Eastern United States (except Florida). By Charles L. Selman. Ohio Biol. Survey Biol. Notes no. 9. 1975. 31 pages. $1.00.

The above two books may be ordered from the University Publication Sales Office, Ohio State University Press, 2070 Neil Avenue, Columbus, Ohio 43210.

The Stoneflies, or Plecoptera, of Illinois. By Theodore H. Frison, Illinois Natural History Survey Bull. 20, no. 4. 1935, reprinted 1975. 195 pages. $15.00.

The Mayflies, or Ephemeroptera, of Illinois. By Barnard D. Burks. Illinois Natural History Survey Bulletin 26, no. 1. 1953, reprinted 1975. 224 pages. $15.00.

The above two books have been reprinted by and are available from Entomological Reprint Specialists, P.O. Box 77224, Dockweiler Station, Los Angeles, California 90007.

PEPONAPIS FERVENS (SMITH) IN BOLIVIA (HYMENOPTERA: APOIDEA)

In their paper "South American squash and gourd bees of the genus *Peponapis* (Hymenoptera: Apoidea)," Hurd and Linsley (1967, Ann. Entomol. Soc. Amer. 60:647–661) cited only three specimens of *Peponapis fervens* (Smith) from Bolivia: two males and one female collected by Steinbach in "O. bolivien, 750 m." Because *P. fervens* reaches its northwesternmost distributional limits in Bolivia and there approaches the range of *Peponapis citrullina* (Cockerell), more definite distributional information from the area is desirable.

During December 1973, I made two collections of *Peponapis fervens* in Bolivia. On December 15, I collected seven males and one female from closed and closing blossoms of domestic *Cucurbita* sp. growing in a waste place along a roadside at Portachuelo (ca. 17° 20′ S., 63° 23′ W., 289 m.) in the Department of Santa Cruz. At this locality, I also took a female from the entrance to a burrow among the vines of the host plant. On December 18, I collected ten males and one female from closed and closing blossoms of domestic *Cucurbita* sp. growing in a garden at Quillacollo (ca. 17° 26′ S., 66° 16′ W., 2,536 m.) in the Department of Cochabamba. These records are of interest because they are the first records of *Peponapis fervens* from definite localities in Bolivia and are the first records of any species of *Peponapis* from the drainage of the Amazon 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. The author thanks Richard B. Selander, University of Illinois, for his generous support of the author's fieldwork in South America and for his company on the trip. Thanks are also due to Wallace E. LaBerge, Illinois Natural History Survey, for verification of the determinations of the bees.

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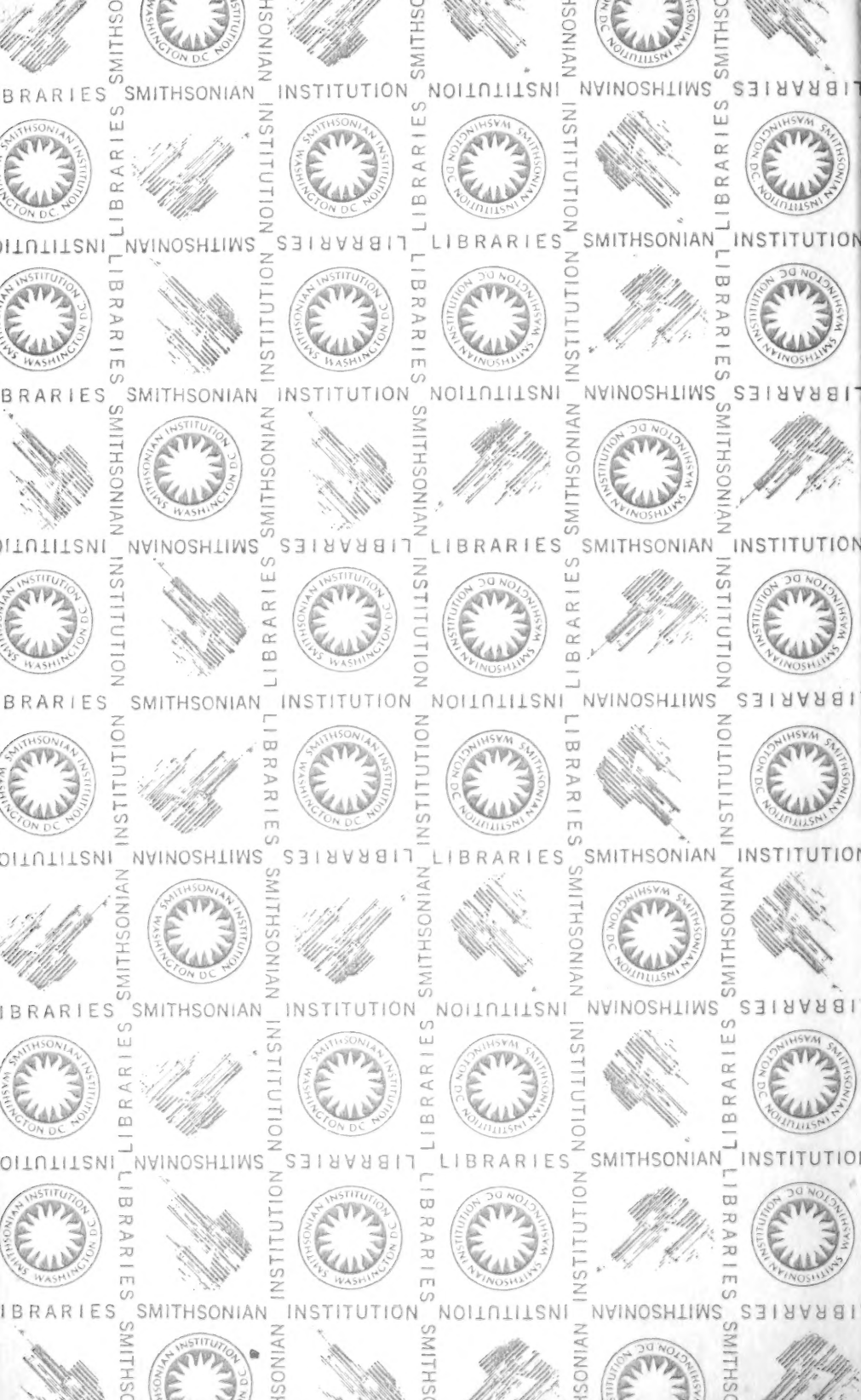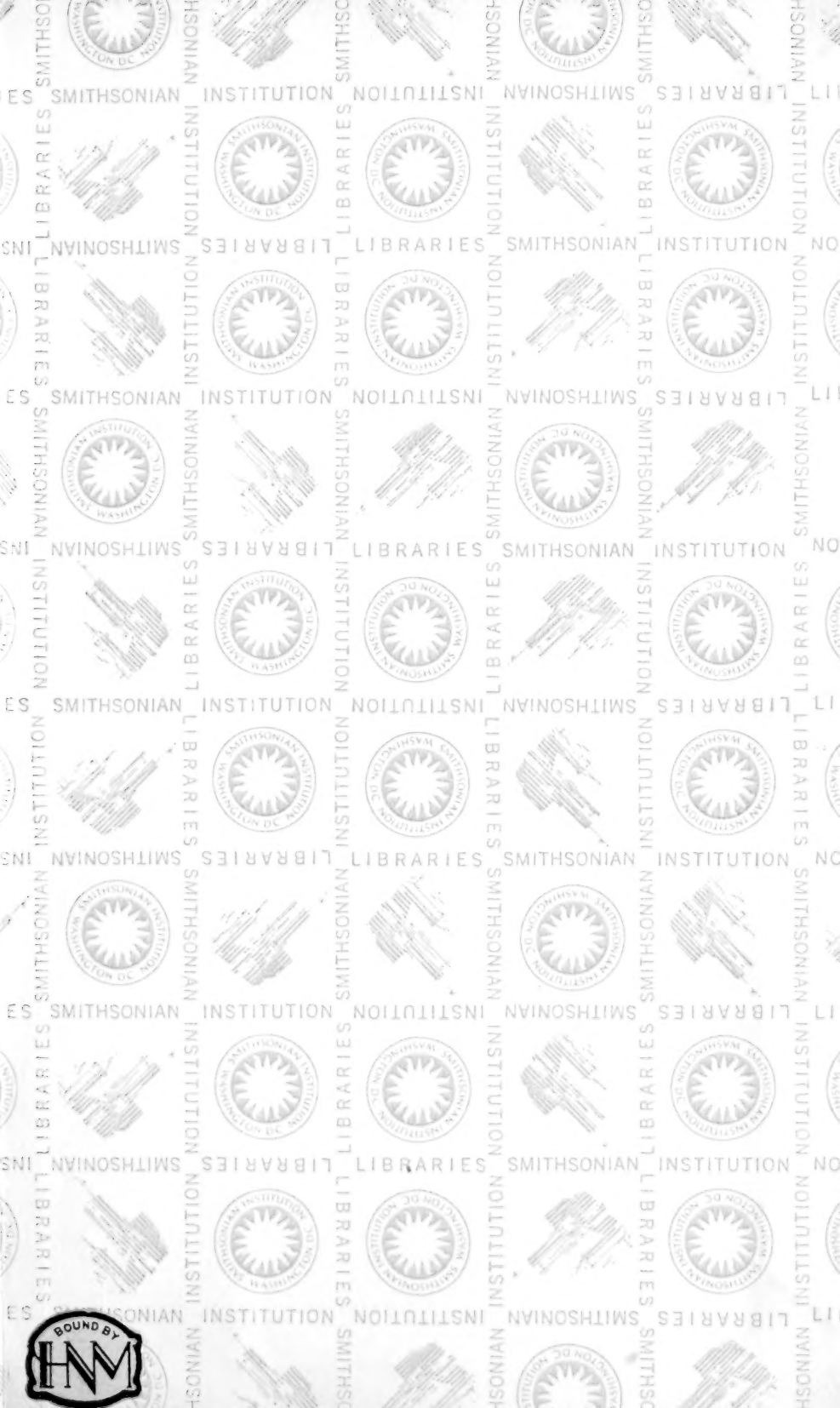
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